US Army Counter-Unmanned Aerial Systems: More Doctrine Needed

A Monograph

by

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This monograph asks if current US Army Counter-Unmanned Aerial Systems (C-UAS) doctrine enables operational commanders to deliver fires and preserve freedom of maneuver and action. This monograph argues that the US Army needs to create new operational doctrine addressing both detection and defense. Additionally, the employment and organization of these assets within US Army units need authoritative guidance. Recent state and non-state conflicts have demonstrated the need for focused doctrine incorporating new technology and emerging considerations for Rules of Engagement. Using the examples of the Islamic State in Iraq and Greater Syria attacks in Iraq, and the Russo-Ukraine War Zelenopillya rocket attack in the War in Donbas, this monograph highlights shortcomings in current US Army C-UAS doctrine. In order to address these shortcomings, the monograph recommends that the US Army update its C-UAS Army Training Manual, and create a C-UAS Army Doctrinal Publication, Army Doctrinal Reference Publication, and Field Manual. This new doctrine should frame C-UAS methods around the fundamental principles of detection and defensive systems, and include a discussion of how ROE may constrain operations.

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Abstract

US Army Counter-Unmanned Aerial Systems: More Doctrine Needed, by MAJ Jason M. Kowrach, US Army, 41 pages.

This monograph asks if current US Army Counter-Unmanned Aerial Systems (C-UAS) doctrine enables operational commanders to deliver fires and preserve freedom of maneuver and action. This monograph argues that the US Army needs to create new operational doctrine addressing both detection and defense. Additionally, the employment and organization of these assets within US Army units need authoritative guidance. Recent state and non-state conflicts have demonstrated the need for focused doctrine incorporating new technology and emerging considerations for Rules of Engagement. Using the examples of the Islamic State in Iraq and Greater Syria attacks in Iraq, and the Russo-Ukraine War Zelenopillya rocket attack in the War in Donbas, this monograph highlights shortcomings in current US Army C-UAS doctrine. In order to address these shortcomings, the monograph recommends that the US Army update its C-UAS Army Training Manual, and create a C-UAS Army Doctrinal Publication, Army Doctrinal Reference Publication, and Field Manual. This new doctrine should frame C-UAS methods around the fundamental principles of detection and defensive systems, and include a discussion of how ROE may constrain operations. By developing this doctrine, the Army will provide clear guidance to commanders, enabling them to more effectively execute C-UAS missions.

Contents

Acronyms

ADP Army Doctrinal Publication

ADRP Army Doctrinal Reference Publication

ATP Army Techniques Publication

C-UAS Counter-Unmanned Aerial System

FM Field Manual

ISIS Islamic State in Iraq and Greater Syria

ROE Rules of Engagement

UA Unmanned Aircraft

UAS Unmanned Aerial System

UAV Unmanned Aerial Vehicle

VBIED Vehicle Born Improvised Explosive Device

Illustrations

Introduction

According to John Leicester's article, "Drones 'A Huge Game Changer' For Aviation," the most significant shift in aviation technology during the last fifteen years has been the development and spread of Unmanned Aerial Systems (UASs).[1] The technology proliferation of UAS to civilian global markets has expanded the threat of adversarial Unmanned Aircraft (UA) able to target the US Army. Despite the increasing presence and danger of this type of threat, US Army doctrine is extremely limited and inadequate in describing ways to meet the current UAS threat. Further, current doctrine does not facilitate any discussion on how Rules of Engagement (ROE) in state and non-state conflicts might affect the employment of C-UAS.

Commanders need to organize and employ Counter-Unmanned Aerial Systems (C-UAS), but lack sufficient doctrinal guidance on how to do so. Despite the recognition of a threat by senior Army leaders, current field commanders have insufficient doctrine when fighting either state actors or non-state actors.[2] Contemporary US Army C-UAS doctrine does not give commanders proper guidance on how to organize and employ US Army C-UAS to meet adversarial UA in the next crisis. To date, the US Army has released one unclassified doctrinal publication addressing C-UAS.[3] This doctrinal publication only focuses on training and educating the force at the tactical level. Doctrinally, theater commanders are required to establish security, yet doctrine does not adequately address adversarial UA, which directly threatens the security of

[1] John Leicester, "Drones 'A Huge Game Changer' For Aviation," *USA Today*, June 20, 2017, accessed December 9, 2017, https://www.usatoday.com/story/travel/flights/2017/06/20/drones-a-huge-game-changer-aviation-evidenced-drones-all-shapes-and-sizes-showcased-paris-air-show/412207001.

[2] Patrick Tucker, "US Army Chief Announces Major Reorganization For How Army Develops Weapons," *Defense One*, October 6, 2017, accessed March 30, 2017, http://www.defenseone.com/technology/2017/10/feeling-rivals-heat-us-army-streamlining-and-centralizing-way-it-buys-weapons/141603.

[3] US Department of the Army, Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System Techniques* (Washington, DC: Government Printing Office, April 2017).

the theater.[4] This monograph argues that the combination of minimal current doctrine, rapidly emerging technology, and potentially changing ROE have created the need for additional doctrine within the US Army's use of C-UAS. Outside of doctrine, much has been written on various aspects of this topic; sources include military journals and magazines, US Army Training and Doctrine Command Pamphlet Publications, and multiple research studies. These resources provide ideas for the way forward that this paper will expand on. This research focuses on the doctrinal integration needed to combat the near term (five to ten-year) UAS threat.[5] This monograph argues that the Army needs to provide more precise thought on how to organize C-UAS and how to employ C-UAS assets. Specifically, detection and defense need to become the foundational principles for future doctrine. These two principles of C-UAS already exist. Detection against UA belongs at the small unit level.[6] Defense against UA belongs above the small unit level to prepare for the next crisis.[7] However, US Army C-UAS doctrine fails to provide sufficient guidance to commanders because it does not frame employment regarding detection and defensive systems, or explain how to organize C-UAS units. Doctrinal guidance on organization and employment of C-UAS units should also facilitate a broad range of ROE, which will vary depending on the conflict.

Methodology

The monograph starts by reviewing current literature about C-UAS. This literature includes the Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System Techniques*, which is the sole US Army unclassified doctrine for training and educating the force

[4] US Department of Defense, Joint Staff, Joint Publication (JP) 3-10, *Joint Security Operations in Theater* (Washington, DC: Government Printing Office, 2014), II-1.

[5] US Department of the Army, United States Army Counter - *Unmanned Aircraft System (C-UAS) Strategy Extract* (Washington, DC: Government Printing Office, 2016), 8.

[6] Ibid., 9.

[7] Ibid., 11.

in this field.[8] Non-doctrinal publications also reviewed, include the *Counter-Unmanned Aircraft System Strategy Extract of October 5, 2016*, which provides the current US Army intellectual framework for the C-UAS threat.[9] Data on UASs comes from academic research articles, as well as numerous military journal articles.

Following the review of current doctrine and research, the monograph first examines emerging technology, noting how the proliferation of UAS has spread to the point where UAs are a common threat on the modern battlefield. UAS technology keeps becoming more sophisticated, and adversaries are taking advantage of these advances. Next, this paper looks at the concept of ROE, and argues that the laws governing UASs domestically in the US will likely affect risk aversion calculations for policymakers, who determine what the US military's ROE will be in conflicts overseas. While ROE vary by conflict, detection and defense are two areas of C-UAS measures that may be affected by ROE, and how ROE could affect these measures is also something that doctrine could discuss.

Based on this literature, this monograph's thesis is that doctrine needs to give commanders adequate guidance on the fundamental principles of detection and defensive systems which are usable within a conflict's specific ROE. This monograph proposes the creation of a full series of C-UAS doctrinal manuals. Then, moving to an analysis of the current environment, this monograph will identify changes in contemporary military operations, based on events occurring in Iraq and Ukraine. The recent crises in Iraq and Ukraine offer insight into the increased role UASs will play during the next conflict. This increase in UASs on the battlefield demonstrates the growing threat that Army forces will face.[10]

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[8] US Army, ATP 3-01.81, (2017), 1.

[9] US Army, US Army UAS Roadmap 2010-2035, *US Army C-UAS Strategy Extract* (2014), 1.

[10] Charlie Savage, "ISIS Displaying a Deft Command of Varied Media," *New York Times*, May 23, 2017, accessed December 12, 2017, https://nyti.ms/2qTjQ5c.

This paper will evaluate two focus areas in the case studies, detection and defense, to see how C-UAS doctrine can respond to the increasing use of UASs on the battlefield. Detection requires that the US Army forces be able to identify friend from foe promptly so that defensive action can be taken to disable or destroy enemy UASs. Both detection and defense are influenced by the larger circumstances surrounding the conflict, which affects the ROE for C-UAS operations. These case studies provide a context to discuss how additional C-UAS doctrine could better support operations and help commanders win against state and non-state actors.

Definitions

Understanding any field of study, especially one like UASs, that has a rapidly changing vernacular due to its quickly evolving technological development, requires a clear vocabulary. Whenever possible, current Army doctrine is used to provide the necessary foundational definitions.[11] Army doctrine provides "fundamental principles… used for the conduct of operations… that directly support operations. It is authoritative but requires judgment in application."[12]

ADRP 1-02 defines Unmanned Aircraft as "an aircraft that does not carry a human operator and is capable of flight with or without human remote control."[13] However, an unmanned aircraft is not necessarily autonomous. Ruth David and Paul Nielson, study chairs for the Defense Science Board Summer Study on Autonomy, define autonomy as "a system [that]

[11] Walter Kretchik, *US Army Doctrine: From the American Revolution to the War on Terror*, (Lawrenc: University Press of Kansas, 2012), 5. Doctrine is authoritative in nature giving commanders and planners purpose and effect. Walter E Kretchik,. a historian in military affairs, distinguishes doctrine "by two characteristics. The first is approval by an authority, typically the government. The second is that the approving authority mandates its use by all the armed forces or by a particular service." In this case the US Army is the approving authority for all Army doctrine. Commanders need doctrine to provide purpose and effect within units ensuring that they are following the US Army's guidance.

[12] Dale Hayden, "The Search for Space Doctrine's War-Fighting Icon." *Air & Space Power Journal* 28, no. 6, Air Force Research Institute: 55; US Department of the Army, *Army Doctrine Reference Publication Np. 1-02. Terms and Military Symbols* (Washington, DC: Government Printing Office, November 16, 2016), 1-6.

[13] US Army, ADRP 1-02 (2016), 1-100.

must have the capability to independently compose and select among different courses of action to accomplish goals based on its knowledge and understanding of the world, itself, and the situation."[14]

This paper assumes that most UASs will require some human command, despite the UA itself not carrying a human operator. Fully autonomous UA, both in the military and civilian markets will not exist on a large scale in the next five years.[15] Therefore, this paper will focus on semi-autonomous systems that still require remote human control. For this reason, the paper uses the Department of Defense definition for UA System, an airframe that requires a "system whose components include the necessary equipment, network, and personnel to control an Unmanned Aircraft."[16]

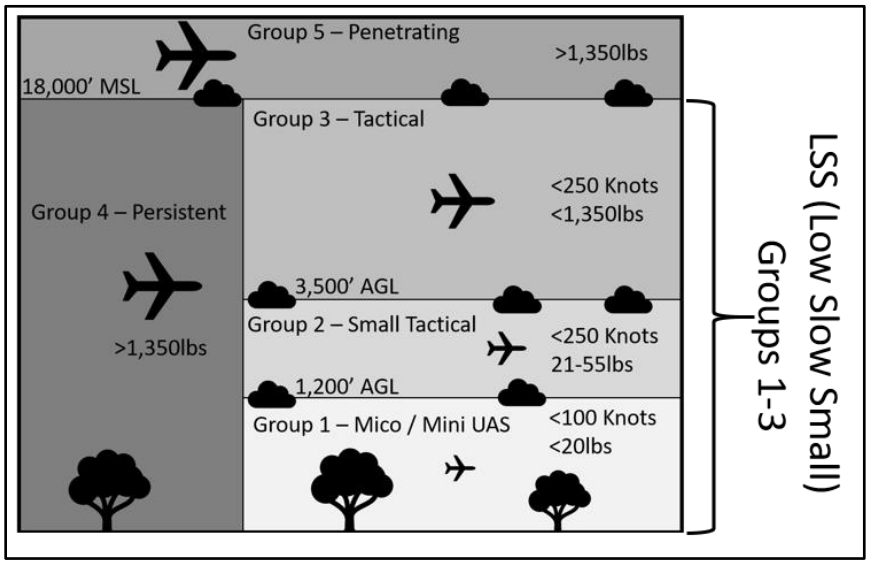

Figure 1. Data adapted from US Department of the Army, Army Techniques Publication (ATP) 3-01.81, *Counter-Unmanned Aircraft System Techniques*, Figure 1-1. LSS UAS Threat Categories (Washington, DC: Government Printing Office, April 2017), 1-2.

[14] Ruth A David and Paul Nielsen, "Defense Science Board Summer Study On Autonomy," *Defense Science Board*, Washington DC: United States, 2016, 4.

[15] David Martin, "New Generation of Drones Set to Revolutionize Warfare," *CBS News*, August 20, 2017, accessed December 5, 2017, https://www.cbsnews.com/news/60-minutes-autonomous-drones-set-to-revolutionize-military-technology-2.

[16] US Army, ADRP 1-02 (2016), 1-100.

Figure 1, above, provides a graphical definition of UAS groups, based on classifications in ATP 3-01.81. Each group diferientiates from the other by weight (Pounds (lbs)), speed (Nautical Miles (Knots)), and typical operating altitudes (Above Ground Level (AGL)). Groups four and five, penetrating missions and persistent missions, behave like traditional manned aircraft, meaning the same theories and doctrine applied to traditional piloted air threats also apply to these groups. The Low Slow Small (LSS) UASs, defined as "slow, small, tactical-level UASs operating at relatively low altitudes" comprise groups one through three.[17] These LSS aircraft prove problematic because they can operate outside the conventional detection systems developed for larger platforms.[18]

Within the LSS sub-category, all three groups diverge from traditional aviation enough that new countermeasures doctrine may be required. Micro/Mini UASs, Small Tactical UASs, and Tactical UASs are all increasing in numbers available and potential uses by adversaries.[19] *The Economist* magazine reported that in 2015 $3.2 million in drones were sold worldwide, and predicted an upward trend to $10.2 billion in sales by 2020.[20] ATP 3-01.81 warns that, because of the indirect fire capability with these decreased detection groups, LSS constitute a significant threat.[21] With this increase in numbers, planning requires consideration of their "intelligence, surveillance, reconnaissance, and targeting capabilities."[22] Technological enhancements will continue to become more prevalent; multi-role UASs will include "electro-optical or infrared optics, radar, signals intelligence, or laser designation supporting delivery of electronic warfare,

[17] US Army, ATP 3-01.81 (2017), 1-1.

[18] Gabrie C. Birch, John C. Griffin, and Matthew K. Erdman, "UAS Detection, Classification, and Neutralization: Market Survey 2015," *Sandia National Laboratories* (2015), 3, accessed March 30, 2017, http://prod.sandia.gov/techlib/access-control.cgi/2015/156365.pdf.

[19] US Army, ATP 3-01.81 (2017), 1-1.

[20] "Taking Flight," *Economist Technology Quarterly* (August 2017): 35, accessed October 30, 2017, http://www.economist.com/technology-quarterly/2017-06-08/civilian-drones.

[21] US Army, ATP 3-01.81 (2017), 1-1.

[22] Ibid., 2.

air-to-surface weapons, or one-way lethal payloads."[23] This definition from ATP 3-01.81 describes a high-risk threat capable of performing a suite of operations while maintaining a low detection profile. This definition identifies the need to plan for multiple contingencies, but there is little in existing doctrine to help with that planning.

Generally speaking, all efforts taken to mitigate against the threat posed to militaries by UAS fall under the general term of C-UAS. C-UAS defends Army personnel and infrastructure from UA surveillance, targeting, and attack. J.R. Wilson, a military aerospace writer, defines C-UAS as the "capability to defend US and allied forces and critical infrastructure from enemy Unmanned Aerial Vehicle surveillance, electronic warfare, and conventional attack."[24] The Army can attempt to counter the UAS threat in many different ways; however, ultimately all countermeasures should reduce the enemy's UAS advantage on the battlefield.

C-UAS methods fall into two broad categories, detection and defense. Detection is the ability to successfully acquire and positively identify a system as friend or foe. Systems that detect low flying platforms will often do so only at such close ranges that reaction time becomes a defensive issue.[25] Defending means the ability to successfully engage the UAS before harm can come to friendly assets.[26] Both detection and defense are essential missions under the umbrella of C-UAS.

A small unit is typically a company size or below component capable of delivering fires to defeat the enemy while preserving freedom of maneuver and action. A higher than small unit has the additional capacity to sequence fires and maneuver to defeat a UAS across the range of

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[23] US Army, ATP 3-01.81 (2017), 2.

[24] J.R. Wilson, "The Proliferation Of Relatively Inexpensive Unmanned Aerial Vehicles (UAVs)," *Military Aerospace* 27, No. 11 (2016): 1.

[25] Van Jackson, "Kim Jong Un's Tin Can Air Force," *Foreign Policy Magazine* 11, No. 12 (November 2014): 1, accessed December 5, 2017, http://foreignpolicy.com/2014/11/12/kim-jong-uns-tin-can-air-force; US Army, ATP 3-01.81 (2017), 1-2.

[26] US Army, ATP 3-01.81 (2017), A-3.

military operations; larger units have greater capability and can carry out more complex tasks.[27] Doctrine needs to incorporate this distinction to ensure employment of detection and defensive systems at the right level.

Assumptions and Limitations

Just as aircraft use multiplied on the battlefield following the first widespread use in World War I, as militaries sought to develop the new technology to gain an advantage over the adversary, this paper assumes that the current arms race over the military use of UASs will continue.[28] Non-state actors and state actors will continue to expand military UAS applications and employment.[29] This increased number of UAS on the battlefield constitutes a shift in how military planners must prepare for operations; for the US military, which is currently accustomed to air superiority, adjusting to such a change in the battlefield environment is critical.

Regarding limitations, this paper does not cover every aspect of UASs or actions to counter UA on the battlefield. It does not attempt to predict the future of C-UAS technology. Instead, this paper focuses on current UAS doctrine, analyzes it against current threats and future C-UAS technology, and argues for an expansion of doctrine to better guide commanders in dealing with this threat.

Literature Review

In December 2016, Congress passed the *National Defense Authorization Act of 2017*. The Act created a new section on UA in Title 10 of the United States Code. It also directed the Secretary of Defense to submit a report to Congress on the potential for cooperative development

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[27] Van Jackson, “Kim Jong Un’s Tin Can Air Force,” 1-34.

[28] “Viewpoint: How WWI Changed Aviation Forever,” *BBC News*, November 20, 2014, accessed March 30, 2017, http://www.bbc.com/news/magazine-29612707.

[29] Michael J. Boyle, "The race for drones," *Orbis* 59, No. 1 (2015): 76-94, accessed March 30, 2018, https://www.files.ethz.ch/isn/187861/boyle_on_drones.pdf.

to defeat UASs that threaten deployed forces of the United States.[30] With this Congressional emphasis on UASs, and the growing use of adversarial UA on the current battlefield, the US Army owes its commanders guidance on C-UAS measures.

To understand what guidance is necessary, this monograph first details current research, military guidance, and doctrine on countering strategies. Then, it looks at the current threat UA technologies pose. Finally, it examines international and domestic issues that are likely to affect the ROE for C-UAS operations in any future conflict.

Doctrine

The *UAS RoadMap 2010* provided analysis in "the direction of UASs development to defeat peer threats in the 2030+ battlespace."[31] This roadmap calls for emerging doctrine of Brigade Combat Teams to shift from considering UAS as a simple tool for overhead observation to considering UAS as a full team member integrated into formations.[32] However, the concerns and analysis raised by this article have not translated into doctrine, even following the emergence of UASs on the battlefield.

With only one US Army ATP published, little guidance exists in the form of current C-UAS doctrine. The Army has also published a short strategy extract, which calls for a focus on detection and defense as two aspects of C-UAS, but does not go into detail as to how to implement those concepts. ATP 3-01.81 and *US Army C-UAS Strategy Extract*, while offering useful information, are too limited in scope to provide adequate guidance to commanders.

The US Army's only C-UAS doctrinal publication, ATP 3-01.81, *Counter-Unmanned Aircraft System* provides "planning considerations for defending against LSS unmanned air

[30] National Defense Authorization Act of 2017, Senate - Armed Services. 114th Cong., Senate Bill 2943, accessed November 1, 2017, https://www.congress.gov/bill/114th-congress/senate-bill/2943/text.

[31] US Army, US Army UAS Roadmap 2010-2035 (2014).

[32] Ibid., 47.

threats during operations."[33] ATP 3-01.81 indicates the US Army's desire to maintain a C-UAS capability within current operations.[34] To do this, the manual identifies a required level of integration of C-UAS tasks with other unit tasks.[35] This publication also "provides guidance on how to plan for, and incorporate, C-UAS soldier tasks into unit training events."[36] By offering planning guidance to brigade and below level forces, this publication gives commanders tactical threat estimates "to include the smaller unmanned aircraft system platforms."[37] While this doctrine provides some essential tactical techniques for C-UAS, it does not provide the broader guidance for employment and organization against LSS.

US Army C-UAS Strategy Extract 2016 suggests a comprehensive three-part approach with four lines of effort. The three-part approach includes the actions of pursuing joint combined arms solutions, integrating capabilities across all domains, and adopting a whole-of-government approach. To achieve this tripartite approach, the four lines of effort for success are mission command, detection, identification, and defeat.[38] Existing C-UAS capabilities require a comprehensive approach facilitated by an Army-wide assessment across all domains.[39] This strategy identifies two elements, detection and defeat, that must respond to the changing UASs capability for mission success. However, this strategy extract does not provide operational guidance on how to support these lines of effort.

The two other lines of effort, mission command and identification, have essential roles in C-UAS. Army Doctrinal Publication (ADP), *6-0, Mission Command* already provides the clear

[33] US Army, ATP 3-01.81 (2017), iii.

[34] Ibid., 1.

[35] Ibid., 1-5.

[36] Ibid.

[37] Ibid.

[38] US Army, US Army UAS Roadmap 2010-2035 (2014), 7-8.

[39] Ibid., 7-13.

principles and function to commanders and does not require further revision.[40] Identification of LSS as friend or foe belongs under detection as a critical element to enabling defensive C-UASs.

A 2015 article titled, *Countering the Unmanned Aircraft Systems Threat,* by US Air Force Colonel Mattew Tedesco emphasizes the fundamental principles of detection and defense. He argues that militaries who fail to examine "ways to defend against the use of UA Systems are not preparing adequately for the next war."[41] Of the six recommendations Colonel Tedesco provides, the second addresses "the challenge of detection and identification to improve defeat."[42] Colonel Tedesco identifies detection and defense as interconnected elements. It is hard to defend against an adversarial UAS without detecting it, and vice versa. Army doctrine does discuss detection and defense. ATP 3-01.81 calls for the small unit to "identify Soldiers to act as observers (air guard) throughout all phases of the operation."[43] This manual follows the 1999 Field Manual 44-8 passive and active air defense techniques verbiage, originally created for identifying Soviet-style fighter and bomber jets. However, the effectiveness of placing an individual on guard duty to spot LSS UASs seems a wasteful—if not impracticable—allocation of resources. In an Army constrained by both funding and personnel available, the need to automate or efficiently allocate resources is essential. Resourcing twenty-four-hour sector guards on the watch for LSS UASs severely drains personnel strength from a small unit. At times this may be necessary, but this procedure should not constitute the standard doctrinal approach, especially as electronic detection systems may perform better than human ones.

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[40] US Department of the Army, Army Doctrinal Publication (ADP) 6-0, *Mission Command* (Washington, DC: Government Printing Office, September 2012), iv.

[41] Matthew T. Tedesco, Colonel USA, "Countering the Unmanned Aircraft System Threat," *Military Review* (November-December 2015): 64.

[42] Ibid.

[43] US Army, ATP 3-01.81 (2017), 4-1.

ATP 3-01.81 also calls on small units to defend against detection or observation from these LSS UASs. It describes how units must first avoid detection and observation from LSS UASs and then defeat them by using organic means.[44] For defense, the military can target UASs through kinetic and non-kinetic means.[45] Some non-kinetic methods include electronic warfare, microwave attacks, or cyber-attacks.[46] Kinetic methods include rockets, missiles, and explosives. Typically, the organic means available for these tasks refers to using "small arms fires organic to the unit while simultaneously relocating the unit."[47] This publication warns if detection has occurred, position security has been compromised.[48]

This guidance is sound at face value, but without adequate detection and defense doctrine how can a commander mitigate the threat? The UAS problem requires discrimination between the fundamental principles of detection and defense. By differentiating, US Army doctrine can guide commanders employment of "either electronic or kinetic mitigation, depending on the area of operations, and rules of engagement."[49] Additional doctrinal guidance should include explaining how a commander should position mobile detection assets versus fixed detection systems, whether human or electronically automated. Moreover, doctrine should analyze what size units should bear responsibility for detection, and for defense. Also, guidance on further employment and organization could provide more useful C-UAS implementation against LSS UASs within the larger operational plan.

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[44] US Army, ATP 3-01.81 (2017), 4-1.

[45] US Army, US Army UAS Roadmap 2010-2035 (2014), 83.

[46] US Army, ATP 3-01.81 (2017), 1-2.

[47] Ibid.

[48] Ibid.

[49] J.R. Wilson, "The Dawn Of Counter-drone Technologies" *Military Aerospace* 27, no. 11 (2016): 1, accessed March 30, 2018, http://www.militaryaerospace.com/articles/print/volume-27/issue-11/special-report/the-dawn-of-counter-drone-technologies.html.

In sum, current Army doctrine for C-UASs lacks operational guidance for commanders to successfully implement the techniques correctly laid out in ATP 3-01.81.[50] The vision and strategy extracts are not authoritative, leaving a gap in doctrine. Current doctrinal publications do not provide operational level C-UAS organization or employment guidance. Therefore, this paper argues that the US Army needs to create additional operational doctrine addressing the employment of detection and defensive assets. Additionally, the organizational placement and size of these assets within US Army units needs authoritative guidance.

Technology

The proliferation of UASs on the battlefield has not shown any signs of slowing. Technological advancements in UASs continue to promote the development of both reconnaissance and attack capabilities. This maturing represents a significant threat to Army operations from both state and non-state actors. According to the ATP 3-01.81 of 2017, "this problem can escalate as UAS technologies become less expensive and more capable, accessible, and adaptable" because of the overwhelming effects of massing UASs on the battlefield.[51]

The number of violent non-state actors with UAS capability is unknown, but approximately seventy states currently have weaponized UASs.[52] Marine Corps Lieutenant General Vincent R. Stewart, director of the Defense Intelligence Agency, highlighted the seriousness of this growing threat. Testifying before the Senate Armed Services Committee in

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[50] US Army, ATP 3-01.81 (2017), iv.

[51] Ibid., 1-1.

[52] Peter Bergen, David Sterman, Alyssa Sims, Albert Ford, and Christopher Mellon, "Who Has What: Countries with Armed Drones," *New America*, accessed October 30, 2017, https://www.newamerica.org/in-depth/world-of-drones/3-who-has-what-countries-armed-drones; "Drones by country: who has all the UAVs," *The Gaurdian*, August 3, 2012, accessed October 30, 2017, https://www.theguardian.com/news/datablog/2012/aug/03/drone-stocks-by-country; "The Drones of War: Pakistan strikes highlight the Increasing Use of Remotely Piloted Aircraft," *IISS*, Volume 2009, Edition 4, May, accessed October 30, 2017, http://www.iiss.org/en/publications/strategic%20comments/sections/2009-12ef/the-drones-of-war-436b. Depending on the report there is a variation in the number of countries with weaponized drones.

May 2017 he said, “in the past year, [non-state actors] use of UASs for surveillance and delivery of explosives has increased, posing a new threat to civilian infrastructure and military installations."[53] Non-state actors will likely continue to exploit the multiple roles that UA provide. In Michael C. Horowitz, Sarah E. Kreps, and Matthew Fuhrmann’s article, “Separating Fact From Fiction in the Debate Over Drone Proliferation,” they highlight the reasons for non-state actors’ uses of UA.[54] The two reasons they highlight for non-state use of LSS UA are providing the same accuracy as suicide bombings, and the psychological terror of undetected attacks at any time and any place.[55] This evolving threat requires a hard look at the adequacy of operational doctrine currently available to commanders.

The US Army identified the need to train against the UAS threat as early as 2002, evidenced by the creation and continuation of the annual exercise, Black Dart.[56] During this exercise, the US Army conducts counter UA live fly and fire, bringing together commercial and military professionals with the mission of developing C-UAS technologies. One of the commercial professionals, Grant Jordon, remarked that, “the biggest surprise to military folks was how difficult it was to combat small drones.”[57] This drone defense and airspace control solution expert emphasizes that the “assumptions of traditional air defense are all wrong” when the targets

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[53] Robert Windrem, “US Fears New Threat From ISIS Drones,” *NBC News*, May 24, 2017, accessed November 28, 2017, https://www.nbcnews.com/storyline/isis-terror/u-s-fears-new-threat-isis-drones-n764246, 1.

[54] Michael C. Horowitz, Sarah E. Kreps, and Matthew Fuhrmann, “Separating Fact From Fiction in the Debate Over Drone Proliferation,” *The MIT Press Journals*, 41, No. 21 (Fall 2016): 8, accessed November 28, 2017, http://www.mitpressjournals.org/doi/pdf/10.1162/ISEC_a_00257, 34-35.

[55] Ibid., 1.

[56] Allyson Versprille, “Military Tests Anti-Drone Weapons at Black Dart,” *National Defense Magazine* (August 2015), accessed March 30, 2017, http://www.nationaldefensemagazine.org/articles/2015/8/1/military-tests-antidrone-weapons-at-black-dart.

[57] “Taking Flight,” 35.

are LSS.[58] The problem is not only changing current assumptions, but also that changes within UA airframes are not slowing, as engineers discover and develop more uses for LSS aircraft.

The proliferation of commercial UASs is giving less-technologically inclined adversaries the ability to conduct sophisticated information collection and reconnaissance on Allied forces; this is a threat that doctrine must address. For example, *CNN* reports that Hamas has engineered three distinct types of drones for surveillance, armed, and suicide missions. Suicide missions entail self destruction of the UA when it flys into the target, while UA on armed missions drop an explosive and return to the operator for additional missions. Isreal percieves these drones to be enough of a threat that they shot one down in July 2014.[59] In another example, in August 2014, Islamic State in Iraq and Greater Syria (ISIS) released footage from a drone showing a UA undertaking a suicide bombing attack.[60]

Non-state actors and adversarial states already have systems that allow robust surveillance through the use of still photos and streaming video. The US should assume that LSS UASs can "provide at least rough global positioning system locations of ground targets, sufficient for area targeting."[61] Technological improvements in all UAS groups continue to provide higher payloads, thus increasing range, armament, and surveillance options. Given the diversity of actors who currently have UAS, it is likely that the next crisis will see a higher number of UASs performing both reconnaissance and attack missions.

In the face of the current and emerging UAS technology, senior Army officers have concerns about LSS UASs currently employed at the operational level.[62] According to J.R.

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[58] "Taking Flight," 35.

[59] Bergen and Schnelder, "Now ISIS has drones?" 1.

[60] Ibid.

[61] US Army, ATP 3-01.81 (2017), 1-6.

[62] Ibid. This definition encompasses Unmanned Aerial Vehicles as a synonymous term to UAS.

Wilson, these leaders do not believe the US Army has adequate detection or defensive doctrine.[63] Given the increasing pace of technological change and adversarial adaptation, it is critical that the US Army can guide commanders by employment of "either electronic or kinetic mitigation, depending on the area of operations, and rules of engagement."[64]

Rules of Engagement

On October 28, 2016, the US Department of State, in conjunction with fifty-two other states, issued a Joint Declaration to limit the proliferation of armed or strike-enabled Unmanned Aerial Systems.[65] This declaration shows an effort to slow the growing proliferation of a potentially malicious capability in future conflicts. Within the measures outlined in this document, the US acknowledges the rapid development of UASs and the need to apply the international law of armed conflict and human rights law.[66]

While the law of armed conflict governs the ethical behavior in all conflicts, rules of engagement focus on additional, specific limitations that address more political concerns. ROE provide the constraints for US military action in every crisis.[67] These rules strive to ensure that the US Army will not escalate a situation beyond the political aim of the intended conflict. ROE seek to mitigate risk for the politician by limiting the commander's actions during conflict. For the Army, these regulations provide authority when operating outside the US.

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[63] J.R. Wilson, "The Proliferation of Relatively Inexpensive Unmanned Aerial Vehicles (UAVs) That Can Carry Spy Cameras or Powerful Explosives Gives a Sense of Urgency To Protecting Airports, Power Plants, Prisons, and Military Bases From The Drone Threat," 11.

[64] Ibid., 1.

[65] US Department of State, "Joint Declaration for the Export and Subsequent Use of Armed or Strike-Enabled Unmanned Aerial Vehicles (UAVs)," Office of the Spokesperson Washington DC 2016, Doc. 262811, 2016, 1, accessed September 21, 2017, 1, https://2009-2017.state.gov/r/pa/prs/ps/2016/10/262811.htm.

[66] Ibid.

[67] US Department of Defense, Joint Staff, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 2017), I-7.

The trend in the US is towards more aggressive C-UAS measures, as the threat these UAs pose becomes more well-known. The trend can be seen in recent policies by the President and Congress. According to Charlie Savage of the *New York Times*, the Trump administration requested sweeping powers to "track, hack, and destroy" LSS UASs domestically.[68] It warned that LSS UASs are currently challenging detection and defensive capabilities, as advancements in harmful payloads and surveillance evade "traditional ground security measures."[69] Congress is also interested in C-UAS. The Federal Aviation Administration in Section 2206 of the *Federal Aviation Administration Extension Safety and Security Act of 2016* "established a pilot program for airspace hazard mitigation at airports and other critical infrastructure using unmanned aircraft detection systems."[70] The Federal Aviation Administration initiated a pathfinder program with select companies to test detection technology at airports. Based on these policies, it appears that the ROE for C-UAS activities might be less constrained in the future. However, the current ROE for the US military, imposed before drone technology existed, does restrict operations.[71] In the case where the ROE require US forces to be fired upon before returning fires, soldiers are potentially put at unnecessary risk by UASs.

ROE will vary depending on the circumstances of a given conflict.[72] Therefore, this monograph does not try to forecast what specific ROE for C-UAS will be. Instead, it tries to analyze what likely issues might arise, given general categories of C-UAS. If commanders can

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[68] Charlie Savage, "Proposed Rules Would Allow US to Track and Destroy Drones," *New York Times*, May 23, 2017, accessed December 12, 2017, https://www.nytimes.com/2017/05/23/us/politics/drone-surveillance-policy.html.

[69] Ibid., 1.

[70] Jonathan Rupprecht, "Drone Jammer Gun Defender Legal Problems," J, *Rupprecht Law*, August 1, 2917, acceseed on August 26, 2017, https://jrupprechtlaw.com/drone-jammer-gun-defender-legal-problems.

[71] Ibid., 2.

[72] US Marine Corps, *Law of War/Introduction To Rules of Engagement* (Camp Barrett, VA: Government Printing Office, 2017), 14.

understand how the ROE will affect the principles of detection and defensive C-UAS, they can better understand what the requirements are, and how best to organize and employ their force.

Traditionally, ROE allows for more extensive uses of detectors. In general, UAS detectors do not legally complicate military operations. Detectors are passive in that they only identify the presence of a UAS and whether that UA is a friend or foe.[73] This detection and identification mission is comparable to what traditional radar does for group four and group five UA.[74]

Defenders, on the other hand, may have a stricter ROE. Defensive attacks, because of their overt nature, can escalate a conflict beyond the intended political aim.[75] For example, one way to defend against UAS is to target the launching site for the UAs. However, the launching site may be part of a larger military base, and the defensive attack on the launching site might be viewed by the adversary as an offensive attack on the military base.

In sum, ROE for C-UAS are likely to vary by conflict. US domestic policy can provide some insight into ways ROE might be limited. The US Army owes its commanders guidance on likely ROE that will affect C-UAS detection and defense; C-UAS doctrine should incorporate this guidance.

Summary

Today's doctrine provides some essential tactical techniques without providing the broader guidance for employment and organization against LSS. In a world where technologies are becoming increasingly less expensive and more capable, accessible, and adaptable, the need to automate or efficiently allocate resources is essential. The problems with current C-UAS

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[73] "Passive, RF-based Drone Detection," *Drone Go Home*, January 1, 2017, accessed March 30, 2017, http://www.dronegohome.tech/wp-content/uploads/DGH-Drone-Detection.pdf.

[74] Ibid.

[75] Forrest E. Morgan, Karl P. Mueller, Evan S. Medeiros, Kevin L. Pollpeter, and Roger Cliff, "Dangerous Thresholds Managing Escalation in the 21st Century," *RAND Corporation*, 2008, iii, accessed April 7, 2018, https://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG614.pdf.

doctrine come from its inability to keep up with changing technology and ROE, as well as its lack of specificity regarding the implementation of detection and defense. Doctrine discusses but does not focus on detection and defense as the fundamental principles to guide commanders. However, detection and defense measures, to include a discussion of how ROE may constrain a commander's available options, are a critical part of effective C-UAS doctrine.

Developing C-UAS Doctrine

Research continues to describe UASs as a critical change on the battlefield, but there are few if any viable solutions in the area of doctrine. Army leaders need to identify, continually monitor, and assess threats as they adapt and change over time.[76] Therefore, the Army has a requirement to provide clear guidance to commanders in regards to the emerging adversarial use of UAS.

Adversarial UAS pose several risks to a commander. First, there is the risk to personnel; adversarial UAS can identify and then directly target, or provide information to other strike assets to target friendly forces. Second, there is the risk to the mission; adversarial UAS can provide intelligence, surveillance, and reconnaissance to adversarial forces that enable them to block US forces' operational objectives. In order to mitigate these risks, this monograph argues two points. First, current doctrine does not provide sufficient guidance to commanders in addressing how to counter the UASs threat within the US Army. Second, a C-UAS doctrine organized around detection and defense, which includes a discussion of ROE considerations, would provide commanders with practical guidance on how to defeat adversarial UA from both state and non-state actors.

As described above, detection is the identification of friend from foe in time for defense. Defense is the use of kinetic or non-kinetic means to prevent harm to US Army forces or

[76] US Department of the Army, Army Doctrinal Reference Publication (ADRP) 3-0, *Operations* (Washington, DC: Government Printing Office. November 2016), 1-3.

infrastructure. Both detection and defense are critical to C-UAS. Without detection, efficiently defending against UAS is unlikely; without defensive actions, mitigating known threats becomes unattainable.

Detection is essential for C-UAS because it informs the commander what assets are operating within the operational environment. Detection is the first step in a comprehensive C-UAS strategy; without knowing what type of threat is present, or where the threat is, any efforts to defend are likely futile.

Detection considerations for doctrine should include the size of a unit tasked with detection, and a discussion of the different types of detection, including what the advantages and disadvantages of each type of detection are. This monograph argues that detection needs to occur at the small unit level. Organizing detection assets at the small unit level would provide overlapping sectors for detection of LSS UA. If doctrine included the employment of detection equipment and operations at the small unit level, then this capability would have redundancy across Battalions and Brigades, increasing the probability of timely identification of adversarial UA. Commanders will have to accept higher risk levels if the principle of detection remains at the higher unit level because of the threats posed by range and simultaneous attacks. An increase in the range of UA will expose more forces to attacks, and the threat of simultaneity will require more C-UAS to respond in case of multiple attacks.

Doctrine does not identify how to effectively organize or employ detection techniques within small units. One recommendation would have a vehicle in every small unit outfitted with electronic C-UAS detection equipment. By disseminating C-UASs detection, small units can achieve a heightened level of awareness to the overall situation. Doctrine should provide guidance on how to employ detection for static and mobile units at all unit levels. This guidance should include both personal and electronic methods, depending on the type of threat and ROE.

Current doctrine does not provide practical guidance for US forces to employ small unit detection.[77] Current doctrine calls for the spotter technique, where personnel identify incoming adversarial UAS visually. However, this type of detection is problematic with LSS UA. Because of their small size and the altitude that LSS UA operate at, the likelihood of a human spotter staring into the sky and visually detecting the platform is low. Audial detection of LSS UA is also problematic; unless the wind is blowing in the right direction, the spotter will have a hard time hearing the small motor of an LSS UA. However, spotter-based detection may be useful when no digital systems are available or when environmental conditions degrade electronic systems.

In addition to the spotter technique, this monograph argues C-UAS doctrine should also include guidance for the electronic detection. Electronic detection should begin at the small unit level, allowing independent operations under the umbrella of the higher unit's detection capability. This overlapping capability would facilitate timely identification at all unit levels.

Detection of UA alone cannot prevent or mitigate all strikes, but once detection occurs defense against UASs can begin. Defensive measures are required to remove adversarial UA from the battlefield. Doctrine states the most effective way to target a system is to disable the command and control station.[78] However, this is not always feasible. Another defensive option includes destroying or disabling the UASs themselves as they come within range of a unit. As with detection, defense considerations for doctrine should include a discussion of the proper unit size for defensive measures, and an exploration of the different types of defensive measures, both kinetic and non-kinetic, that are available. Larger units will have better capabilities to defeat the adversarial systems which enable UAS. However, the local defense against UA that are in close proximity to the battlefield should begin at the small unit level, with the ability to fix UAs with

[77] US Army, ATP 3-01.81 (2017), 1-5.

[78] Ibid., A-7.

organic C-UAS systems. The higher echelons need to be able to also employ organic defensive measures when small units are overwhelmed by the number of UAs in the local battlespace.

The specific type(s) of defense employed will depend on the ROE and available technology. Defensive systems come in many types, both kinetic and non-kinetic. Current kinetic systems use lasers, nets, or traditional munitions to capture or destroy the UA.[79] Non-kinetic systems hack the UA, overriding the device, either sending it home or forcing it to land.[80] Doctrine should facilitate an assessment of current and emerging technologies' strengths, ensuring that the right technology is provided to the appropriate size unit or organization. Once detection of a UA occurs, the appropriate weapon system should ensure that a low probability target, like an LSS UA, does not always receive a high-cost ordinance like a surface-to-air missile.[81]

Small unit defense needs to consider mobility and rapid deployment in determining which type of system to use. Current doctrine calls on units to use organic means for defeating UASs. In small units, the defensive systems can either be individual or crew served weapons. The advantage of a kinetic system is that it typically destroys the UA immediately; however, it also risks collateral damage, fratricide, or violation of ROE. Non-kinetic defensive systems maintain the integrity of the UA and are less prone to collateral damage or fratricide; however, are over-reliant on electronic systems. Different unit sizes should consider different types of defense depending on the anticipated enemy threat and the ROE.

As described above, the use of detection and defense measures, at the right organizational levels, can provide adequate protection to US forces, preserving freedom of maneuver and

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[79] Erik Schechter, "What's Really the Best the Way to Take Down a Drone?" *Popular Mechanics*, April 5, 2016, accessed April 7, 2018, https://www.popularmechanics.com/flight/drones/a20194/best-the-way-to-take-out-a-drone.

[80] Ibid.

[81] Joshua Thibeault and Phillip Karber, "Russia's New Generation Warfare," *The Potomac Foundation*, May 13, 2016, accessed October 19, 2017, http://www.thepotomacfoundation.org/russias-new-generation-warfare-2.

freedom of action across the range of military operations. However, detection and defense are not, by themselves, enough. There is a third consideration that doctrine must address: the rules of engagement.

While there will likely be conflict-specific ROE, doctrine should provide the foundational guidance for commanders to understand what topics are likely to be addressed by C-UAS ROE. Typically, UA detection systems are not controversial. Detection systems are passive and do not damage or destroy the UA, similar to the radar systems currently used in air traffic control.

However, once detection occurs, defensive actions must take into account the ROE. A C-UAS defense system is feasible only when the corresponding ROE supports effective targeting of adversarial UAS. Currently, doctrine does not differentiate between kinetic or non-kinetic defensive activities.[82] However, depending on the type of adversary and the type of conflict, future doctrine should note how ROE might differentiate between these types of defensive activities.

For example, in the case of a state actor, an adversarial UA could be a target finder that connects a firing system containing multiple artillery batteries. Identifying UA as part of a more extensive fires system means that a higher threat may be assessed by the C-UAS commander, justifying a higher level of force in response. In this scenario, a high-level kinetic response would be the firing of an anti-aircraft machine gun; this might prove useful in shooting a small UA down. However, the rounds that miss the target will travel upwards of five kilometers, potentially falling on population centers, depending on the direction and angle of fire.[83] Justifying these possible collateral damages may seem simple enough in a conventional conflict, but in a limited

[82] US Department of Defense, Joint Staff, Joint Publication (JP) 3-01, *Countering Air and Missile Threats* (Washington, DC: Government Printing Office, 2017), V-7. Active Air Missile Defense is direct, defensive action taken to destroy, nullify, or reduce the effectiveness of air and Balistic Missile threats against friendly forces and assets.

[83] "Air Defense/Anti-aircraft gun/ZPU," *Weapon Systems dot Net*, 2014, accessed November 1, 2017, http://weaponsystems.net/weaponsystem/EE02%20-%20ZPU.html.

conflict, or one fought against non-state actors, the potential for civilian casualties could be an unacceptable risk.

Commanders need to have guidance to consider this type of ROE issue before approving defensive measures. This discussion of ROE could fall under the topic of defense. If doctrine were updated to address this issue, then commanders could combine guidance from doctrine with the conflict-specific ROE to develop an effective operational plan.

These concepts discussed above should form the foundation of C-UAS doctrine commanders can use to apply to state or non-state conflicts within the ROE. This monograph argues that a shift within the US Army C-UAS field requires additional doctrinal publications. The revised Army C-UAS doctrine could frame employment regarding detection and defensive systems, and include discussion of C-UAS ROE considerations. Specifically, doctrine could address or explain how to organize detection and defense, depending on the type (human/electronic and kinetic/non-kinetic) and the size of the unit.

Figure 1, below, depicts the main points of context, fundamental principles, and guidance areas recommended for doctrine to deal with the threat types of state or non-state actors. A C-UAS Army Doctrinal Publication (ADP), Army Doctrinal Reference Publication (ADRP), and Field Manual (FM), depicted as circled red text on figure 1, could fill this void by providing commanders details on fundamental principles. A C-UAS ATP already exists providing "planning considerations for defending against LSS unmanned air threats during operations."[84] However, ATP 3-01.81 needs to incorporate updated techniques for detection and defense against LSS because technology has advanced beyond the 1999 Field Manual (FM) 44-8 passive and active air defense techniques. The ADP, ADRP, and FM are all necessary because they provide different levels of detail based on different audiences. The ADP and ADRP provide the operational level guidance commanders need to plan and command and control operations. The

[84] US Army, ATP 3-01.81 (2017), iii.

ATP and FM manuals provide more detail at the tactical level for planning and conducting operations.

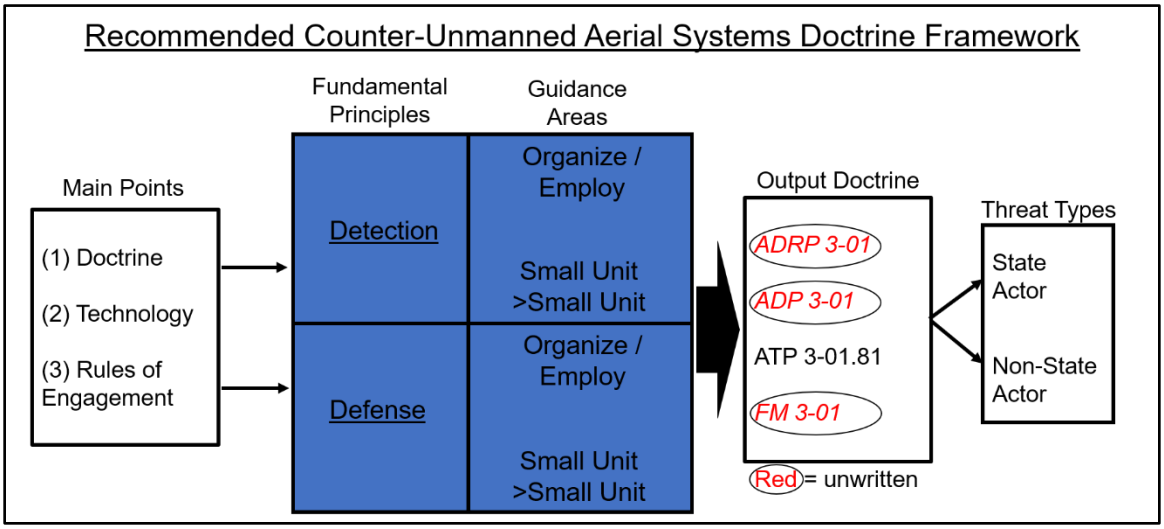

Figure 2. Created by author. Recommended Counter-Unmanned Aerial Systems Doctrine Framework.

To summarize, this monograph argues that current C-UAS doctrine should be updated, with an emphasis on detection and defense. Such doctrine should describe how to detect against UA at the small unit level in order to provide timely identification. Doctrine should also describe how to defend against UASs both at and above the small unit level. Doctrine should also include a discussion of ROE, which will assist commanders in determining how and when to employ these detection or defensive assets by small units or above small units.

Case Studies

Non-State Actor – The Islamic State in Iraq and Greater Syria attacks in Iraq

The Islamic State in Iraq and Greater Syria (ISIS) has recently employed LSS UA on the battlefield. ISIS represents one of the world's most notable non-state actors. This non-state actor has used emergent technology from its beginnings in 2004.[85] Using cell phones to detonate bombs

[85] John Tara, "Timeline: The Rise of ISIS," *Time Inc*, October 9, 2015, accessed October 30, 2017, http://time.com/4030714/isis-timeline-islamic-state.

and the internet to publish video recordings, technology has become an operating norm for this group during the last ten plus years of conflict in Iraq and Syria.[86] In 2016, ISIS conducted a short-lived, large-scale attack on the first day of the Battle of Mosul. This attack pioneered the use of armed commercial LSS UA in surprise strike attacks and suicide missions.[87] The US should not dismiss this style of attack as a disconnected anomaly, but rather expect that non-state actors will continue to perfect the techniques of LSS UASs on the battlefield. While non-state actors have used UA for several years, only recently have these actors trained pilots to perform multi-role missions.[88] The missions discussed in this case study demonstrate a concentrated effort by ISIS to leverage commercial systems for intelligence, surveillance, reconnaissance, and targeting capabilities.

During the first six months of 2017 numerous Islamic State propaganda videos surfaced glorifying the fighting in Iraq by depicting vehicle born improvised explosive devices and unmanned air attacks from the vantage point of a commercially purchased UA. Rita Katz, a terrorism analyst, published an article on May 3, 2017, referencing one of the latest videos called "The Knights of the Sectors" depicting multiple attacks.[89] During this video, an LSS UA follows a sedan laden with explosives through a city, presumed to be in Iraq.[90] The vehicle weaves through the streets, and comes upon an Iraqi and Allied force convoy stopped at an intersection. The vehicle picks up speed as it approaches the intersection, at which point members of the

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[86] Robert Windrem, "US Fears New Threat From ISIS Drones," 1.

[87] "How the Battle for Mosul Unfolded," *BBC News*, July 10, 2017, accessed March 30, 2017, http://www.bbc.com/news/world-middle-east-37702442.

[88] Joby Warrick, "Use of Weaponizes Drones by ISIS Spurs Terrorism Fears," *The Washington Post*, February 21, 2017, accessed November 28, 2017, https://www.washingtonpost.com/world/national-security/use-of-weaponized-drones-by-isis-spurs-terrorism-fears/2017/02/21/9d83d51e-f382-11e6-8d72-263470bf0401_story.html?tid=a_inl&utm_term=.0d4abf08b8a0.

[89] Rita Katz, "How ISIS Maximizes Terror From its Killer Drones," *The Daily Beast*, 2017, accessed October 4, 2017, https://www.thedailybeast.com/how-isis-maximizes-the-terror-from-its-killer-drones.

[90] Robert Windrem, "US Fears New Threat From ISIS Drones," 1.

convoy appear to identify the urgency of the situation. Allied troops begin to move away from their vehicles when, boom, the suicide bomber detonates the vehicle sending a cloud of dirt, metal, and body parts flying into the air. The video of this attack, captured by the UA, is set to upbeat music. It mimics US drone strike videos set to songs like Thunder Struck.[91] The use of technology, like the LSS UA for propaganda, in an information age exponentiates the recruiting, radicalization, and funding of non-state actors.[92] In this first example, the UAS went undetected and unthreatened.

The last five minutes of "The Knights of the Sectors" video changes from footage of a UA following vehicles into footage of a UA staging an attack.[93] During this portion of the video, two men launch a commercial LSS UA and guide it over an Allied force element of four vehicles. As the UA approaches undetected from a low altitude, the UA operators line up the video crosshairs on one of the convoy's vehicles, using it as an aim point. A modified 40 mm mortar round suddenly comes into view and falls away from the UA. The feathered fins on the end of the ordinance stabilize the round as it plummets onto the unsuspecting forces below. The 40 mm mortar strike falls perfectly onto a vulnerable point on the up-armored vehicle, sending metal, rocks, and body parts flying. This video is one of many found on the internet that shows ISIS-controlled LSS UA targeting boats, vehicles, buildings, and marketplaces.[94] This type of attack seeks to create chaos amongst Allied Forces and serve as motivation for new ISIS recruits.

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[91] Katz, "How ISIS Maximizes Terror From its Killer Drones," 1.

[92] Horowitz, Kreps, and Fuhrmann, "Separating Fact From Fiction in the Debate Over Drone Proliferation," 23.

[93] Katz, "How ISIS Maximizes Terror From its Killer Drones," 1.

[94] Examples of these videos include: Thomas Luna, "ISIS Drone Dropped Bombs Into Ammunition Dump," *We Talk UAV*, October 25, 2017, accessed March 30, 2017, https://www.wetalkuav.com/isis-drone-dropped-bombs-into-ammunition-dump; Chris Tomson, "In Pictures: ISIS drones drop bombs on Kurdish Boats Crossing the Euphrates River," *Almasdar News*, February 4, 2017, accessed March 30, 2018, https://www.almasdarnews.com/article/pictures-isis-drones-drop-bombs-kurdish-boats-crossing-euphrates-river; Ben Watson, "Islamic State Fighters Are Launching An Ever-Wider Assortment Of Deadly Drones, Even As Their UAV Factories Come Under Heavy Attack," *Defense One*, January 12, 2017, accessed March 30, 2018,

These videos provide examples of situations where neither detection nor defensive doctrine was adequate against a UA threat. C-UAS doctrine calls for protection against UA. Current doctrine provides the spotter technique as a method for detection with the use of organic defensive measures. In the first part of the video, a UA records a vehicle born improvised explosive device operation while maintaining a safe standoff position, demonstrating a detection failure by the coalition forces. In the videos, the small units on the ground did not appear to have personnel looking skyward for potential UA. Instead, soldiers on the ground focused on the people and vehicles moving through the checkpoints or convoys. Once the Vehicle Born Improvised Explosive Device (VBIED) or mortar attack occurred, the Allied units did not begin taking defensive measures against the UA with individual or crew-served weapons. Because of the LSS nature of these UA, the inability to detect these systems prevented soldiers from defensive actions. The attack was a successful surveillance and targeting strike by the non-state actors.

In both situations, the cameras on the LSS UA documented the attacks for later strategic messaging. Perhaps the most disturbing revelation comes in the small size of the UA itself. The small size of the aircraft and payload seem disproportionate to the destructive power it harnesses through surprise and accuracy. The LSS UA achieved surprise because it can operate outside the C-UAS detection capability of traditional class four and five UA. As demonstrated in the video, the UA was technologically advanced enough to precisely target individual vehicles with high accuracy.

The ROE during this non-state actor conflict did not prevent friendly forces from taking kinetic and non-kinetic actions. However, friendly forces never took kinetic defensive actions

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http://www.defenseone.com/technology/2017/01/drones-isis/134542; Matthew L. Schehl, "ISIS Is Expanding The Reach And Sophistication Of Its Drone Fleet," *Your Marine Corps*, April 17, 2016, accessed August 15, 2017, https://www.marinecorpstimes.com; Cody Poplin, "Look Who Else Has Drones: ISIS and al Nusra," *Lawfare*, October 24, 2014, accessed March 30, 2017, http://www.lawfareblog.com/2014/10/lookwho-else-has-drones-isis-and-al-nusra.

against the ISIS drones because detection did not occur. The ROE would have allowed the ground forces to take defensive actions with individual and crew-served weapons; however, the inability to detect the LSS did not provide an opportunity for defensive measures.

State Actor – Russo-Ukraine War, Zelenopillya rocket attack in the War in Donbas

Within the broader Russo-Ukrainian War, the War in Donbas began in March 2014 in the aftermath of the Ukraine revolution, which followed the relatively bloodless annexation of Crimea by the Russian Federation.[95] The Zelenopillya rocket attack took place on July 11, 2014 within the War on Donbas.[96] In May 2014, the Russian 'separatists' started flying LSS UA in the Donbas region. These UA consisted of at least five different types, each with different capabilities.[97] Ukrainian forces began visually spotting UA and became familiar with the different types and what attacks would follow after identifying specific airframes.[98]

The importance of Russian drone usage comes from their ability to combine multiple platforms in real-time targeting, to mass precision fires.[99] This combination presented itself on the morning of July 11, 2014.[100] A column of battalions from the Ukrainian 24th Mechanized Brigade and 79nd Airmobile Brigade assembled along the highway leading north to the city of Luhansk,

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[95] Phillip A. Karber Dr., "Lessons Learned: from the Russo-Ukrainian War," *The Potomac Foundation,* July 8, 2015, accessed October 31, 2017, https://prodev2go.files.wordpress.com/2015/10/rus-ukr-lessons-draft.pdf.

[96] Ibid., 1.

[97] Ibid., 12.

[98] Ibid.

[99] Pavel Felgenhauer, "Russia Seizes Opportunity to Expand Drone Usage," *Real Clear Defense*, September 13, 2017, accessed November 28, 2017, https://www.realcleardefense.com/articles/2017/09/13/russia_seizes_opportunity_to_expand_drone_usage_112287.html.

[100] Shawn Woodford, "The Russian Artillery Strike That Spooked The US Army," *Dupuy Institute*, March 29, 2017, accessed October 31, 2017, http://www.dupuyinstitute.org/blog/2017/03/29/the-russian-artillery-strike-that-spooked-the-u-s-army.

Ukraine.[101] Using multiple UASs stacked over the target to gain near-real-time targeting information, the Russians launched a short-range BM-21 Grad Multiple Rocket Launch System (MLRS) strike on the column.[102] Within three minutes, the Russian forces destroyed nearly two battalions and decimated the 79th Airmobile Brigade.[103]

Similar UAS events, while not matched in scale and destruction to the Zelenopillya attack, continued for the next six weeks, resulting in fifty-three strikes at forty different locations.[104] The operational impact of combining multiple UA as part of a system, to mass fires, enabled Russia's decisive ground offensive in August 2014.[105] Over the course of multiple operations conducted during this war, Russian UA surveillance combined with massed area fires from artillery and rockets produced a "new level of intensity in modern conventional combat."[106]

However, Russian-linked forces were not the only users of UAS. According to Phillip Karber and Joshua Thibeault, defense and national security researchers, the Ukraine crisis is the first time UAs have appeared in significant numbers on both sides of a conflict.[107] Moscow and Kiev were deploying large numbers of UASs to operations in the Crimea crisis.[108] Ukraine and

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[101] Shawn Woodford, "The Russian Artillery Strike That Spooked The US Army," 1.

[102] Ibid.

[103] Ibid.; Karber, "Lessons Learned: from the Russo-Ukrainian War," 13. Two Ukrainian mechanized battalions were virtually wiped out.

[104] Julian Borger and Eliot Higgins, "Russia Shells Ukrainians From Within Its Own Territory, Says Study," *The Guardian*, February 17, 2015, accessed November 28, 2017, https://www.theguardian.com/world/2015/feb/17/russia-shelled-ukrainians-from-within-its-own-territory-says-study.

[105] Karber, "Lessons Learned: from the Russo-Ukrainian War," 18.

[106] Alan Taylor, "NATO: Russian Soldiers Are Now in Ukraine," *The Atlantic* 1, No. 8 (2014): 1, accessed November 28, 2017, https://www.theatlantic.com/photo/2014/08/nato-russian-soldiers-are-now-in-ukraine/100800.

[107] Thibeault and Karber, "Russia's New Generation Warfare," 3.

[108] US Army, US Army UAS Roadmap 2010-2035 (2014).

Russia used unarmed and unmanned reconnaissance aircraft to report enemy movements and positions. UA also emerged as an enabler for artillery target acquisition in this war.[109]

Regarding detection, the Ukrainians relied on visual identification of adversarial UA; this meant that, by the time a spotter identified a Russian UA, the UA had already reported targeting information back to the Russians, and an artillery strike on the Ukraine position would occur within ten to fifteen minutes.[110] Ukraine suffered eighty percent of all casualties from artillery during the first twenty-five months of fighting.[111]

Regarding defense, the destruction of UA has been high on both sides. Ukrainian and Russian LSS UA losses have not come from Surface to Air Missiles but from machine gun or targetable jammers. One of Russia's primary missions was detection and defense of Ukranian UASs through electronic warfare.[112] The Russians had great success employing a self-propelled electronic targetable jammer that breaks the Global Positioning System signal which controls UA flight, causing the UA to fall from the sky. In Ukraine, the single largest killer of UASs came from "electronic warfare" through "jamming either the controller or Global Positioning System signal."[113] Both sides have also had some success in using "14.5 mm machine gun or 23mm/30mm rapid-fire cannon" which can effectively target LSS UA.[114]

ROE restricted Ukraine's defensive ability to remove Russian UA from the battlefield. Before the Zelenopillya rocket attack, pressure from US and Western European leaders led to restraint on UA shoot downs and cross-border counter-battery fire missions in order to not provoke Russia.[115] As a result, Ukraine's strict ROE increased Russia's freedom of maneuver in

[109] US Army, US Army UAS Roadmap 2010-2035 (2014), 6.

[110] Ibid., 15.

[111] Thibeault and Karber, "Russia's New Generation Warfare," 3.

[112] Ibid., 2.

[113] Ibid., 1.

[114] Karber, "Lessons Learned: from the Russo-Ukrainian War," 15.

[115] Thibeault and Karber, "Russia's New Generation Warfare," 18.

the use of UAS. Even after the Zelenopillya attack, the Ukranian ROE remained the same, due to continued international pressure. In the case of the Zelenopillya rocket attack, a different, less-constrained ROE might have prevented such decimating losses.

Analysis

These two case studies demonstrate how emerging technology and ROE affect C-UAS on today's battlefield. Emerging technology determines new UAS employment methods that will continue to challenge freedom of maneuver across the range of military operations. The use of UA for kinetic attacks or as spotters for artillery demonstrates how adversaries harness the emerging capabilities of these platforms.

These case studies help show some differences that doctrine should address regarding detection. In the case of non-state actors, detection assets at the small unit become important as non-state actors are not traditionally looking to attack the main body of friendly forces. Instead, these groups seek to harass forces at their weak points, on the periphery. The state actor differs in that it is seeking decisiveness in its military actions. While state actors will undoubtedly also harass, their preferred focus is on the adversaries' centralization of combat power. When the preferred method of attack comes in massed barrages of fires, dispersion of forces is critical. Such dispersion prevents detected forces from simultaneous attack. State actors are not seeking to strike a small unit patrol with massed fires. Instead, they will seek the more substantial massing of forces. New operational doctrine could give clarity as to what size forces require larger detection systems, or when smaller units need these assets.

In the case of ISIS, the LSS profile of UA permitted ISIS to conduct operations undetected, or only detected immediately before an attack. The first part of the ISIS video, capturing a vehicle born improvised explosive device operation while maintaining a safe standoff position, demonstrated a detection issue. In the video, only four vehicles were present in the feed; this small convoy would need a C-UAS detection at the small unit level for dispersed checkpoint or perimeter defense operations to detect the UA.

In the case of the Ukranian conflict, the inability of the Ukrainian column outside of Zelenopillya to detect unmanned enemy aircraft proved catastrophic, as this failure to detect meant Russian artillery targeted Ukranian troops unimpeded. A better detection capability would have permitted the Ukrainian forces situational awareness of the LSS UA surveilling the Ukrainian massing of forces. The detection of the UA could have led to units dispersing, to prevent pin-point targeting by the Russian artillery. In this instance, Ukranian forces needed small unit detection for routine operations which would have layered detection assets when large units massed.

In terms of defense, Ukraine needed doctrine that would aid in applying the limiting ROE by allowing more non-kinetic methods. Defensive measures should differ between small units and large units. At the small unit level, non-kinetic C-UAS assets could have allowed Ukrainian forces to safely remove and deter Russian UA from reconnaissance operations without violating the ROE. By disrupting or safely capturing several of the Russian UA before July, Ukraine would have been able to employ non-kinetic security before massing larger units. The higher units could have retained kinetic C-UAS systems for employment when massing forces on the battlefield. By using non-kinetic means on the defensive perimeter, an escalation of ROE could then occur if Russian UA penetrates within range of the massed units. At this point, larger units could use kinetic assets to destroy UAS before an attack occurs.

In the non-state actor example, the small units that were targeted could have destroyed the UA with non-kinetic measure such as the electronic jamming weapons that were used to destroy the Ukrainian UA. In this type of conflict, non-kinetic defensive measures offer a way to defeat adversarial UA without the risk of civilian casualties that kinetic methods pose. Both of these case studies demonstrate that commanders need to organize defensive measures of the right type, and at the right level, depending on the ROE for that conflict.

The ROE used by Allied forces against ISIS, and by the Ukrainians against Russia, support this paper's argument that not only will emerging capabilities matter in C-UAS doctrine, but

emerging conflict-dependent ROE will also limit the response to adversarial UA and use of C-UAS. The ROE in Iraq would have allowed defensive measures if detection had appropriately occurred, and had the small units organized with C-UAS systems embedded. ROE placed severe constraints on the Ukranian's forces ability to defend against UA. Ukraine did not want to appear provocative, and limited the defensive measures its military could take; however, this led to higher casualties when the minimal C-UAS systems permitted by this ROE were not successful in defeating Russian UAS.

Both scenarios showed situations where neither detection nor defensive doctrine was adequate for operations conducted. The result was successful UA strikes by both state and non-state actors. Russian actions in Ukraine, and ISIS success with LSS UA, make it clear that there is an increasing likelihood that adversarial actors will use UAS in the next conflict. Given this context, it is critical that C-UAS doctrine is updated with a full discussion of detection and defensive measures.

Conclusion

Rapid technological advances, combined with the current adversarial use of UA on the battlefield, present a contemporary challenge for US military commanders. However, US Army C-UAS operational doctrine falls short when addressing existing technologies within current operations. Current C-UAS doctrine only addresses the tactical level training and techniques without providing the right operational guidance to maneuver commanders in the form of an ADP, ADRP, or FM.

This monograph reviewed military publications, emerging UAS technology, and potential ROE issues facing C-UAS. The one available doctrinal manual, ATP 3-01.81, does not frame employment regarding detection and defensive systems or explain how to organize the assignment of detection and defensive duties to specific units. In terms of technology, UAs are becoming increasingly sophisticated. They are also proliferating and becoming more common as a battlefield threat. ROE will continue to limit the commanders' employment of C-UAS, as

political risks limit the countermeasures that commanders can take. These main points provide the context for needing to create new C-UAS doctrine.

This monograph argues that additional C-UAS doctrine must provide commanders clear guidance on how to defeat UASs. Crafting doctrine around the fundamental principles of detection and defense, to include a discussion of ROE, would provide additional guidance to commanders. This doctrine should be in the form of a C-UAS ADRP, ADP, ATP, and FM. Of these four doctrinal publications, only one, the ATP, currently exists; this monograph calls for the development of the rest of the C-UAS doctrinal manuals. The creation of such doctrine will guide commanders in C-UAS methods against both state and non-state actors.

The principles of detection and defense are examined further in two case studies, which demonstrate the broad scope doctrine needs to span, addressing both state or non-state actors. The Russian case study identified how UASs facilitated a decimating effect on the Ukrainian forces due to Ukranian inability to detect adequately. Then, restrictive Ukrainian ROE prevented forces from taking adequate defensive measures. In the ISIS case study, the effect UASs had on small unit convoys demonstrates a need for both small and above-small unit detection measures. The analysis of these two case studies suggests that doctrine should provide flexible guidance based on the fundamental principles of detection and defense, while application of these methods will vary depending on the specific mission or adversary.

The US Army should not dismiss UA uses in Iraq and Ukraine as disconnected anomalies. Instead, the expectation should be that state and non-state actors will continue to perfect the warfighting techniques of UA on the battlefield. The significance of new UA operational techniques means that airspace, which the US has typically operated freely in, could become highly contested in the next crisis. Therefore, the US Army must ensure success by creating doctrine to meet potential adversaries' developing capabilities. Army leaders need to

identify, continually monitor, and assess threats as they adapt and change over time.[116] This same need is true of doctrine.

[116] US Army, ADRP 3-0 (2016), 1-3.

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