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Air Force Acquisitions of Counter Unmanned Aircraft Systems

September 2022

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Thesis Advisors: Dr. Robert F. Mortlock, Professor
Dr. Nicholas Dew, Professor

Department of Defense Management

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

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ABSTRACT

Drones, more formally recognized as unmanned aircraft systems (UAS), offer a wide variety of utility and great potential for harm. The U.S. Air Force and the rest of the Department of Defense (DoD) represent significant targets for UAS. Addressing the UAS threat that the Air Force is facing can be undertaken by looking at how the Air Force can employ an acquisition strategy by which it acquires counter-unmanned aircraft systems (C-UAS) and delivers the capabilities of those systems to its Airmen. By exploring the DoD's acquisition system and counter-small, unmanned aircraft systems (C-sUAS) and capabilities, this research argues for establishing an acquisition strategy of those systems. The research concludes by providing recommendations on how the Air Force can align itself with official and authoritative C-sUAS elements within the DoD to ultimately frame a C-sUAS acquisition strategy for the Air Force to utilize.

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ABOUT THE AUTHOR

Captain Karl Fagnant is a Security Forces Officer in the United States Air Force. He commissioned through Officer Training School in 2015. Prior to commissioning, he earned his Bachelor of Arts in Criminal Justice from the University of Wyoming in 2013. In 2020, he also earned a Master of Science Degree in Cybersecurity Management and Policy from Embry-Riddle Aeronautical University Worldwide. Captain Fagnant started his career in the Air Force by serving as a Flight Commander where he oversaw nuclear security operations at Minot Air Force Base, North Dakota. In his next assignment, he served as the Operations Officer for law and order, and security operations at Dyess Air Force Base, Texas. In 2020, Captain Fagnant deployed to Bagram Airfield, Afghanistan to serve as the Defense Force Commander. He has a daughter, Rylee, with his ex-wife Amber, who was born in 2020. In his free time, Captain Fagnant enjoys golfing. For his next assignment, he will be assigned as the Operations Officer at Incirlik Air Base, Turkey.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGL	Above Ground Level
AAF	Adaptive Acquisition Framework
AFMAN	Air Force Manual
AFOTEC	Air Force Operational Test and Evaluation Center
AFRL	Air Force Research Laboratory
AoA	Analysis of Alternatives
AOR	Area of Responsibility
CJCS	Chairman of the Joint Chiefs of Staff
CASCOM	Combined Arms Support Command
C2	Command and Control
COTS	Commercial, Off-The-Shelf
CONUS	Continental United States
C-RAM	Counter-Rocket, Artillery, and Mortar
C-UAS	Counter-Unmanned Aircraft Systems
C-sUAS	Counter-Small Unmanned Aircraft Systems
DAS	Defense Acquisition System
DAU	Defense Acquisition University
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DDS	Digital Defense Service
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy
ESD	Electronic Services Directorate
EMD	Engineering and Manufacturing Development
EA	Executive Agent
FY	Fiscal Year

FAAD-C2	Forward Area Air Defense Command and Control
FS-LIDS	Fixed Site-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System
FOD	Foreign Object Debris
FOC	Full Operational Capability
ICD	Initial Capabilities Document
IOC	Initial Operational Capability
JCIDS	Joint Capabilities Integration and Development System
JCS	Joint Chiefs of Staff
JCO	Joint Counter-Small Unmanned Aircraft Systems Office
JROC	Joint Requirements Oversight Council
KIAS	Knots Indicated Airspeed
LOE	Line of Effort
LS	Logistics Support
MSA	Materiel Solutions Analysis
MTA	Middle Tier of Acquisition
MDA	Milestone Decision Authority
MSL	Mean Sea Level
MEDUSA	Multi-Environmental Domain Unmanned Systems Application
NDS	National Defense Strategy
NSIB	National Security Innovation Base
NSS	National Security Strategy
NFE	Non-Federal Entities
NPS	Naval Postgraduate School
NINJA	Negation of Improvised Non-State Joint Aircraft
OSD	Office of the Secretary of Defense
OUSD A & S	Office of the Under Secretary of Defense for Acquisition and Sustainment

O&S	Operations and Sustainment
OCONUS	Outside the Continental United States
PPBE	Planning, Programming, Budgeting and Execution
PSS	Product Support Strategies
P&D	Production and Development
PM	Program Manager
PL	Protection Level
S&T	Science and Technology
SECARMY	Secretary of the United States Army
sUAS	Small Unmanned Aircraft Systems
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TTP	Tactics, Techniques, and Procedures
TMRR	Technology Maturation and Risk Reduction
T&E	Test and Evaluation
UA	Unmanned Aircraft
USAF	United States Air Force
USCENTCOM	United States Central Command
USC	United States Code
UAS	Unmanned Aircraft Systems

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I. INTRODUCTION

The emergence of unmanned aircraft systems (UAS), more commonly referred to as drones, has been meteoric in terms of the widespread use and popularity of these systems across the globe. The utility provided by these systems and their capabilities continues to be revered based on the capability growth and function of the systems. While the benefits these systems offer to society are admirable, the reality exists for these systems to be used for nefarious means. Just as the emergence of UAS has led to the recognition of the societal benefits that these systems can provide, so too have malevolent entities, ranging from lone individuals to the military superpowers of the world, come to recognize the potential gain UAS can provide against those that they seek to wrong. The employment of UAS for illicit means represents a legitimate threat against individuals, organizations, industries, and governments across the globe. The United States of America has recognized this fact and has sought a litany of ways in which to combat against the UAS threat. Arguably one of the biggest targets of UAS in the United States has been the U.S. military and the Department of Defense (DoD). Military assets, installations, and personnel provide lucrative targets for UAS to surveil, disrupt, antagonize, and attack. The threat from UAS toward the US military has become so pronounced as to get the attention and focus of top-ranking commanders from with the DoD. In November 2021, the U.S. Central Command (USCENTCOM) commander, General Kenneth McKenzie testified before the House Armed Service Committee, where he labeled drones as one of the most dangerous threats to the U.S. military, before further expanding how remarkably unprepared the military was to combat this threat (Bacon, 2021). This threat that was identified by one of the top-ranking officials from within the DoD, from one of the most contentious regions in the world, has provided a single, yet significant, example of the attention that must be afforded to the threat that are UAS. From this raised alarm, a simultaneous call has been made to truly address this threat.

A. PROBLEM

The attempt to address this threat and the corresponding processes have been considered and discussed for nearly as long as UAS capabilities have existed for

operational use. Unfortunately, a comprehensive solution has yet to be found that is singularly and wholistically capable of defeating the UAS threat. From this, a serious problem exists in the form of the military units and installations having to figure how to combat the UAS threat; without established formal guidance and a comprehensive DoD vision. Each branch of military Service cannot adequately defend itself against the sUAS threat without an acquisition strategy for counter-small, unmanned aircraft systems (C-sUAS) that delivers those capabilities to today's warfighter. Additionally, without any kind of formal C-sUAS acquisition strategy, formal programs of record for C-sUAS for the Air Force and the rest of the DoD cannot be established. Optimism exists for a solution to be presented that ultimately delivers the capability to defend against UAS to all military customers but until then, units and installations are being left to piecemeal their own defense.

Military units and installations being left to their own devices and ingenuity for their defense against UAS are limited by those same factors. To further that concern, one must consider what these military entities are trying to defend: billions of dollars of strategic resources and assets vital to national security, national critical infrastructure, inherently dangerous property, and the lives and safety of millions of Service members, families, and civilians that occupy these installations. This concern has been recognized as being of such importance that the former acting Secretary of Defense, Christopher Miller, noted the potential hazard the UAS pose to the military, which was captured in the DoD's *Counter-Small Unmanned Aircraft Systems Strategy* (U.S. Department of Defense [DoD], 2021). To illustrate this point, one could consider the consequences and impact to national security if a single UAS was allowed to self-detonate inside a nuclear storage facility, or to record special operations members' tactics, techniques, and procedures as they prepared for a raid of a high value target. Without a program actively delivering systems and subject-matter experts to provide a precise solution to this problem, those units and installations are left on their own to solve these omni-reaching problems. Until a universal solution can be provided across the DoD, individual entities whether they are at the unit, installation, major command, or even Service level may be left without any other recourse than to address this threat based on the ingenuity and knowledge of their own workforce. This project attempts to define how branches of

Service, specifically the U.S. Air Force, can pursue a more holistic solution to the posed problem.

B. PURPOSE

The purpose of this study is to understand how each branch of military Service, with emphasis given to the U.S. Air Force, cannot adequately defend itself against the UAS threat without an established acquisition strategy for C-sUAS that will ultimately deliver that capability to today's warfighter. Without an acquisition strategy, formal C-sUAS acquisition programs of record cannot be established to physically engage in the process to acquire, field, and support C-sUAS capabilities. This realization could be argued to represent the need for support to justify research behind this project. To that point, an equally important factor to justify research of this problem could be found in the ultimate purpose of that research. A preliminary response to this issue would offer that the purpose of this research endeavor is to provide a recommended solution to address to the previously stated problem. Applying this concept to the problem identified for this project, seeks to determine how the U.S. Air Force can establish a C-sUAS acquisition strategy that will support the establishment of various acquisition programs that deliver C-sUAS capabilities to its Airmen. To address the stated the stated problem of this research, a qualitative literature review was used to identify how an acquisition strategy can be applied to ultimately deliver C-sUAS capabilities to Airmen across the Air Force from 2021 into the future. The ultimate purpose of identifying how the Air Force can establish and implement a strategy and system to defeat the UAS threat is argued to be a critical initiative in defending the Air Force and its strategic assets, installations, and personnel. To understand the importance of protecting these resources, one must first be able to explicitly identify and be conscious of the need for and nature of these elements.

Considering the research question and purpose of this project helped to frame how this research was constructed. The problem of the Air Force not having any specific or codified acquisition strategy for C-sUAS has left Air Force installations currently are limited by their own resources and capabilities to defend against the sUAS threat. This problem gave rise to the purpose of the research to establish such an acquisition strategy. The research methodology for how that strategy could be formulated is discussed in

subsequent chapters, but it should be noted from this initial point that a qualitative literature review from authoritative C-sUAS sources helped to frame the final recommendations for how the Air Force could establish and align its C-sUAS acquisition strategy. From the problem and the corresponding purpose of this research, specific research questions must also be answered. The primary research question to be answered is how can adopting and employing a formal C-sUAS acquisition strategy help the Air Force to defend its installations against the sUAS threat? A secondary question to the primary one asks what exactly that C-sUAS acquisition strategy would look like for the Air Force? Defining the C-sUAS acquisition strategy also requires asking how it will be executed? Answering these questions will be completed using the research methodology to pose answers to those questions. Specifically, the qualitative literature review conducted during this research identifies existing DoD acquisition strategies and practices that can be tailored and adopted by the Air Force to its own C-sUAS acquisition strategy. Further, the qualitative literature review identified C-sUAS functions, capabilities, and solutions that are ready to be employed for defense against the sUAS threat. Using the information and data obtained during the literature review, an analysis is used to identify the strengths, weaknesses, opportunities, and threats (SWOT) associated with the above elements. The SWOT analysis notes the major points of each of the previous elements, and ultimately allows the previously posed questions to be answered.

C. THE UAS THREAT AGAINST AIR FORCE ASSETS

The Air Force and the rest of the DoD are continuously engaged in identifying threats and vulnerabilities against the force and looking for ways to mitigate them. This is accomplished from the tactical level for individual Service members all the way to a strategic process that is conducted for the entirety of the DoD. The Joint Capabilities Integration and Development System (JCIDS) represents that strategic process (U.S. Government Accountability Office [GAO], 2021). Specifically, JCIDS functions to validate gaps, primarily of capabilities, for joint warfighting and the requirements that are needed to mitigate or resolve those gaps (GAO, 2021). The JCIDS process entails an integrated process to identify, document, and prioritize capability gaps within the DoD (GAO, 2021). That process then transforms into developing or delivering weapons

systems or capabilities that can address those gaps by establishing capability requirements (GAO, 2021). The JCIDS process could be used to identify the threats and vulnerabilities that are posed by UAS against the DoD, and subsequently be used to establish capability requirements to counter the UAS threat.

That same UAS threat looms over the entirety of the DoD. That general UAS threat may be ubiquitous across the force, but the targets and challenges in addressing that threat are argued to be uniquely distributed across the DoD. It is from this reality that the Air Force and the challenges pitted against it by UAS will be a subject of focus for this project. A previous example of the strategic impact and consequences of a UAS against nuclear weapons and their storage facilities and special operations members and assets being monitored have ties traced back to the Air Force. Before delving further into these examples, this research argues that the asset(s) that principally define and shape the U.S. Air Force is its vast and diverse aircraft fleet. The Air Force is inherently "air minded" with its mission to fly, fight, and win through airpower that is delivered anytime and anywhere. This driving mission focus is the locus behind the overall posture of the force and is further argued to be one of the most easily identifiable targets for UAS, for which those aircraft can be "targeted" by a number of different means.

Considering the concept of targeting through a militaristic lens could lead one to picture kinetic and physical actions represented by overt actions to inflict tangible damage. Applying this example in the form of a real-world example would be recognized as a UAS being used to destroy an aircraft, likely through explosive means. Arguably the most concerning and lethal mean for this measure would be when a UAS is laden with explosive materials that are either fixed to or able to be released by the UAS. Aside from this conventional thought of how a UAS could potentially target an Air Force aircraft, there are alternative means that exist for targeting of aircraft. The next mean could be either an active or passive targeting of aircraft whereby a UAS would interfere with the flight of the aircraft. This act is especially concerning against aircraft when they are in critical stages of flight where the ability of the aircraft to react and maneuver is extremely limited such as during takeoffs and landings. The interference of an aircraft's flight could lead to a collision with the UAS, introduction of foreign objects debris (FOD) into the

aircraft, or forcing an unplanned maneuver, all of which could lead to damage or destruction of an aircraft.

Aside from the physical damage that may be inflicted by a UAS against aircraft, there are also non-kinetic actions that UAS may take against aircraft which also can pose adverse consequences against the aircraft. The first example of these non-kinetic actions is recognized as the unauthorized surveillance of aircraft. Aircraft within the Air Force are designated with respective protection levels (PLs), security classifications, functions, purposes, and capabilities. UAS can be used to capture images and footage of secret and experimental aircraft, study their flight tactics, observe aircraft armaments and instruments, determine parking spots and mass parking areas, and track the time to launch aircraft placed in an alert status. Adversaries of the United States with access to this information can position themselves to exploit that information and gain tactical, operational, and even strategic advantages based on that exploitation. Aside from other non-kinetic, passive action of conducting unauthorized surveillance of aircraft, UAS are also capable of conducting similar in nature actions. These actions include disrupting air operations based on the mere presence of a UAS in an unauthorized area, distracting or diverting assets and personnel that would otherwise be supporting aircraft, and interrupting operations and support of aircraft based on false alarms and unfounded sightings of UASs within a range of influence to the aircraft. From these listed examples of kinetic, non-kinetic, passive, and non-passive actions that a UAS can pose against an Air Force aircraft, one could begin to appreciate and comprehend the magnitude of the threat and resulting consequences UAS can pose.

Having acknowledged just some of the means by which a UAS can target an asset, the next step returns to the matter of identifying Air Force assets and resources that may be vulnerable to those targeting tactics. As discussed, regarding possible targeting tactics by UAS, the Air Force's vast and diverse aircraft fleet has offered to be one of the most readily apparent targets of illicit UAS activities. The Air Force's mission to fly, fight, and win, is achieved through more means than just physical air power. While the aircraft fleet could be thought of as the face of the Air Force, it is not the most strategically important resource in the Air Force's arsenal. This research assumes that that title belongs to the nuclear weapons that the Air Force is charged with maintaining,

securing, and, if necessary, delivering. From a pure domestic viewpoint of the Continental United States (CONUS), the Air Force has multiple nuclear storage and launch facilities located across the country. Beyond their devastating and destructive power, the weapons are argued to serve an equally important purpose of providing a deterrence against other nuclear-capable actors who otherwise may be left unchecked in the use of their own nuclear weapons. The safety, security, and effectiveness of America's nuclear arsenal is paramount to the trust and confidence that the country, as well as the rest of the world holds with America and its nuclear arsenal.

Continuing with the astounding capabilities of the Air Force, one could next consider the space, cyber, and communication capabilities it provides. While each of those elements could be considered as its own unique mission set and warfighting capability provided by the Air Force, the important note to take away from all of these elements could be recognized in their broader information collecting and sharing design which provides critical data and knowledge to the American warfighter at the point-of need. Any interference, degradation, interruption, or loss of Services from these missions could have strategic consequential impacts for the United States. One of the final key assets of the Air Force is the people and places that comprise the Air Force. With a total force of over 800,000 active duty, Air National Guard, Reserve, and civilian personnel spread across over 100 active duty, Air National Guard, and Reserve bases (*Air Force Magazine*, 2021), the Air Force is capable of covering the globe to ultimately meet the mission needs of the Service. Based on the vast geographic dispersion, and the number of personnel assigned to these installations, the Air Force is charged with a monumental task of protecting the people and places that ensure its warfighting capabilities. Questions of, or compromises to, the security of these assets may open the door for further challenges to that security status. While compiling a comprehensive list of all Air Force assets could be the subject of a classified research endeavor, the point being made from the above section has been to convey the strategic importance of some of the most critical assets in the Air Force's inventory. From this understanding, readers are provided with insight into what all UAS can seek to target based on their previous targeting tactics which could be utilized against any one or combination of the listed examples. Having identified the threat posed by UAS against Air Force assets to set the stage of the environment that is

influenced by UAS, the next step becomes identifying the various types and functions of UAS that are in existence today.

The expanse of the U.S. Air Force represents a nearly unlimited number of targets for UAS. The Air Force's aircraft fleet, its nuclear arsenal, the space, cyber, and communication systems, and the personnel and installations of the Air Force all represent potential UAS targets. Those targets can be exploited by UAS in more than one manner. Those manners include active, passive, physical, non-physical, and any combination of those manners. The possibilities that range from unauthorized surveillance to active explosive attacks represents the seriousness of the threat that UAS pose against the Air Force.

D. TYPES OF UAS

The term *drone* is often thought of as a colloquial term to represent any unmanned aircraft system or vehicle. While this research subscribes to this notion, it is important for readers to understand the differences between these systems, especially as applied to the systems and tactics that are employed to defend against them. The DoD officially has recognized five different UAS groups, with classifications based on the maximum gross takeoff weight (measured in pounds), the normal operating altitude (measured in feet above ground level [AGL] and mean sea level [MSL]), and speed of the system (measured in knots indicated airspeed [KIAS]; DoD, 2021). Table 1 from the *U.S. Department of Defense Counter-Small Unmanned Aircraft Systems Strategy* (DoD, 2021) explicitly defines these unmanned aircraft (UA). Figure 1 from the Joint C-sUAS Office (JCO) provides pictographic examples of what the UAS look like in their respective groups (JCO, 2021).

Table 1. Unmanned Aircraft System Categorization. Adapted from DoD (2021).

UA Category	Maximum Gross Takeoff Weight (lbs)	Normal Operating Altitude (ft)	Speed (KIAS)
Group 1	0-20	< 1200 AGL	100 knots
Group 2	21-55	< 3500 AGL	< 250 knots
Group 3	< 1320	< 18,000 MSL	< 250 knots
Group 4	> 1320	< 18,000 MSL	Any Airspeed
Group 5	> 1320	> 18,000 MSL	Any Airspeed
Legend: AGL – above ground level; MSL – mean sea level; KIAS – knots indicated airspeed			

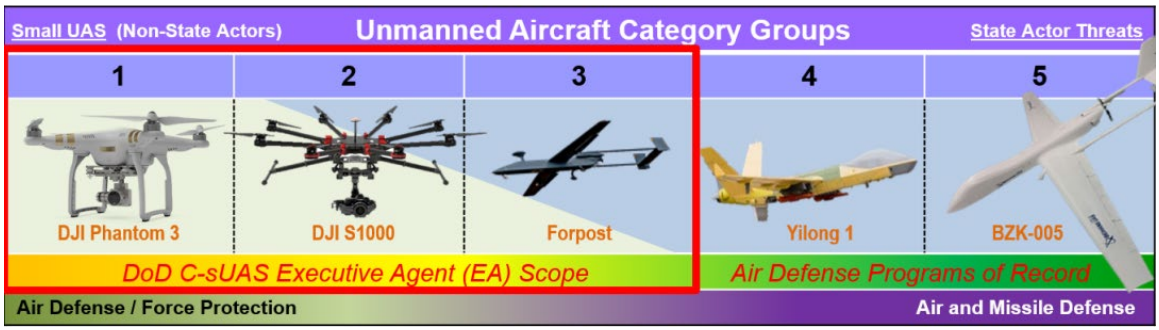

Figure 1. sUAS Groups. Source: JCO (2021).

Comprehending the differences between the groups of UAS will provide utility toward the understanding over how the Air Force is trying to defend against these different systems. An important distinction between the above UAS was made by the DoD whereby Groups 1, 2, and 3 were considered "small" unmanned aircraft systems (sUAS) and the more complicated systems to defend against were Groups 4 and 5 UAS (DoD, 2021). Group 4 and 5 UAS are more characteristic and representative of military aircraft, of which the possession, use, and presence of would likely come from state actors and symbolize an overt act of aggression or hostility if committed against the United States. This contrasts with sUAS that are more difficult in terms of determining ownership and attribution. Determining the ownership and attribution of sUAS is further complicated by the fact that these systems can be bought commercially and are therefore much more easily attainable by individuals or entities wishing to use these systems for illicit and covert means against the Air Force. Based on the likelihood of a Group 4 or 5 UAS being utilized by technologically advanced militaries of the world where the

employment of those systems could result in escalating hostilities between nations, the DoD, and this research, specifically focused on defending against Groups 1, 2, and 3, sUAS. Understanding the types of UAS, and the threat against Air Force assets represents a significant, but not entire portion of the problem that the Air Force is facing. To better understand the scope and magnitude of this problem, an understanding must be provided of the issues that have arisen in trying to combat the sUAS threat.

E. AIR FORCE C-SUAS ACQUISITION

Defense acquisition programs are often criticized for being excessively complex, political, and cumbersome. Understanding how to successfully navigate the DoD's acquisition process is both an art and a science that require considerable experience, practice, and study by the practitioners of the profession. These professionals operate in the acquisition realm where their ultimate goal and responsibility is to deliver on and meet the needs of warfighting customers. This charge is shared by all acquisition professionals spread across the DoD, regardless of their branch of Service. Throughout their tours of Service as an acquisition professional, these individuals will work on a number of products that are comprised into larger acquisition programs. This building of products into programs will mirror the career path of these professionals as they transition from product managers into program managers (PMs). Each branch of the DoD has varying names and titles for these professionals and what level of work they are responsible for, but for the purposes of this research, the individuals and levels of work they are responsible for will generically be recognized as PMs.

The DoD relies on a decision support system to execute its acquisition programs. That decision support system is recognized as Big "A" acquisition and consists of the Defense Acquisition System (DAS), the Joint Capabilities Integration and Development Systems (JCIDS), and the Planning, Programming, Budgeting and Execution (PPBE) systems (Defense Acquisition University [DAU], 2022b). To meet the needs of U.S. warfighters, DoD professionals utilize the Big "A" acquisition system to aid in strategic planning for the acquisition of military capabilities (DAU, 2022b). That strategic planning that is enabled by Big "A" acquisition, helps to set program and budget

requirements for DoD acquisition programs (DAU, 2022b). Each one of these support systems address specific aspects for DoD acquisition.

The DAS (referred to as little "a" acquisition) represents the management process and practice for the acquisition of DoD weapons, systems, and capabilities (DAU, 2022b). The DAS was built on polices such as DoD directives (DoDDs) and DoD instructions (DoDIs) to guide acquisition practices (DAU, 2022b). Aside from the polices that the DAS was built on, the system itself was designed to allow for decentralized and streamlined acquisition activities, as recognized in the Adaptative Acquisition Framework (AAF) (DAU, 2022b). The flexibility that constitutes the DAS and its AAF, allows PMs for greater autonomy and control within their acquisition programs while simultaneously placing emphases on discipline and accountability on PMs and their acquisition programs.

JCIDS is recognized as a systematic and transparent method focused on the capability requirements of DoD acquisition (DAU, 2022b). JCIDS helps the Joint Requirements Oversight Council (JROC) and Chairman of the Joint Chiefs of Staff (CJCS) in their processes to set capability requirements for the Joint Force (DAU, 2022a). This is based on how those requirements are identified, assessed, validated, and prioritized by both the JROC and CJCS (DAU, 2022a). The JROC is an organization that assists the Joint Chiefs of Staff (JCS) to establish joint requirements that meet the National Defense Strategy (NDS; DAU, 2022a). The JCIDS Manual sets the policies and procedures that entail the requirements process (DAU, 2022b).

The DoD uses the PPBE system as a strategic process to plan, program, develop and allocate resources across the Department (DAU, 2022b). The strategic nature of PPBE allows the system to draft and implement plans to meet the demands of the National Security Strategy (NSS) of which, those demands are levied against resource constraints for the Department (DAU, 2022b). Under PPBE, resources are allocated annually and within a quadrennial planning cycle whereas programs and budgets within the DoD are built annually with budgets covering 1 year and the larger programming schedule encompassing 4 additional years (DAU, 2022b).

Considering the focus of this research of addressing a capability gap against the UAS threat, the one system of Big "A" acquisition that directly responds to that gap is in the requirements of JCIDS. Under JCIDS, a capability gap could be assessed against the UAS threat that results in a documented need for the Joint Force. The JCIDS process looks to address the documented need for the capability gap across the spectrum of Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities–Policy (DOTmLPF-P) (DAU, 2022b). The materiel element of the DOTmLPF-P spectrum considers commercial, off-the-shelf (COTS) solutions to address capability gaps (DAU, 2022b). Addressing capability gaps for the DoD the materiel solutions of COTS systems involve purchasing, fielding and employing ready-made/ready-to-use systems and solutions (DAU, 2022b). As an example of the DoD using a COTS materiel solution to address the capability gap in defending against the UAS threat, C-sUAS systems and capabilities would be purchased by the DoD from a respective vendor and be employed in an expedited manner compared to longer acquisition processes of developing, prototyping, acquiring, and supporting the same capabilities from a DoD-organic perspective. Before a materiel solution, can be implemented to address the capability gap, an Analysis of Alternatives (AoA) must be conducted.

AoAs are thorough processes that provide an assessment for materiel solutions that satisfy capability needs that have been identified in the approved Initial Capabilities Document (ICD), an official acquisition document that specifies capability requirements and associated gaps (DAU, 2012). The AoA identifies and assesses potential materiel solutions by examining tradeoffs between costs and capabilities; total life-cycle costs of sustainment, schedule, and concept of operations possible solutions; and the overall risk for those possible solutions (DAU, 2012). AoAs utilize analyses of affordability, costs, early systems engineering, as well as sustainment considerations, threat projections, and market research to aid in possible materiel solution recommendations (DAU, 2012). The AoA is meant to support decisions for solutions that are the most cost-effective and provide a reasonable likelihood of providing validated capability requirements (DAU, 2012).

Creating and establishing formal acquisition programs can be accomplished via a number of different means. DoDD 5000.01 governs DoD acquisition policy in support of

the National Defense Strategy (NDS; Office of the Under Secretary of Defense for Acquisition and Sustainment [OUSD (A&S)], 2020b). From that policy, "The acquisition system will be designed to acquire products and Services that satisfy user needs with measurable and timely improvements to mission capability, materiel readiness, and operational support, at a fair and reasonable price" (OUSD [A&S], 2020b, p. 4). The DAS is further guided by 25 regulations and instructions that support developing a lethal force through technical innovation and performance that yields both a sustained and decisive advantage for the U.S. military (OUSD [A&S], 2020b). One of the first policies of the directive which is helpful in understanding the current DoD acquisition environment, especially as it applies to the acquisition of C-sUAS, calls for acquisition programs to be guided by tailorable acquisition strategies and approaches, and using AAF models in support of this policy of "delivering performance at the speed of relevance" (OUSD [A&S], 2020b, p. 4). It is from these guiding principles that call for tailorable strategies and adaptative frameworks that this research will consider in studying how the Air Force could use these same processes in support of a C-sUAS acquisition efforts.

F. TYPES OF ACQUISITION PROGRAMS

The tailorable strategies and adaptative frameworks needed by the Air Force to establish a C-sUAS program have been built and executed to acquire numerous defense weapons and systems capabilities. The little "a" AAF consists of six different acquisition pathways, shown in Figure 2. Each of these pathways shares the ultimate purpose of supporting the National Defense Strategy (NDS) through developing and acquiring products and services that provide a more lethal force through technological innovation and performance enabling both decisive and enduring advantages for the U.S. military (OUSD [A&S], 2019). The DoD's acquisition process enables this goal through the employment precisely of an acquisition framework that is comprised of multiple pathways, all of which are designed to be tailorable to meet the unique characteristics and associated risks of the program that is being acquired. A significant note regarding the goal of the DAS is to deliver solutions to the force and warfighters to allow for execution of the end-state system at the speed of relevance (OUSD [A&S], 2019). The speed of relevance that delivers solutions to warfighters ensures that those solutions are: effective,

secure, supportable, and affordable (OUSD [A&S], 2019). Figure 2 shows the different kinds of acquisition pathways under the Adaptive Acquisition Framework (AAF) by which solutions can be delivered to the warfighter (OUSD [A&S], 2019).

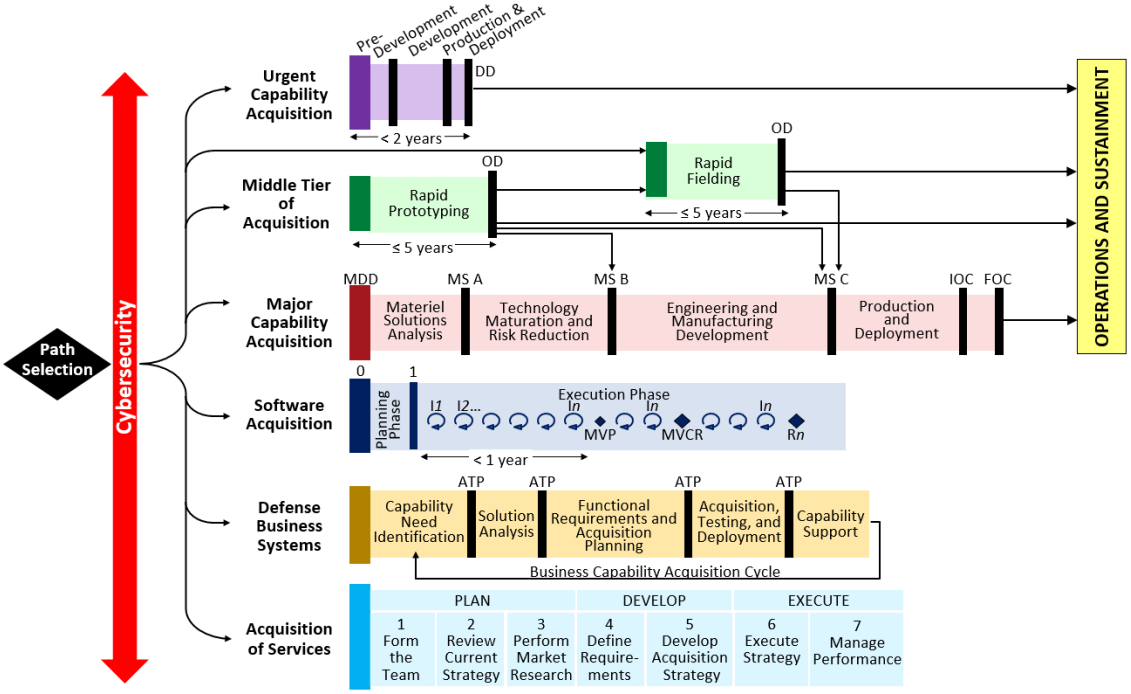

Figure 2. Adaptative Acquisition Framework. Source: OUSD [A&S] (2019).

Each of the pathways presented above provide different means to provide capabilities to the warfighter. The Urgent Capability Acquisition was designed to provide the quickest path for delivery of capabilities that could be fielded in 2 years (DAU, 2022a). The Middle Tier of Acquisition (MTA) pathway allows for more time in delivery of capabilities whereby prototypes for acquisition programs were developed that could showcase new capabilities and/or issue systems with already-proven technologies in an expedited manner that would require little development with both efforts being accomplished in less than 5 years (DAU, 2022a). The Major Capability Acquisition was designed to acquire and modernize specifically designated programs within the DoD (DAU, 2022a). The pathway for Software Acquisitions focused on its namesake in the delivery of software capabilities through rapid and iterative processes (DAU, 2022a). The pathway for Defense Business Systems was built to acquire information systems that support business operations, capabilities, and systems within the DoD (DAU, 2022a). Finally, the Defense Business Systems pathway was meant to support "as-a-service"

solutions for the DoD and its business operations (DAU, 2022a). This research focuses on Urgent Capability Acquisition, MTA, and Major Capability Acquisition to deliver C-sUAS solutions to the Air Force.

While following portions of this research provide greater detail on the processes by which the MTA and AAF can be utilized to establish and formalize a C-sUAS program, the purpose of introducing the AAF is meant to highlight the different pathways by which C-sUAS can be delivered to the Air Force and simultaneously show how those same pathways can be transformed into a formal acquisition program to streamline the delivery of those systems.

G. CONCLUSION

The emergence of UAS technologies poses the opportunities to provide both great utility and great harm to the DoD. It is that threat against the DoD that is driving the acquisition of technologies that are capable of countering those threats. That technology is recognized as C-sUAS. From these realizations, a problem was identified in the lack of a formal C-sUAS acquisition strategy specifically for the Air Force. This lack of strategy will hinder the Air Force from to acquiring needed C-sUAS capability at the speed of relevance. From this problem, a purpose for this research was established as helping to identify and understand how the Air Force cannot adequately defend itself against the UAS threat without a formal C-sUAS acquisition strategy.

To further highlight the purpose and a need to address the problem, examples were provided for where the Air Force could be exploited by the UAS threat. Understanding the different types of UAS became necessary to better identify the threat that the Air Force is combatting for UAS. A final introduction was provided for DoD acquisition that could be used for C-sUAS as well as the different types of acquisition frameworks (collectively recognized in the AAF) that can provide PMs certain levels of freedom and flexibility in how they conduct their acquisition programs. From this introduction, the next step for this research is to examine the background by which all of those piece's tie together and become relevant to today's military and specifically, its Air Force.

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II. BACKGROUND AND LITERATURE REVIEW

The purpose of this chapter is to provide the information needed to 1) understand the capabilities provided by C-sUAS against the UAS threat and 2) explain the processes by which DoD acquisition programs operate in order to procure such systems and capabilities. That information serves as the foundation for the analysis and subsequent recommendations as to how the DoD acquisition system can be used to deliver capability at the speed of relevance and establish a formal C-sUAS acquisition strategy for, a program of record that will benefit the Air Force (in addition to the other branches of the military) to protect installations, resources, and personnel against the UAS threat.

A. UAS THREAT

This research first explores what malicious UAS are capable of and the risks they pose to the Air Force. Arguably the biggest concern against UAS is the kinetic damages that they can inflict. There have been repeated instances and examples of UAS being directly responsible for strikes against physical resources and personnel. Such examples were highlighted by Miller (2020) when UAS that were equipped to drop small explosives were directly attributed for attacks targeted against U.S. and coalition forces and Iraqi security forces in Mosul, Iraq in 2016. Another case was an attack against the Saudi Arabia Abqaiq-Khurais oil refinery in 2019, where sUAS were used to strike oil processing facilities (Miller, 2020). While the agents responsible for these attacks and the motives behind their attacks should be treated with a considerable level of concern and attention, these examples highlight how UAS were used to inflict kinetic damage that could equally be perpetrated against the Air Force.

Considering these two examples, one could begin to understand the consequential impacts brought on by UAS aimed against the United States and its Air Force. Starting with the threat against forces and personnel, those platforms could inflict harm through a number of different tactics, whether they be explosive in nature (dropping munitions or acting in an improvised explosive manner), being equipped with other weaponry, or directly targeting and striking personnel. The potential for harm to be brought against

U.S. forces, specifically Airmen, represents a risk and even threat against those that are lacking adequate defensive measures.

Continuing with the risks and threats posed by UAS, the potential for destruction and damage against assets and resources equally exists. Returning to Miller's (2020) example of the Saudi Arabia Abqaiq-Khurais oil refinery attack from 2019, the image of a well-placed explosion in a highly volatile environment is easily envisioned. Without delving into installation specifics, it is sufficient to note that the same scenario from Abqaiq-Khurais could be applied to locations that store their own explosive and volatile elements such as munitions (conventional, and nuclear in some locations), aircraft, communication stations and equipment, and even their own fuel storage facilities and delivery systems.

One last example that highlights the consequential impacts brought on by UAS against the Air Force represents a bridge of threats against personnel and resources conducting operations. Aircraft in flight (especially those in the critical phases of flight such as takeoffs and landings), Airmen performing maintenance on or handling munitions, and a communications center that is staffed and in the process of transmitting sensitive data all represent lucrative targets for UAS that could end in damages and harms against personnel and resources, some of which could have strategic consequences for the Air Force and United States if an attack of such nature were to be perpetrated.

B. C-SUAS FUNCTIONS

From this brief consideration of threats posed by UAS, the next topic to be addressed is that of the defensive systems and capabilities that could be used to protect against those threats. Fortunately for the potential targets discussed in the preceding paragraph, there is a litany of defensive systems and capabilities that already exist. Before specifically identifying examples of C-sUAS systems and capabilities, the processes by which those elements operate must first be presented.

In his work on existing technologies for C-sUAS, Popescu (2021) discussed the manners by which such technologies defend against UAS. From that work, Popescu (2021) found that C-sUAS work by detecting, recognizing, identifying, localizing,

blocking, capturing, or destroying UAS operating in unauthorized airspace as either a lone function or as part of a series of functions conducted by one system. Detection of UAS is formally defined as when the system enters protected airspace and is found by radar, audio interception systems, motion sensors, and infrared and electro-optical devices (Popescu, 2021). Recognition of a UAS occurs when distinctive signs or features of the UAS are matched against imagery of the system that categorize it into its respective UA category (Group 1-5; Popescu, 2021). Identification of UAS is a detailed process whereby the system is recognized based on matching imagery and then verifying the system characteristics (physical, digital, frequency signature, etc.) against existing digital databases that have catalogued known and common systems (Popescu, 2021). Localizing of UAS requires the employed C-sUAS to successfully determine the location of the UAS, which is commonly recognized through grid coordinates and/or its relative relation to the defensive system (Popescu, 2021). In order for a C-sUAS to block a UAS, it must interrupt or deny access to the link between the system and its remote pilot source (Popescu, 2021). This can be accomplished through methods such as radio frequency jamming, or blinding (such as through lasers or microwave energy pulses) the UAS's electro-optical equipment that the pilot requires to remotely operate the system (Popescu, 2021). A capturing function of a C-sUAS system would literally entail the physical capture of a UAS through a system like a net fired at the UAS to restrict its flight capabilities or piloting a friendly UAS into the enemy UAS to either destroy it or severely cripple its flight capability (Popescu, 2021). Finally, there are multiple methods by which a C-sUAS could destroy a UAS. Those methods include actions such as: explosive charges or rounds that target the UAS, directed lasers that terminate the internal electronic components of the UAS, or high-velocity impacts from a targeted friendly UAS with the purpose of obliterating the enemy system (Popescu, 2021).

These functions represent the basic requirements for C-sUAS. Those requirements are then translated as functions and the tactics, techniques, and procedures (TTPs) that are used to employ C-sUAS. The basic functions of C-sUAS as described by Popescu (2021) help to explain the design, functionality, and use of modern systems. Those functions, and how they shape defensive operations for an installation, will ultimately dictate which kind of system is chosen to be employed there. It is due to the range of

functions that are provided by C-sUAS systems that installations are provided with more than one mean to defeat the UAS threat. From those means, the next step becomes considering some of the more prominent C-sUAS systems that exist to defend Air Force Installations.

C. C-SUAS SYSTEMS

As the use and popularity of UAS has risen over past years, the technologies aimed at deterring their use and operations haven't just risen but have become commercialized. Public and private companies alike have recognized a market where entities have demonstrated a strong need to dissuade UAS from operating in certain air spaces. The need of defense from UAS has become so pronounced that in 2021, the collective C-sUAS market was valued at $1.92 billion and projected to grow to $5.02 billion by 2028 (The Insight Partners, 2022). This 14.7% growth rate (The Insight Partners, 2022) is attributed to increasing and improving technologies in the C-sUAS market. Some companies have become more renowned and established in the DoD and Air Force to showcase their C-sUAS systems, and those systems products' capabilities. A preliminary market research from Strout (2020) yields the following C-sUAS companies and systems: the Air Force Research Lab (AFRL)'s Negation of Improvised Non-State Joint Aircraft (NINJA) system; Kongsberg Geospatial's Multi-Environmental Domain Unmanned Systems Application (MEDUSA); SRC Inc.'s Fixed Site-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System (FS-LIDS); and Northrup Grumman's Forward Area Air Defense Command and Control (FAAD-C2; Strout, 2020). These companies and systems were among those selected by the DoD and by the Joint C-sUAS Office (JCO) to "reduce redundancy in the development and fielding of various C-sUAS solutions by the Services" (Strout, 2020, p. 1). The Army was designated by the Secretary of Defense to lead for this joint initiative and program office to best address the DoD's operational needs from these systems while also utilizing resources in an effective and efficient manner, according to the JCO's director, U.S. Army Major General Sean Gainey (Strout, 2020).

1. NINJA

One of the first systems employed by the Air Force for defense against UAS was the NINJA system. As recently as September 2021, the AFRL took transfer from the Digital Defense Service (DDS); a rapid response team working within the Office of the Secretary of Defense comprised of private industry, government, and military technical experts charged with addressing emergent and primarily technology-based threats of its technologies to sense and detect UAS (Mitchell, 2021). Specifically, it was AFRL's Negation of Improvised Non-State Joint Aircraft (NINJA) system that was targeted to absorb those drone-sensing capabilities (Mitchell, 2021). The UAS sensing capabilities have included sensors that provide high-fidelity and long-range capable sensors that are further able to be integrated with a user interface (Mitchell, 2021). The acting director of DDS, Katie Olson described the NINJA program, that it was designed as "a fielded, affordable, and software-adaptable system capable of taking control of or disabling" (Mitchell, 2021, p. 1) certain UAS and respective UAS groups. From the brief synopsis of the NINJA system that AFRL has undertaken the development and fielding initiatives for, the C-sUAS functions that were previously described become apparent. Specifically, the NINJA is presented as being capable of executing the full gambit of C-sUAS functions of detecting, recognizing, identifying, localizing, blocking, capturing, or destroying the threat (Popescu, 2021). The NINJA effort can be used to understand potential technologies and set the requirements for a formal major capability acquisition by the Air Force. The same arguments could be considered from a different facet when examining the next C-sUAS program, Kongsberg Geospatial's MEDUSA.

2. MEDUSA

While one system may be specially employed with the ultimate purpose of defeating a UAS threat, other C-sUAS systems may be utilized by Air Force installations as a means to provide command and control (C2) capabilities over those systems. One such system is the Multi-Environmental Domain Unmanned Systems Application (MEDUSA) from Kongsberg Geospatial. This application was designed with the intent of providing C-sUAS operators (more broadly applied to battle space owners) with a multi-domain display picture that captures a real-time C2 visualization of the battle space,

which for this research is recognized as the air defense of an Air Force installation (Kongsberg Geospatial Ltd., 2020). MEDUSA provides its users with a literal way of tracking and displaying what the employed C-sUAS sensors are tracking in the area in order to provide decision-makers with real-time imagery and information on what their C-sUAS are engaged in and fixed on in the forms of UAS in order to provide up-to-date information on the evolving UAS scene (Kongsberg Geospatial Ltd., 2020). The MEDUSA system does feature, by proxy of another employed C-sUAS, the functions of detecting, recognizing, identifying, and localizing a UAS (Popescu, 2021). For example, a NINJA system sensor operating on an Air Force installation could detect, recognize, identify, and localize a UAS flying over the restricted air space of the installation. A second sensor could yield the same findings. The data from the NINJA sensors would be displayed on the MEDUSA desktop application, which would also present the C-sUAS operator with other relevant information (such as information on friendly aircraft flying in the same airspace). From MEDUSA's C2, the C-sUAS operator can make a real-time decision to have the NINJA systems engage and destroy the UAS threat while simultaneously deconflicting with any concerns posed against the friendly aircraft. Though the primary C2 capability provided by MEDUSA does not directly tie to one of the C-sUAS functions previously mentioned, it does provide C-sUAS operators and decision-making authorities with multiple other crucial capabilities. These capabilities include the ability to gather detailed information on a UAS and gather a more wholistic sight picture of the UAS threat, while simultaneously commanding and controlling multiple C-sUAS systems and/or sensors (if employed) to best control the contested battle space. What is important to note from the C2 capabilities of MEDUSA is not in its technical functions insomuch as the broader situational awareness provided by this C2 C-sUAS system, a capability that can similarly be seen in another C2 C-sUAS system, the FAAD-C2.

3. FAAD-C2

Another C-sUAS that provides C2 capabilities and battle space situational awareness, and that can be employed by Air Force installations is Northup Grumman's Forward Area Air Defense/Counter-Rocket, Artillery and Mortar Command and Control

or, FAAD-C2. Though this system provides a very similar C2 functions to that of the MEDUSA, Northrup Grumman's FAAD-C2 features capabilities, intricacies, and nuances that differentiate it from the MEDUSA, as related to ultimately meeting an installations C-sUAS mission. The first of those differences can be found in the counter-rocket, artillery, and mortar capability (C-RAM) of the system. Detecting, tracking, and defeating rockets, artillery, or mortars aimed at an Air Force installation, may not be recognized as a primary function of C-sUAS, but could ultimately represent the most important aspect of any system: to defend an installation's resources and personnel from airborne threats.

Speaking more specifically on the workings of FAAD-C2, Northrup Grumman (2020) described their system as one that is capable of integrating with a variety of C-sUAS sensors and systems, including those that are enabled with electronic warfare and directed energy capabilities. The interface of the system was presented by the company as being "multi-domain, system-of-systems, and vendor neutral architecture," which allows for "integration and interoperability across diverse platforms and systems," while simultaneously "facilitating rapid and cost-effective technology insertion and modernization" (Northrup Grumman, 2020, p. 1). The architecture of FAAD-C2 was designed to be non-proprietary and compatible with any network (Northrup Grumman, 2020). That architecture was further designed to integrate with sensors, all to correlate and fuse data from active track sources and generate a detailed, current digital sight picture of the air and battle space that is intended to provide C-sUAS operators with early threat warnings and provide courses of action (COAs) that are able to be enacted by all applicable C-sUAS (Northrup Grumman, 2020).

For the capabilities and functions offered by this C2 systems, the FAAD-C2 provides means to maintain a real-time sight-picture and situational awareness for an Air Force installation's battle space. This is accomplished through the generation of real-time data and displaying that to C-sUAS operators and decision-makers so that they have the most current information possible to best employ their C-sUAS sensors systems to defeat the UAS threat (Northup Grumman, 2020). Having explored multiple C2 C-sUAS that are capable of integrating systems, one final system included in this research is the FS-LIDS.

4. FS-LIDS

SRC Inc.'s Fixed Site-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System or, FS-LIDS, is capable of providing Air Force installations with C-sUAS capabilities, specifically with the capability to defeat the UAS threat. FS-LIDS technology was reported by SRC as possessing a radar component that is complemented with electronic warfare components and camera tracking systems which provides users with a suite of systems to counter a UAS (SRC, 2020). Those systems were more explicitly defined by SRC as AN/TPQ-50 air surveillance radar, which is aided by a C-sUAS electronic warfare system and cameras enabled with electro-optics and infrared components to comprise the key interworking systems of FS-LIDS (SRC, 2020). The interconnection of these systems was intended to provide installations and their C-sUAS operators with a means of detecting and identifying/classifying a UAS operating within the battlespace, which can then be engaged by a precision strike from the electronic warfare system to ultimately defeat that threat (SRC, 2020).

From the capabilities reported of the FS-LIDS system, the functions that it is capable of providing include: detecting, recognizing, identifying, localizing, and destroying a UAS threat (Popescu, 2021). Arguably one of the most important features of FS-LIDS, is not its electronic warfare defeat capability (though that is still an incredibly important function) but rather, its camera and imagery technology capabilities (SRC, 2020). As it has previously been discussed at length, one universal function of C-sUAS systems is to provide operators of the systems, and those charged with defending Air Force installations, with the most complete and current information in any UAS scenario. Perhaps one of the best manners in which to do this is through a live camera feed that can actively track and interrogate a UAS threat, precisely what FS-LIDS is capable of (SRC, 2020). It is through this combination of capabilities and functions that FS-LIDS becomes a promising and alluring C-sUAS option to defend Air Force installations against the UAS threat.

The C-sUAS systems discussed in this preliminary market research represent a small portion of the available systems and products that exist to defeat the UAS threat. It should be noted that each of these systems has been employed by various branches of the

U.S. military, including the Air Force. These systems and programs have demonstrated their capabilities in operational environments and settings such as in CONUS, outside the continental United States (OCONUS), and even in formally designated combat zones. With a brief understanding of some of the C-sUAS systems that are available to provide defense for Air Force installations, the next step involved in determining how the Air Force can defend itself against these threats is to examine the methods by which the Service can formally acquire these systems and their respective capabilities.

D. C-SUAS ACQUISITION

The existence of the UAS threat and what it poses against Air Force and DoD installations, as well as current and future C-sUAS that can be employed to defeat that threat do not intuitively interlock. In order for Air Force installations to employ C-sUAS against UAS, they must first acquire those systems. Though Air Force installations organically possesses the means to acquire the systems, the focus of this research is to determine a recommended strategy for the entire Air Force to execute large-scale acquisition of such systems and field them to the force for their employment against the UAS threat. Though the acquisition of C-sUAS system at the individual, installation level is certainly a viable and expedited manner by which stations can facilitate and ensure their own UAS defense, a broader approach is called for in order to wholistically apply UAS defense across the Air Force. That broader approach can be accomplished through multiple acquisition pathways in the AAF.

In order to determine how the Air Force might best pursue and achieve such a strategy, one must first have an understanding of how the DoD acquisition process operates. The following sections provide a deeper exploration of the DoD acquisition process before venturing into explanations and recommendations as to how the Air Force can engage this process to formally acquire C-sUAS capabilities for the force.

The Defense Acquisition University (DAU) defines *acquisition* (as practiced by the DoD) as: "the conceptualization, initiation, design, development, testing, contracting, production, deployment, Logistics Support (LS), modification, and disposal of weapons and other systems, supplies, or Services (including construction) to satisfy DoD needs, intended for use in, or in support of, military missions," ([DAU, 2012, p. 54). The

highlight of the definition for acquisition for the DoD shows that the process involves more than a singular procurement. Rather, DoD acquisition is presented as a multi-step, multi-faceted process that brings a system or capability to the DoD, through deliberate and methodical action, and follows that entity from its creation to its ultimate disposal and destruction. Understanding that the acquisition of a system, specifically a C-sUAS, requires more than simply purchasing the system, allows one to contextualize the greater process that is DoD acquisition.

The DoD explicitly highlights this process through one of its directives; specifically, DoDD 5000.01: *The Defense Acquisition System* (2020). The policy of the DAS (2020) is to support the NDS in its development of a lethal force by acquiring capabilities to meet warfighters' needs by improving their mission capabilities, materiel readiness, and operational support, all at a fair and reasonable price to the U.S. government and its taxpayers. DoDIs were further developed and able to be more prescriptive in the acquisition process. The utilization of DoDIs on acquisitions is instrumental for the Air Force and its sister Services in their pursuit of new systems and capabilities, including C-sUAS.

For the Air Force to ensure the lethality of its force through the acquisition of C-sUAS capabilities, the DoD 5000 series of documents are crucial enabler to effectively deliver capability to the warfighter. While each of these documents are relevant and necessary to ensure the ultimate successful fielding of a system or capability to meet modern warfighters' needs, this research focuses on the documents of the DoD 5000 series that are more directly aimed at the procurement and fielding of such items. Of the 25 overarching polices within DoDD 5000.01, there are five specific policies highlighted in this research. Those five specific policies are: deliver performance at the speed of relevance; develop and deliver secure capabilities; employ performance based-acquisition strategy; plan for product support; and deploy interoperable systems (OUSD [A&S], 2020b).

As part of the DAS, the governing policy of delivering performance at the speed of relevance enables the following operating policies:

- empower PMs with greater authority and autonomy within their programs

- simplify acquisition policy to remove administrative and bureaucratic hurdles that stymie programs
- employ tailored acquisition approaches that allow programs and their PMs flexibility in determining how that program is developed
- conduct data driven analysis to produce the best priced and most technically feasible product
- actively manage risk across the acquisition process
- emphasize product support and sustainment (OUSD [A&S], 2020b).

The second part of this policy calls for the use of an adaptive acquisition framework (AAF) in order to emphasize the former principles (OUSD [A&S], 2020b).

The policy for the development and delivery of secure capabilities focuses on full-range spectrum of security (physical and cyber) for the protection for acquisition technologies throughout all phases of that process to ensure an uncompromised delivery of the system or capability to the customer (OUSD [A&S], 2020b). Acquisition professionals bear the responsibility of ensuring this policy is met by coordinating all phases of the acquisition process with the appropriate security professionals to identify, integrate, and continually evaluate security for the program (OUSD [A&S], 2020b).

The employment of performance-based acquisition strategies calls for PMs to build an acquisition strategy around a structure that focuses on the results that can be achieved from the program versus previously traditional approaches that focused primarily on the manner and timeline with which work was completed and when set milestones were reached for a program (OUSD [A&S], 2020b). The intent of this policy is to provide customers with incremental capabilities instead of focusing purely on timelines, where if the schedule of a program slips or is extended, the risk is posed of no capability being delivered if that slip could result in the cancelation of the program.

The planning for product support policy calls for product support strategies (PSSs) that are guided by business case analyses, which are also mandated by Section 2337 of Title 10 of the United States Code (U.S.C., OUSD [A&S], 2020b). The PSSs from the business case analyses is meant to ensure enduring and affordable products that are determined through the use of supporting metrics which are used to conclude that program objectives will be achieved and sustained throughout the life cycle of the program (OUSD [A&S], 2020b).

Finally, the policy that calls for the deployment of interoperable systems is meant to enable joint concepts, standardization, and interoperability for acquired systems and capabilities across the U.S. military Services, and to the maximum extent possible with coalition partners (OUSD [A&S], 2020b).

These five specifically mentioned polices from DoDD 5000.01 were noted for their applicability to the Air Force to acquire C-sUAS because they represent some of the most vital requirements that must be met in order to allow for successful procurement and fielding of those systems for the Air Force. For instance, if the delivery for performance at the speed of relevance did not empower PMs to tailor their acquisition strategies and approaches and did not work to simplify the DoD's acquisition policy, the proposed Air Force acquisition of C-sUAS may never be able to efficiently and effectively be executed. As that program could otherwise be subjected to protracted, bureaucratic, and rigid processes, which may significantly delay the program, or even doom it before any capability is delivered to the warfighters that are desperately in need of that capability. This example could further be extrapolated from the policy of employing performance based-acquisition strategies whereby the focus on meeting timelines for when various aspects of a system or capability are scheduled to be delivered instead of allowing performance standards to dictate when those elements can be delivered. What this approach and policy allows for is incremental development and delivery of capabilities which gives the warfighting customer some semblance of what they are in need of vice, holding any and all deliveries until the end of a program, when final products are scheduled to be delivered.

One final example that can be highlighted for the importance of these five polices as they can allow for the Air Force acquisition of C-sUAS, is in the plan for product support. Counter to the previous polices, which are more focused on the beginning and initiating stages of an acquisition program, this policy focuses on supporting that program through the, often, substantially longer-lasting life-cycle of the program once it is fielded and becomes operational. Without planned support for equipment, manpower, training, logistics, and other elements that will be needed to sustain a program throughout its lifecycle, that program will inevitably serve a short-lived operational life and have limited utility to its customers. The acquisition of C-sUAS in no exception to this notion.

Examples and implications to Air Force acquisition of C-sUAS could be highlighted for each of the 25 over-arching policies from DoDD 5000.01, but the five previously presented policies are argued to be the most vital to establishing the groundwork of an acquisition program for C-sUAS. With having identified some of the key polices of Defense Acquisitions, the next step becomes examining how that system and its framework can be employed by PMs to deliver capabilities and meet the needs of their customers.

E. ADAPTIVE ACQUISITION FRAMEWORK

The next instruction from the DoD 5000 series that can enable PMs to utilize the acquisition system to acquire C-sUAS for the Air Force is the DoDI 5000.2: *Operation of the Adaptive Acquisition Framework (AAF).* This instruction sets policy and procedures for managing acquisition programs while assigning PMs responsibilities within their programs and making improvements for processes for the AAF (OUSD [A&S], 2020a). One of the main features of DoDI 5000.02 is to capture the general procedures by which PMs develop their acquisition strategy. That formal acquisition strategy is codified and presented for approval to what is known as a milestone decision authority (MDA) who is ultimately accountable for that program and all of its associated costs, schedule and timeline, and performance reports that are submitted to higher authorities such as Congress (OUSD [A&S], 2020a). Through the construct and ultimate approval of an acquisition strategy, PMs become empowered to employ a variety of acquisition pathways in a manner that they determine as fit to acquire a system or capability. DoDI 5000.02 establishes several responsibilities, requirements, and priorities for PMs, some of which include:

- identifying and adhering to all regulatory requirements of DoD acquisition programs
- employing strategies that yield cost-effective technology solutions in manners that are mutually beneficial between the DoD and its business partners
- ensuring any cybersecurity concerns for the program are addressed early and continuously throughout the life cycle of a program
- considering long-term support requirements for the program in the forms of data and license rights
- prioritizing affordability for all aspects of the program's life cycle

- establishing a risk management program to manage risks at all levels and stages of the program
- setting appropriate engineering tradeoffs and technical baselines (OUSD [A&S], 2020a).

From the responsibilities, requirements, and priorities that the AAF sets for PMs, the document also identifies and describes the different acquisition approaches that are capable of both giving the PMs and users of the pathways direction in how exactly they use those pathways, while simultaneously capitalizing on advanced acquisition methods by which the DoD can stand to benefit from its business partners and their innovative accomplishments (OUSD [A&S], 2020a). Those six pathways identified as part of the AAF include:

- Urgent Capabilities Acquisition
- the MTA
- Major Capability Acquisition
- Software Acquisition
- Defense Business Systems Acquisition
- Defense Acquisition of Services (OUSD [A&S], 2020a).

Each of the listed pathways was designed with specific characteristics to further meet the intended purpose of that framework (OUSD [A&S], 2020a). While the defining characteristics and purposes of the listed pathways are more evident than others based on their namesakes, there are other pathways that may require further explanation to provide insight on what that pathway was designed to achieve.

One of the pathways that is newly established is the MTA. The purpose of the MTA was described in DoDI 5000.02 (OUSD [A&S], 2020a) as the rapid development of fieldable prototypes that are meant to either demonstrate a new capability that was requested by a warfighting customer and/or; rapidly fielding proven systems and technologies that are able to be produced in quantity with minimal development efforts. The purpose of MTA is fulfilled in the characteristics of the pathway that focus on the rapid nature of the pathway as applied to prototyping and fielding efforts (OUSD [A&S], 2020a). Translating "rapid" into a measurable metric within the MTA equates to 5 years or less from the start date of a program for either the prototyping or fielding a system or capability that can be demonstrated within an operational environment (OUSD [A&S],

2020a). While rapid prototyping and fielding certainly presents an allure of warfighters having either prototypes or operational systems and capabilities delivered to them within 5 years, other pathways offer their own appealing benefits for customers.

One of the pathways that offers a more apparent utility to the warfighting customer who may wish to employ the method is found in the Urgent Capability Acquisition pathway (OUSD [A&S], 2020a). Similar to MTA, the Urgent Capability Acquisition pathway can deliver a system or capability to a customer within a designated timeframe. When comparing timelines, the difference between MTA and the Urgent Capability Acquisition pathway is that the purpose for acquisition programs designated as "urgent" is to field those capabilities in less than 2 years (OUSD [A&S], 2020a). The characteristics of this acquisition pathways were defined within DoDI 5000.02 as being the top priority for the DoD to provide its warfighters with the systems and capabilities that they are in urgent need of to combat evolving threats and also to reduce the risks of suffering causalities all to ultimately achieve mission success (OUSD [A&S], 2020a). There are stipulations that systems and capabilities within the framework are subject to. For example, urgent needs must be identified and approved to move forward by the proper authority who simultaneously ensures that estimated costs provided by the system or capability solution will not exceed either $525 million for research, development, test and evaluation actions (or any combination of those activities) or, that the acquired solution will not exceed $3.065 billion for total procurement, with Fiscal Year (FY) 2020 being used as the base measure for dollars spent (OUSD [A&S], 2020a). There are four phases of this pathway which include: Pre-Development, Development, Production and Deployment, and Operations and Sustainment (OUSD [A&S], 2020a). The entirety of this pathway focuses on aggressively streamlined operations and processes based on the urgent need that the pathway is charged to deliver (OUSD [A&S], 2020a). "The imperative is to quickly deliver useful capability to the warfighter in a timely fashion," (OUSD [A&S], 2020a, p. 11). Apart from acquisition pathways being built around designated timelines to deliver systems and capabilities to warfighting customers, other pathways exist that were built with a focus on the processes and phases that comprise the pathway.

One of the most prominent pathways used in DoD acquisition is that of the Major Capability Acquisition pathway. What makes the pathway so prominent can be recognized in the overall purpose of the program: "To acquire and modernize military unique programs that provide enduring capability" (OUSD [A&S], 2020a, p. 12). This succinct purpose statement for the Major Capability Acquisition pathway highlights its foundational premise of procuring new, lethal systems and capabilities, ensuring that existing elements maintain their lethality and operational capabilities and, providing means by which those systems and capabilities maintain their relevance through planned sustainment measures. The characteristics of the pathway further speak to its prominence and utility within the DoD's acquisition system. The characteristics of the pathway are not only representative of the operations and utility of the pathway, but also help to highlight how integrated acquisition plans and processes can help to deliver systems and capabilities that meet the intended requirements as set by the customer and shaped by the PM and their office. The specifics of those characteristics were described within DoDI 5000.02 as an acquisition process based on an approach that is designed to "analyze, design, develop, integrate, test, evaluate, produce, and support" defense systems and capabilities (OUSD [A&S], 2020a, p. 12). There are five distinct stages within the pathway that include: Materiel Solutions Analysis (MSA), Technology Maturation and Risk Reduction (TMRR), Engineering and Manufacturing Development (EMD), Production and Development (P&D) and, Operations and Sustainment (O&S; OUSD [A&S], 2020a).

The transition between each of these phases is signified by decision points, recognized as milestones and operational capabilities of the program (OUSD [A&S], 2020a). Each of the milestones (A, B, and C) represent either the start or continuation of an acquisition program into its next phase. Milestone A signifies a program that will enter into TMRR, Milestone B represents an acquisition passing into the EMD phase and being recognized as a program of record and, Milestone C represents that the program is ready for that system or capability to enter P&D. In order for a program to pass through the respective milestones and from one phase of the Major Capability Acquisition pathway, the MDA must approve the program to proceed. Once a program has progressed past Milestone C and the P&D phase, it becomes eligible to enter into operations and later into

sustainment for its operations (OUSD [A&S], 2020a). There are also varying levels of operational capabilities that the program transitions through that signify increased levels of operational ability. Those operational levels are that of when a system is declared is either Initially Operational Capable (IOC) or Fully Operational Capable (FOC) (OUSD [A&S], 2020a). Though each of the phases of the Major Capability Acquisition pathway, the associated milestones, the levels of operational capabilities, and all the supporting documents and processes could be discussed in much greater detail, the point is to introduce readers to the larger framework and provide a base-level understanding of the characteristics and ultimate purpose of it.

Determining how the U.S. Air Force can defend its installations, resources, and personnel from the UAS threat requires more than garnering a singular understanding of the threat itself. It requires a wholistic approach to understand the threat, the systems and capabilities that can be used to counter the threat, and the ways in which those counter systems and capabilities can be acquired to ultimately provide a defense.

F. CONCLUSION

Understanding the need for the Air Force to acquire C-sUAS and have a strategy for those acquisition starts with understanding the threat posed by sUAS. That threat from sUAS can be actualized in a number of different ways with one of the main concerns being recognized in the kinetic damages that they can inflict. Without delving into specific ways by which sUAS can inflict damage against the Air Force, the next step of this research to explore how C-sUAS can counter that threat. Popescu (2021) provides highly useful research in understanding the functions of C-sUAS which included detecting, recognizing, identifying, localizing, blocking, capturing, or destroying UAS operating in unauthorized airspace as either a lone function or as part of a series of functions conducted by one system. Four specific C-sUAS that had been identified by the JCO for investments by the DoD were explored in the functions that they can provide. Those C-sUAS were NINJA, MEDUSA, FAAD-C2 and, FS-LIDS.

Understanding how these systems could be acquired required providing an understanding of how the DoD acquisition process operates. This was accomplished by exploring background on the operations of the DAS and the AAF that are both primarily

guided by directives and instructions that are authored and set by the DoD. Having provided background information on these elements, the next step is to explore and consider existing literature that can assist with providing a recommendation as to how this collective process can be successfully executed strategically and operationally.

III. METHODS

This research highlights a vulnerability for the U.S. Air Force, specifically, the lack of an established acquisition strategy for C-sUAS, that fails to allow for the delivery of that capability to today's warfighter. The development of a C-sUAS acquisition strategy will allow for a program of record to be established for the Air Force in its acquisition of a C-sUAS capability. This can be accomplished by utilizing a larger DoD strategy, market research, and a qualitative literature review and analysis to examine existing products that have been successfully acquired and employed against sUAS. From this analysis, the following sections of this research report will identify successful acquisition strategies and programs and leverage those cases to ultimately provide recommendations on how the DoD can effectively establish a C-sUAS acquisition strategy and then a program of record that streamlines the delivery of that capability to the in-need warfighters of today. This approach is appropriate because garnering an understanding of C-sUAS products, and processes, while simultaneously identifying manners in which to navigate the complex DoD acquisition system can help to provide a way of circumnavigating the obstacles, roadblocks, and stovepipes that slow the delivery of systems and capabilities to warfighters. The analysis of these resources offers multiple C-sUAS, and multiple acquisition processes that can be aligned to better help the Air Force to combat the sUAS threat. The qualitive literature review that was conducted was based on collection and analysis of open-source documents that provided information on both C-sUAS and the DoD acquisition system.

The literature review that was conducted for the completion of this research examined three distinct elements individually to allow for follow-on synthesis of each of these elements. The three elements that were selected for individual studies and analysis were: C-sUAS functions, C-sUAS systems and operations and, DoD acquisition of C-sUAS. By garnering a better understanding of each of these elements, one can recognize the avenues by which the U.S. Air Force can deliver capability to the warfighter.

A. DATA TYPES

The nature and purpose of this research and its query was to examine how the Air Force can formally acquire C-sUAS and the capabilities that they provide. The most common data type was recognized in that of DoD-published directives and instructions. DoD directives regularly set policy that orients the DoD with the originating components vision for the relevant area of concern. This was largely the same premise for DoD instructions with a chief distinction being that the instructions tend be much more prescriptive in their deliveries. The importance of researching and referencing these types of documents is argued to be that not only do they provide a path to follow and meet the strategic goals and initiatives of the most senior members within the DoD, but those same paths also describe, in some cases literally, how warfighters can acquire the needs that must be met. By following published guidance from top-level authoritative sources within the DoD, this research aims to identify the methods by which a C-sUAS acquisition strategy and subsequent program can be established by the U.S. Air Force for C-sUAS.

Another type of data that was referenced in this analysis was that of technical documentation of C-sUAS design, functions, and operations. It is discussed in more detail in the following section, but this technical documentation was cited directly from the owning companies' websites. Based on proprietary rights and concerns, as well as protecting the systems and capabilities that protect important and valuable resources, this documentation was largely restricted on the information that it was able to provide through open-source mediums such as company websites for the products. Even despite the limited technical information that was available for these C-sUAS, their respective sites provided valuable insight, background, and basic functions and operations of those systems. As the purpose of this research is not to dissect the inner workings of C-sUAS, the type of data cited from these companies helped to demonstrate the capability that C-sUAS can provide in combating against the UAS threat through multiple approaches.

One final data type that was vital to this research came from scholarly and academic writings. These data types helped to provide supporting and supplemental information to the previously mentioned areas as well as offering expertise and

significant knowledge in the areas of UAS, C-sUAS, DoD acquisition, Air Force acquisition, and academic data sources. Whether data used for this project were that of a government document, private industry technical documentation, or academic-based supporting information, all of these data types helped to convey information and knowledge into how the Air Force can establish a C-sUAS program. Aside from the content of the data types that were used in this project, there was also special consideration given to how the data were collected and the sources that were used during the collection process.

B. DATA COLLECTION AND SOURCES

Collection of the data was accomplished in two distinct phases. For the first phase, data were researched, assessed and categorized into DoD acquisition, Air Force acquisition, C-sUAS and C-sUAS education, and UAS operations. Given the ever-evolving nature of each of these categories, with emphasis added to C-sUAS and UAS technologies, referenced material was primarily kept to works that were published from 2015 to the present day. Collection of these data categories came from scholarly sources that consisted primarily of books, peer-reviewed journal articles, and government-published documents such as DoDDs and DoDIs. The retrieval of these data types was accomplished principally by using two different databases: the Naval Postgraduate School's (NPS) Dudley Knox Virtual Library, and the Office of the Secretary of Defense's (OSD) Electronic Services Directorate (ESD). Through the first phase of researching and categorizing different elements related to the primary focus of this project, setting and adhering to collection criteria, and using legitimate DoD databases, this work was able to capitalize on the work of industry and academic experts all to address the main problem of the lack of an existing a C-sUAS acquisition strategy for the Air Force against the sUAS threat.

The second phase of data collection focused on obtaining information on the different C-sUAS that were already in existence and operation. The process by which these data were collected involved accessing respective C-sUAS company websites to locate and report on available information for those systems. The purpose of pulling C-sUAS directly from their company's websites was to allow this project to speak directly

as to the general purpose and operations of their products. Those same general purposes and operations helped to convey how the UAS threat can be combatted through the employment of these systems and capabilities. By utilizing information from private industries, the data that were referenced were intended to start demonstrating relationships that already exists and can further be fostered between the DoD and public and private corporations to help produce and field systems and capabilities for warfighters in need.

The qualitive literature review that was conducted to provide information on both C-sUAS and the DoD acquisition system was a significant undertaking for the completion of this project and was crucial in helping to identify pathways by which the Air Force can acquire C-sUAS solutions. With insight being provided into how the research for this project was completed, the shift turns to identifying recommendations for strategic goals and prescriptive means by how the problem of this research can be addressed.

C. CONCLUSION

The research that was conducted in support of this project was accomplished in the form of a qualitative literature review. That literature review was done by exploring existing products, that have been successfully acquired and employed against sUAS. That review was further based on the collection and analysis of open-source documents that provided information on both C-sUAS and the DoD acquisition system. Data types referenced in the literature review included of DoD-published directives and instructions, technical documentation of C-sUAS design, functions, and operations and finally, scholarly and academic writings. The sources and collection of the literature was obtained in two distinct phases. The first phase focused on sourcing data and information and then categorizing them as DoD acquisition, Air Force acquisition, C-sUAS and C-sUAS education, and UAS operations. The second phase involved obtaining information regarding C-sUAS that were already in existence and operating for the DoD's use. The qualitative literature review that allowed for the collection of the data and information allowed for analysis of those elements.

IV. FINDINGS AND ANALYSIS

Through background information on UAS, C-sUAS, the functions of those systems, various systems in existence, the Air Force and Defense acquisition of defensive systems and capabilities, this research now shifts its focus to what is being done by the DoD and Air Force to integrate all of these elements to provide defense against the UAS threat. Additionally, this section presents an analysis of the current efforts to meet the challenge presented by the UAS threat. This leads to the final chapter of this research that provides recommendations for how the Air Force can defend itself against the UAS threat by establishing an acquisition strategy for C-sUAS.

A. FINDINGS

The threats presented by UAS are not exclusive just to the Air Force. The DoD has recognized the strategic threat that UAS place against the national defense of the United States. The DoD has afforded the UAS threat with enough reverence as to establish its own joint office specifically dedicated to combatting that threat. That office is the Joint Counter Small Unmanned Aircraft Systems Office. The JCO was established as part of the larger US Department of Defense *Counter-sUAS Strategy* to address what the strategy identified as a central challenge of protecting and defending "personnel, facilities, and assets in an environment where increasing numbers of sUAS will share the skies with DoD aircraft, operate in the airspace over DoD installations, and be employed by our Nation's adversaries" (DoD, 2021, p. 3). In response to that challenge, the DoD and JCO have recognized that a materiel solution alone is not enough to mitigate the UAS threat and that protecting against that threat will require an all-encompassing approach that accounts for doctrine, training, equipment and policy (DoD, 2021). Addressing the doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy (DOTmLPF-P) as part of the *C-sUAS Strategy* falls beyond the scope of this project, but it does identify key aspects that this research specifically addresses. One note from that strategy of specific importance to this project was that it called for providing commanders with the "right equipment" (DoD, 2021, p. 4). The right equipment is recognized as C-sUAS technology and systems to counter the

UAS threat. The strategy, however, delves much deeper than singularly incorporating materiel solutions to counter the UAS threat.

1. U.S. Department of Defense Counter-sUAS Strategy

Aside from providing an introduction on the UAS threat, the security environment that the United States is operating in, and the strategic approach to provide layered defenses and new capabilities against the UAS threat, the *C-sUAS Strategy* also identifies three distinct lines of effort (LOEs) to ultimately defeat that threat (DoD, 2021). Those three lines of effort are: 1. ready the force; 2. defend the force; 3. build the team (DoD, 2021). Each one of the LOEs from the strategy, which are subsequently examined, provide means by which the JCO will work to provide commanders and their defensive forces with C-sUAS capabilities.

The first line of effort to ready the force calls for the distribution of a suite of solutions to address emerging requirements of C-sUAS through which those solutions should be designed around a common architecture that can be shared across the Joint Force as well as with allies (DoD, 2021). The strategy offers that accomplishing this objective LOE can be done by utilizing the DAS which will further synchronize science and technology (S&T) strategies and investments made by the JCO (DoD, 2021). Those S&T strategies and investments focus on the development of technology that is capable of providing reliable detecting, tracking, and identification capabilities of employed systems that can operate across a wide variety of environments (DoD, 2021). This LOE also heavily emphasizes common information sharing in the architecture of C-sUAS that is intended to allow materiel components to be adaptable, able to be integrated, and interoperable, all of which is achieved through the common architecture of the systems (DoD, 2021). Materiel solutions identified by the JCO and their acquisition of C-sUAS capability and employment of the broader strategy further emphasize standardizing interfaces to enable joint and multilateral information sharing across forces based on the interoperability of the systems and the ability to plug-and-play with those systems (DoD, 2021). Finally, the first LOE calls for the establishment of test and evaluation (T&E) protocols, standards, and methodologies to further ensure that C-sUAS systems and capabilities are able to successfully operate in the wide array of environments while also

validating integration of those systems and capabilities as part of layered defense for installations (DoD, 2021).

This first LOE naturally leads into and supports the second LOE of defending the force. The *C-sUAS Strategy* clearly recognized a need to provide commanders and their defense forces with systems and capabilities against the UAS threat. In response to that need, the LOE of the strategy called for the development of common and integrated C-sUAS materiel and non-materiel solutions that are both capable of strengthening active and passive defenses against the UAS threat in any and all operating environments (DoD, 2021). What was notable from the second LOE of the strategy was its emphasis on delivering synchronized capabilities across the DOTmPLPF-P spectrum (DoD, 2021). The emphasis of this LOE was to focus on non-technical solutions and instead, focus more on elements of concepts, doctrine, and training to prevent and reduce risks brought on by sUAS (DoD, 2021). This emphasis of an initial focus on non-technical solutions was deemed to set a baseline for the Joint Forces so that once technical solutions are adopted and incorporated the force has common knowledge not just of the C-sUAS systems that they are operating, but how those operations against sUAS more holistically tie to the broader *US Department of Defense Counter-sUAS Strategy* (DoD, 2021). For instance, the strategy cited a need to establish joint training guidelines, standards, and qualifications which the strategy further noted will ultimately allow for and support rapid materiel fielding (DoD, 2021). Even though the second LOE of defending the force may not explicitly focus on the acquisition and employment of C-sUAS, it does set the groundwork for non-materiel solutions (such as C-sUAS training) to allow for more seamless integration with troops and actual materiel solutions of C-sUAS. Accounting for supporting activities and elements for C-sUAS, and even further countering sUAS across the DOTmPLF-P spectrum highlighted how the DoD collectively plans to counter the UAS threat, where C-sUAS systems and technologies represent a facet (yet an incredibly important one) in defense against that threat. Along with accounting for non-technical, supporting elements, the strategy also recognized the importance of incorporating the right personnel and partners who can help in the defense against the UAS threat and in the acquisition and implementation of the systems that will counter that threat.

The third LOE of building the team spoke to how the DoD has a superior competitive advantage in the form of being a partner of choice for business (domestically and internationally), nations, and militaries across the globe, and the ability to leverage those relationships and partnerships in mutually beneficial manners (DoD, 2021). The mutual benefits between the DoD and outside entities facilitates information and data sharing that can be used to further support integrating C-sUAS into a larger ecosystem of air defense (DoD, 2021). The sharing of information and data between the DoD also allows the Joint Force to conduct C-sUAS operations across a broad sphere of environments such as the US homeland, host nations, and contingency locations (DoD, 2021). The third LOE called for working with allies and partners to the DoD to ensure interoperability of C-sUAS capabilities through initiatives such as technology exchanges and shared investments that will allow for unimpeded access to the C-sUAS electromagnetic spectrum (DoD, 2021). This seeking of interoperability between the DoD and its C-sUAS partners, through its technology exchanges and shared investments was subsequently identified by the strategy as allowing for the Joint Force to expedite fielding of C-sUAS materiel solutions that are facilitated through formal acquisition of these solutions with the mission of preventing the loss of technological advantages to adversaries of the DoD (DoD, 2021). One such manner by which these charges could be accomplished by the strategy was through specific partnerships with the national security innovation base (NSIB) and non-federal entities (NFE) who represent rising technology leaders (DoD, 2021). These technology leaders are among the most capable at reducing gaps in C-sUAS technologies and also rapidly expanding the manufacturing throughput of C-sUAS materiel solutions (such as hardware and software), all of which allow these partners and their products to exploit new C-sUAS technological advancements (DoD, 2021).

The *US Department of Defense C-sUAS Strategy* clearly recognized the strategic threat that sUAS pose against the defense of the country. This realization fostered an examination of and guidance for the C-sUAS DOTmLPF-P spectrum (DoD, 2021). The DoD and its strategy into the C-sUAS DOTmLPF-P spectrum offered to spark future investments to be made into systems and capabilities that are made interoperable through shared, common, and secure architectures, all of which are capable of countering multiple

sUAS threats (DoD, 2021). Though this conclusion recognized by the strategy is analyzed in more detail in later sections, this very conclusion helps to accentuate the need for the acquisition of C-sUAS that can meet the spirit and charge of the *US Department of Defense C-sUAS Strategy*.

2. Joint Counter-Small Unmanned Aircraft Systems Office

The DoD's *C-sUAS Strategy* represents the vision and model of the top leaders in the DoD by which to counter the UAS threat. Enacting the strategic vision set forth in that document requires prescriptive actions and policies made by the entity that has been formally authorized to lead the charge and accomplish the mission that was established in the strategy. The mission is to protect and defend personnel, facilities, and assets against the threat from sUAS, and the office designated as the principal enabler for the success of that mission is the JCO (DoD, 2021). In November 2019, Secretary of Defense Christopher C. Miller designated the Secretary of the Army (SECARMY) as the DoD Executive Agent (EA) for C-sUAS, all of which subsequently led to the development of the JCO (DoD, 2021). Since its inception, the JCO has worked diligently to achieve the LOEs established in the *C-sUAS Strategy*. What this section highlights is how the JCO has worked to achieve the LOEs, in part, through the delivery of materiel solutions.

In order to deliver materiel C-sUAS solutions, the JCO first had to determine what form exactly those solutions would take. Given growing markets with both the UAS and C-sUAS industries, a major endeavor for the JCO was to determine what currently available systems and capabilities, or what developing ones will best meet the need and accomplish the mission of protecting and defending against the sUAS threat. The JCO started this undertaking with assessing 40 different C-sUAS solutions (Strout, 2020). Of those 40 possible solutions, the JCO down-selected to fewer than 10 solutions as part of its effort to reduce redundancy in the development and fielding of those C-sUAS solutions into operational use (Strout, 2020). Those solutions have undergone operational assessments and have been slated for continued investments by the DoD (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). In addition to the selection of these solutions, the JCO enacted further steps and measures in support of the selected systems. Some of those were recognized in the following acts. Joint C-sUAS Operational Requirements were

published to set standards and parameters for current and future C-sUAS capabilities (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). Common C-sUAS test range decisions and C-sUAS testing protocols were finalized (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021), These decisions approved three test ranges to support C-sUAS capability and limitation testing and additionally established standards for all C-sUAS testing conducted at those ranges (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). The JCO has also conducted demonstrations at the Yuma Proving Ground to allow vendors to showcase C-sUAS capabilities (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). Among the notable accomplishments that the JCO has already achieved in the relatively short existence of the office, future objectives for the office have also been set. One of the major efforts for the JCO is to sustain a continued focus on expanding their C-sUAS team with interagency and international partners, monitor and utilize global sUAS incidents reports to provide rapid responses and supports to units in need and, work, in collaboration with intelligence communities and entities to further develop threat assessments of sUAS (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). From the efforts already undertaken and the future efforts planned by the JCO to meet the mission of the *C-sUAS Strategy*, the JCO has established, and will continue to establish itself as the focal point within the DoD for everything concerning C-sUAS.

B. ANALYSIS

The findings presented for the *US Department of Defense Counter-sUAS Strategy* and the Joint Counter-Small Unmanned Aircraft Systems Office have offered insight to the initiatives by the DoD and Joint Force in addressing the sUAS threat. Expanding further on these elements in the form of analysis of their undertakings will help to better understand the spirit, intent, and possible end-state of the strategy and JCO. The analysis of *C-sUAS Strategy* and JCO returns to the source documents for each of these elements and provides a detailed investigation of what has and has not been written for each of these elements, and also considers the nuances and narratives that are presented. This research is aimed at providing recommendations as to how the Air Force can align itself with the *C-sUAS Strategy* and JCO to acquire C-sUAS and employ those systems and capabilities to defend against the sUAS threat in a manner that is commensurate with the

rest of the DoD. Leveraging the Department of Defense and its strategy against sUAS as well as the JCO and its central role as the C-sUAS enabler and authority for the Joint Force, will be key to for the Air Force to be able to acquire and defend itself against the sUAS threat. The following analysis discusses how the Air Force can integrate with these elements to achieve this goal. The first part of that integration starts with the *C-sUAS Strategy*.

1. C-sUAS Strategy

The opening of the strategy noted how in its initial and rapid response to the emergence of the sUAS threat, the DoD turned to government and commercially built materiel solutions (DoD, 2021). This approach led to the employment of systems and capabilities that were redundant and also incapable of being integrated with other C-sUAS solutions (DoD, 2021). What the DoD recognized from the problem brought on by the initial wave of attempting to respond to the sUAS threat was that response to that threat would require keeping up with ever-evolving technological requirements while also incorporating holistic strategies that spans across the DoD (DoD, 2021). The three strategic objectives that the strategy seeks to achieve are listed as:

> (1) enhance the Joint Force through innovation and collaboration to protect DoD personnel, assets, and facilities in the homeland, host nations, and contingency locations; (2) develop materiel and non-materiel solutions that facilitate the safe and secure execution of DoD missions and deny adversaries the ability to impede our objectives; and (3) build and broaden our relationships with allies and partners to protect our interests at home and abroad (DoD, 2021, p. 3)

Though the objectives of the strategy represent the wholistic approach that was originally referenced to be adopted across the DoD, it simultaneously highlights various approaches in the form of acquiring and employing materiel and technical solutions (in the form of C-sUAS systems and capabilities) against the sUAS threat. Specifically, the first objective calls for innovative and collaborative efforts to protect military resources across a variety of environments (DoD, 2021). Those protective efforts called for by the first strategic objective could arguably be most recognizable in the acquisition and employment of C-sUAS. This same recognition may be even more apparent in the second strategic objective that calls for the development of materiel solutions that can be employed to deny adversaries sUAS actions (DoD, 2021). Again, this call for the

development of materiel solutions can be easily recognized in the form of physical C-sUAS systems and capabilities. The third objective of the strategy of building relationships and protecting the interest of the DoD and its allies (DoD, 2021) can be accomplished through an acquisition process that shares C-sUAS capabilities with those same allies to afford them with equal defensive capabilities that become enabled through C-sUAS. The acquisition process also presents a means to ensure interoperability between systems and their users as well as with other C-sUAS solutions. Analysis of how the strategic objectives of the *C-sUAS Strategy* call for the acquisition and employment of C-sUAS and how the acquisition and employment must be accomplished in a manner that meshes across the Joint Force can also be applied to the LOEs of the strategy.

Under the first LOE of readying the force, the strategy noted how developing solutions to address emerging requirements will allow the DoD to remain responsive to the needs of commanders by improving existing capabilities (DoD, 2021). The technological advancements that arise in response to emerging sUAS threats will help to continue to drive the need for common architectures that are interoperable across systems (DoD, 2021). The LOE highlighted S&T strategies that called for investments from the DoD in support of projected needs and for applications across operating environments (DoD, 2021). S&T strategies and investments by the DoD into C-sUAS were presented by the strategy as heavily prioritizing technologies that provide reliable detecting, tracking, and identifying capabilities in the environments where the systems are employed (DoD, 2021). The S&T investments made by the DoD were argued by the strategy to present promising returns for C-sUAS capabilities thanks to innovative commercial solutions (DoD, 2021).

Investments made by the DoD into S&T strategies and technologies, pursuing commercially available solutions, and prioritizing acquiring and employing solutions that are interoperable, and capable of providing capabilities that can reliably detect, track, and identify sUAS threats all can be directed towards C-sUAS. Investments by the DoD into these systems will allow for improved countering capabilities against the sUAS threat while also allowing for greater integration between systems and force all to better synchronize defensive efforts between forces and expand protective coverages across respective areas of responsibility (AORs). The benefits offered by investments into C-

sUAS teams through partnerships across the Joint Force and commercial entities, and S&T technologies that have and will continue to improve C-sUAS capabilities all presents a manner by which the Air Force and larger DoD can be protected against the sUAS threat. This point is further accentuated as the second LOE of the strategy is considered.

The second LOE of the strategy focuses explicitly on the defense of installations and their assets against the sUAS threat (DoD, 2021). The strategy recognized how that defense must be in continuous operation as the hazards posed by sUAS may be either negligent or malicious in the actions by the operators of those systems (DoD, 2021). Employing defenses against sUAS was argued by the strategy to rely on both active and passive defenses among common and integrated C-sUAS solutions (DoD, 2021). To allow for a seamless integration between existing and future systems, materiel solutions and base defense operators, non-materiel solutions must also be accounted for in the forms of TTPs, training, and education (DoD, 2021). A synchronized adoption of C-sUAS into the Air Force and DoD will require a multi-domain approach across physical, cyber, and electromagnetic spheres to yield the best operational advantages to C-sUAS (DoD, 2021). Leveraging previous investments in C-sUAS and their functions of degrading, disrupting, and/or destroying sUAS can translate those functions into offensive capabilities against sUAS, all to further improve the protection of Air Force installations (DoD, 2021). Continued synchronization of C-sUAS solutions will expand the capabilities of those systems to deter, deny, and defeat sUAS thanks to the layered defense for installations that has been created that are also in concert with offensive operations (DoD, 2021).

As presented in previous sections on C-sUAS functions and the general operations of the presented systems, the capability to provide active and passive defenses, and some offering offensive capabilities already exist in C-sUAS that the Air Force can acquire and employ to defend its installations. For the strategy to provide guidance on the incorporation of TTPs, training, and education into C-sUAS operations shows how the DoD is prepared to ensure effective C-sUAS operations once those systems have been acquired and employed. This same notion holds true as those systems are engaged across multi-domain spheres. The multitude of capabilities that are provided by C-sUAS

presents an expansive continuum by which these systems can engage the sUAS threat. That continuum of capabilities the C-sUAS offer all presents yet another reason for the Air Force to align itself with the DoD's *C-sUAS Strategy* in its acquisition and employment of these systems. The final LOE of the strategy also helped to highlight this point.

Rather than relying on its own systems and processes to develop, acquire and employ C-sUAS capabilities, the DoD has recognized the importance of partnering with domestic government and non-government agencies as well as ally partners. The partnerships with the DoD across sectors are representative of the third LOE of the strategy of building the team, and a manner by which C-sUAS capabilities can be broadly spread to grow the C-sUAS ecosystem (DoD, 2021). The spreading and growth of the C-sUAS ecosystem between the DoD and its partners presents a manner by which the capabilities of those systems will continue to improve in combatting the sUAS threat. This mutual partnership between the DoD and its C-sUAS compatriots will help to facilitate and ensure the creation of mutually beneficial policies, central authorities, and agreements across stakeholders (DoD, 2021). Improved partnerships will also foster the initiatives for rapid development and deployment of C-sUAS innovations and materiel solutions at a rate faster than adversaries of the United States and its allies can achieve (DoD, 2021). Partnerships by the DoD with NSIBs, NFEs, and ally nations will help to promote joint capabilities between those entities (DoD, 2021). Those joint capabilities will rely on interoperability between systems and the hosts of those systems, which will also be improved through bolstered relationships between all parties (DoD, 2021). All of these capabilities will ultimately benefit the DoD (and its allies) in the protection of its installations and resources thanks to collaborative efforts that have been aimed at improving C-sUAS capabilities and sharing those improvements across all partners.

The third LOE from the strategy of building the team highlights a critical aspect for C-sUAS operations, and larger military operations: the importance and benefits of information sharing. As the DoD and its partners communicate and share knowledge on threats and advancements in C-sUAS technologies and capabilities, the battle against the sUAS threat will continue to trend towards the systems, technologies, and owners of those C-sUAS capabilities. This argument also demonstrates how the Air Force must not

only align itself with the *C-sUAS Strategy*, but it must also align itself with DoD partners in the form of the other Services, NSIBs, NFEs, and ally nations in order to ultimately improve the C-sUAS capabilities for the U.S. Air Force. One critical partner that the Air Force must align itself with to improve its C-sUAS capabilities is the JCO.

2. JCO

The centrality of the fight against the sUAS threat can easily be found in the JCO. The position of that office is cemented in its mission: to lead and direct all joint C-sUAS doctrine, requirements, materiel, and training, aimed at establishing joint solutions that are aimed at addressing both current and future sUAS threats (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). Having been in existence for barely 2 years (established in February of 2020 by SECARMY), the JCO is led by a 2-Star General Officer who serves as the Director for the JCO within the Army G-3/5/7 as well as the Army Rapid Capabilities and Critical Technologies Office (RCCTO), which leads all materiel and acquisition on behalf of the JCO (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). As part of the Combined Arms Support Command (CASCOM), the G-3/5/7 Directorate has the mission to "provide planning and staff management for the integration of programs, processes, and initiatives among CASCOM and U.S. Army Sustainment Center of Excellence (SCoE) agencies," (U.S. Army Combined Arms Support Command [CASCOM], 2019). Despite the Army being designated as the EA for the JCO, as well as the major commands that the office falls under, the efforts, initiatives and support for the JCO has not been, and should not be, exclusively conducted by the Army itself, but should come from across the DoD. The position of the JCO within CASCOM and G-3/5/7 Directorate demonstrates how the JCO has been aligned not only to provide C-sUAS solutions across the Joint Force, but also highlights how C-sUAS solutions need to be aligned and synchronized with other force protection initiatives and solutions for the Joint Force, all to provide for the best defensive capabilities that are available.

Considering the role of the JCO as the central authority figure for C-sUAS within the DoD, there are many important actions that the office has taken in the name of combatting the sUAS threat as well as an untold number of steps that the office can continue to take in that same endeavor. Starting with examination of the most notable

previous accomplishments of the office, the selection of 10 viable C-sUAS solutions to ultimately be acquired, fielded, and employed to defend against sUAS undoubtedly represents the most significant endeavor of the fight against sUAS (Strout, 2020). By limiting the number of possible C-sUAS solutions to be selected by the JCO, the acquisition process of those systems and capabilities becomes less encumbered through the entire acquisition process of developing, testing, acquiring, and fielding of those systems thanks to the removal of unnecessarily redundant systems. Expediting the acquisition process of C-sUAS systems will allow for the JCO to provide a more rapid response to the omnipresent sUAS threat. Further, as the JCO engages in operational assessments of the down-selected systems and continues providing investments from the DoD into the selected C-sUAS companies (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021), then as the final systems become operational the underlying premise will be that the JCO had funded and tested those systems thoroughly enough to mitigate as many vulnerabilities of those systems as possible while also streamlining integrating users of the systems into their operations. Adherence to this notion could be argued to be recognized in the testing protocols and ranges that were established by the JCO (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). Setting DoD-wide standards for how and where C-sUAS are tested helps to ensure that as those systems are made operational, regardless of which Service employs them, they will have been standardized already in their operations thanks to the preceding tests that were conducted on those very systems. It is through the JCO's down-selection of C-sUAS in the elimination of unnecessarily redundant systems, the streamlining of the acquisition process of those systems, and the standardization of testing that will ultimately allow the Air Force and the rest of the DoD to acquire and employ these systems and capabilities with as little struggle as possible.

For the U.S. Air Force to counter the sUAS threat, it must align itself with the *DoD's Counter-sUAS Strategy* and the initiatives of the JCO. As noted throughout the chapter, the *C-sUAS Strategy* provides strategic guidance on how the Department can seek to address the sUAS threat through an approach that provides for a layered defense against the sUAS threat while also incorporating three LOEs that can be synchronized and integrated into defeating the threat. The JCO represents the embodiment of the *C-sUAS Strategy* through its mission of leading and directing all joint C-sUAS solutions

that are meant to combat the sUAS threat. The findings and analysis of these two authoritative elements represent the sources by which the Air Force can align itself in the acquisition and employment of C-sUAS to combat that threat. One framework exists that can simultaneously examine the Air Force aligning itself with the *C-sUAS Strategy* and JCO. That framework is recognized as a strengths, weaknesses, opportunities, and threats (SWOT) analysis.

C. SWOT

The possibilities and scenarios for how the Air Force can position itself to align with the *C-sUAS Strategy* and JCO can be difficult to consider if not using a framework that explores the different avenues for how the Air Force can succeed and fail in meeting the charges laid by these respective elements. A SWOT analysis therefore becomes useful to identify and examine those possible outcomes. This research subsequently uses this SWOT approach to analyze the *C-sUAS Strategy* and JCO as they currently exist. Additionally, the SWOT analysis will expand on the strengths, weaknesses, opportunities, and threats from elements noted the preceding chapters of this research. Conducting a wholistic examination in the form of a SWOT for all aspects of this research, will allow for thorough recommendations to be made as to how the Air Force can develop and employ a C-sUAS acquisition strategy. Simultaneously, this analysis will also help to determine how the Air Force can best position itself for success with its C-sUAS acquisition strategy by aligning with the *C-sUAS Strategy* and initiatives of the JCO. This analysis starts with identifying and exploring the strengths that that can be identified for all of these elements, as well as providing sources of strength to the DoD in its fight against the sUAS threat. Table 2 below, that was created for this research, will highlight the main points for each element of the SWOT, before providing greater detail and information on those points on the following chapters.

Table 2. SWOT Analysis

Strengths	**Weaknesses**
• DoD's Big "A" acquisition has proven practices • The AAF can be tailored to based off the acquisition strategy • Multiple C-sUAS functions exist and can be prioritized • C-sUAS are available COTS and can be immediately acquired • *C-sUAS Strategy* focuses on C-sUAS across DOTmLPF-P • The JCO represents a focal-point for C-sUAS	• PMs must balance the "triple constraint" • No direct path exists within the AAF to acquire C-sUAS solutions • Multiple C-sUAS functions and systems cannot all be acquired and must be prioritized • Ambiguity in the *C-sUAS Strategy* can cause difficulty in creating the acquisition strategy • The JCO does not have redundant safeguards
Opportunities	**Threats**
• The Air Force can set the DoD-standard for C-sUAS acquisition • C-sUAS functions and systems that are properly prioritized can exploit sUAS vulnerabilities • The Air Force's C-sUAS acquisition strategy can align the DoD with private industry and foreign allies • The JCO can provide needed sUAS and C-sUAS to all stakeholders	• Obsolescence could occur in any or all elements noted by this research • The speed of relevancy must be maintained by the *C-sUAS Strategy* to keep competitive advantage against the sUAS threat • The JCO could miss opportunities with C-sUAS that could have been shared with and benefited C-sUAS stakeholders

1. Strengths

The acquisition of a system or capability to meet the need of the warfighter is not a novel concept or practice. The amount of planning and resources dedicated to the Big "A" acquisition for the DoD highlights this argument. For example, JCIDS and its processes represents a formal method to identify capability requirements for DoD acquisition while also setting policies and procedures to meet those same capability requirements (DAU, 2022b). The DAS and its use of the AAF establish pathways that map the path for the DoD to acquire new systems and capabilities (DAU, 2022b). PPBE provides DoD acquisition professionals with a planning tool to help ensure resources are available for acquisition programs (DAU, 2022b). Through the collective of the DoD's Big "A" acquisition, a strength is found in the established and formalized processes for acquisition programs. These processes help to remove significant resources and

manpower requirements that would otherwise be needed to navigate an acquisition program within the DoD for a first time. It is in the Big "A" acquisition construct, that the Air Force can develop and refine its C-sUAS acquisition strategy by exploiting the system, using best practices and lessons learned from the system, and referencing existing products and templates to assist the Air Force as it pens its acquisition strategy.

Continuing with the strengths of Big "A" acquisition, specifically the AAF, not only have multiple pathways been built and established to help the Air Force acquire C-sUAS solutions, but the ability to pick the best pathway and further tailor that pathway to best meet the need of the C-sUAS acquisition program and strategy also exists. Under the AAF, the Air Force has six different paths to choose from in how it will address the sUAS threat. The Air Force has the option to develop a C-sUAS solution from an idea all the way to a fully operational capable system under the Major Capability Acquisition pathway (DAU, 2022a). The Air Force could also determine that it needs to pursue a pathway that will deliver a C-sUAS solution in less than 5 years through the MTA. The point here is that the Air Force has multiple options on how to acquire C-sUAS and the development and enaction of a C-sUAS acquisition strategy by the Air Force will set the pathway to a C-sUAS solution. Using the AAF to set a C-sUAS acquisition strategy represents a strength similar to what was found from Big "A" acquisition as it represents established and proven processes and methodologies for acquiring a needed solution. Within the AAF, regardless of what pathway the Air Force chooses to pursue for a C-sUAS solution, each of those pathways will demand or formal plan (acquisition strategy) for how the respective AAF pathway will be navigated and completed. A strength from this notion is found in how choosing a pathway within the AAF to acquire a C-sUAS solution will force the Air Force to develop and employ a C-sUAS acquisition strategy, and that strategy will be tailored to the chosen pathway, all of which will ultimately deliver a precise acquisition strategy that will also deliver the most appropriate C-sUAS solution to the Air Force.

The DAS also has set policy as to how the DoD (including the Air Force) acquires capabilities to meet warfighters' needs through improved mission capabilities, material readiness, and operational support based on fair and reasonable pricing as set by DoDD 5000.01: *The Defense Acquisition System* (OUSD [A&S], 2020b). DoDD 5000.01

identified polices that can specifically help PMs (to include those acquiring C-sUAS for the Air Force) that will directly aid and facilitate acquisition efforts by the PM. The document set a policy that specifically allowed programs and their PMs flexibility in how they developed their programs. That flexibility, that keeps PMs and their programs from having to adhere to cumbersome, laborious, and unnecessary bureaucratic processes, streamlines how the Air Force can develop a C-sUAS acquisition strategy and ultimately acquire those solutions. Having codified policy that protects the acquisition processes that a PM wants to pursue will serve as a strength for the Air Force as it develops its C-sUAS acquisition strategy by choosing one that is not only the most sound and feasible, but also is best capable of delivering a C-sUAS solution to the Air Force.

Strengths must also be noted in how C-sUAS function. The strengths behind the functionality of those systems will also help drive the acquisition strategy for those solutions. The Air Force must decide what the most important function its C-sUAS will perform. The Air Force can best complete this task by prioritizing its desired C-sUAS functions. Those functions were presented by Popescu (2021) as detecting, recognizing, identifying, localizing, blocking, capturing, or destroying sUAS. Aside from the immediate strength of combatting the sUAS threat, these functions will also help to shape the C-sUAS acquisition strategy by prioritizing each of these functions and then pursuing a solution that best aligns and meets those priorities.

Continuing with an overall theme of tailoring and freedom of choice in how the Air Force acquires a C-sUAS solution, the Air Force could pursue a COTS solution to address the sUAS threat. The Air Force could acquire a direct-engagement system from NINJA (Mitchell, 2021) or FS-LIDS (SRC, 2020) or, employ C-sUAS C2 systems such as MEDUSA (Kongsberg Geospatial Ltd., 2020) or FAAD-C2 (Northrup Grumman, 2020). Each of these systems, the functions they provide, their operations, sustainment, training, costs, etc. all help the Air Force with formulating its C-sUAS acquisition strategy by presenting existing systems and capabilities that the strategy could be specifically written to acquiring and employing.

The ability for the DoD to organize, train, and equip its forces represents one of the greatest capabilities for the U.S. military. The publication of the *C-sUAS Strategy* and

the establishment of the JCO symbolize that exact capability. Both the *C-sUAS Strategy* and the JCO have a list of individual accomplishments that have helped to protect the DoD from the sUAS threat. Starting with the *C-sUAS Strategy*, the focus has been established for the entirety of the DoD to combat the sUAS threat across the full DOTmLPF-P spectrum. By calling for such an approach, the strategy purposefully restricts itself from focusing on a singular approach to battle the threat. Such a singular approach could fail to address other avenues that would allow sUAS themselves and their operators to exploit vulnerabilities within the DoD. The LOEs of the strategy provide those that are subject to the document a certain level of ingenuity freedom in their pursuits of meeting the intent of each of the LOEs. The LOEs and their respective sub-levels provide general intent that the DoD should build and focus their C-sUAS pursuits and endeavors to. By avoiding prescriptive orders, the DoD is granted flexibility in how it adheres to and enacts its C-sUAS acquisition, practices, and operations. The Air Force's C-sUAS acquisition strategy could mimic and benefit from such a construct whereby it sets its own LOEs for C-sUAS acquisition. More importantly, the LOEs within the *C-sUAS Strategy* serve as resources and priorities themselves that the Air Force's C-acquisition strategy should continually reference as it is being drafted to allow for better synchronization between the Air Force's C-sUAS acquisition strategy and the larger *C-sUAS Strategy.*

Through the establishment of the JCO, the DoD provided an embodied and authoritative entity for C-sUAS. This body represents a focal-point for C-sUAS within the DoD, which all branches can turn to for support and guidance aside from individual interpretations of the *C-sUAS Strategy*. That office further represents an entity capable of provide tangible and actionable tasks that further the DoD's C-sUAS missions. Those tasks such as selecting C-sUAS vendors for investments from the DoD, publishing Joint C-sUAS Operational Requirements and, establishing C-sUAS test ranges and testing protocols (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021) provide rippling benefits back to the larger DoD. Corresponding benefits to the tasks carried out by the JCO include providing funding for C-sUAS in their defenses of DoD installations, establishing standardized operational benchmarks to ensure that C-sUAS meet a minimum standard across the DoD and, taking the onus off any one branch by establishing support for the

DoD in the form of test ranges and protocols. As the authoritative body, the authors and strategy makers for the Air Force's own C-sUAS acquisition strategy have subject-matter experts and strategic-level authorities and resources that they can open communication lines with. As the Air Force creates its C-sUAS acquisition strategy, it can utilize the JCO to help shape acquisition efforts and initiative all while avoiding any gaps against the sUAS threat. It is through the strategic guidance and the establishment of a formal body to serve as the focal point for C-sUAS within the DoD that those elements provide strength in the fight against sUAS. They are, however, not without weaknesses.

2. Weaknesses

All of the elements in the previous chapters, such as DoD acquisition systems and programs, C-sUAS functions and systems, C-sUAS acquisition and the AAF all tie back to the original problem identified by this research on how the Air Force is lacking a C-sUAS acquisition strategy that utilizes those elements to combat the sUAS threat. Each of these elements have their own weaknesses that must be identified to help the Air Force avoid any vulnerabilities as it creates its C-sUAS acquisition strategy. A failure by the Air Force to recognize or account for any of those vulnerabilities could allow for those same vulnerabilities to be introduced to the C-sUAS acquisition strategy that would then translate into larger force protection vulnerabilities for Air Force itself.

Perhaps the biggest challenge to PMs as they and their programs navigate the DoD's Big "A" acquisition, is having to constantly balance the "triple constraint" that defines any acquisition program. The triple constraint focuses on how an acquisition program's respective cost, schedule, and system performance must be continually balanced where an overemphasis on an individual element will come at the expense of the other two elements. Balancing the triple constraint within Big "A" acquisition is recognized as a weakness as though a C-sUAS acquisition strategy may envision a perfect balance for all three elements, the reality is that any disruption to the symmetry and balance for a C-sUAS solution will have adverse effects to the program. A parallel argument could be more directly applied to how the Air Force manages its priorities across the DAS, JCIDS, and PPBE that is Big "A" acquisition. What this means is that if the Air Force becomes overcommitted to any one of those areas as it prepares its C-sUAS

acquisition strategy, the final product will ultimately suffer. For example, if the Air Force were to become over-focused on defining C-sUAS requirements within JCIDS, required events in the DAS, and deadlines set by PPBE will be delayed.

The DAS, AAF, and their respective DoDDs and DoDIs undoubtedly allow for flexibility and tailoring as to how an acquisition program navigates through DoD acquisition. It is in that flexibility and tailoring freedom that a weakness could prevail. The presence of multiple options and pathways as to how a system or capability will be delivered to a warfighter means that there is no direct path or guaranteed right approach to delivering those solutions. As acquisition professionals, PMs continuously work to provide warfighters with capabilities at the soonest, best-priced, and most capable solutions that are possible. As different pathways and options are introduced to this mission, perfect execution becomes less assured. The argument being made here is that because of the existence of choice in how a C-sUAS solution is acquired for the Air Force, the possibility also becomes that the soonest, best-priced, and most capable solutions might not be delivered. As the Air Force develops its C-sUAS acquisition strategy, the weakness will exist through failing to identify the best way, path, or process to deliver a C-sUAS solution.

A similar argument could be applied when considering C-sUAS functions and the various systems discussed in this research. As the Air Force, through its acquisition strategy determines what function matters the most through prioritization, it may prioritize a function that can be overcome or exploited by sUAS. For instance, if the Air Force C-sUAS acquisition strategy prioritizes systems that block sUAS over detecting them, then then the acquired solution may fail to detect growing number of sUAS that are developed (and also have their own priority of avoiding detection) because the Air Force is more concerned with blocking the sUAS that are able to be detected as opposed to detecting a wider array of sUAS. This could create a weakness in the C-sUAS System that the Air Force chooses to acquire as part of its acquisition strategy. Returning to the previous example, the Air Force could choose to acquire a C2 system (based off capability prioritization), but it would fail to acquire direct-engagement systems that would otherwise more readily detect a sUAS threat entering restricted air space on an Air Force installation. The freedom of choice in how the Air Force prioritizes its C-sUAS

functions and systems in its acquisition strategy creates a weakness in the possibility of those priorities being exploited by the sUAS threat.

The strengths that are provided to the DoD and its C-sUAS mission from the *C-sUAS Strategy* and JCO are not absolute. Both of these elements have areas that may be exploited or fail to provide utility or guidance to the Joint Force. The previous section noted how the *C-sUAS Strategy* purposefully avoided providing any prescriptive means for how the DoD will acquire, deploy, and sustain its C-sUAS systems and capabilities. Through this approach leaves the DoD freedom and flexibility in these pursuits, the branches of the DoD and their respective installations will also be left to their own interpretations and understandings as to how they might meet the charges and LOEs set by the strategy. Relying on individual interpretations and understandings can create ambiguity. That ambiguity can result in the intent of the *C-sUAS Strategy* not being fully met which can ultimately lead to vulnerabilities being either unmitigated or worse, created. Without specific instruction or a clear understanding of expectations and intent set by the *C-sUAS Strategy*, the DoD may fail to fully recognize and implement the protective means that are intended by the *C-sUAS Strategy*. An additional concern for a weakness of the *C-sUAS Strategy* is that it recognizes each of the LOEs with the same level of priority. From this consideration, those that are executing the C-sUAS mission for their installations are left without a starting point as to which LOE or initiative should, as a minimum, maintain their initial focus and attention. Without any sense of priority given to the LOEs of the *C-sUAS Strategy*, each becomes important, which can overload individuals' and installations' bandwidth, resources, and energy.

The Air Force has imposed a weakness for its own actions against the sUAS as it has failed to publish its own doctrine and policy on C-sUAS and C-sUAS operations. Without doctrinally codified guidance as to how the Air Force will combat the sUAS threat, building an acquisition strategy for C-sUAS becomes increasingly more difficult. By this argument, the Air Force has placed itself in a position where it must decide how it wants to acquire a C-sUAS solution without first identifying what the C-sUAS mission is for the Air Force. By creating an acquisition strategy before a larger-ranging C-sUAS Strategy, the Air Force could be forcing itself into adopting a solution without fully understanding the problem that it is trying to address.

When considering the JCO, a weakness was regarding the singularity of the JCO. What this weakness means is that the JCO could be argued to represent a single-point-of-failure in C-sUAS for the DoD. Extrapolating this argument, if the JCO were to push or mandate that a certain C-sUAS be the official sUAS defense for the DoD, any problems with that C-sUAS and its capabilities would be the result of a mandate set by the JCO. As the authoritative body for C-sUAS within the DoD, the JCO is responsible to ensure that all information, data, and guidance that is produced by the office must be accurate and effective. If not, the entirety of the DoD may subsequently be caught operating with bad versions of those items. As the authoritative and singular C-sUAS entity for the DoD, the necessary redundancies that ensure the efforts, initiatives, and information, that are products of the JCO are placed on to each individual branch of the DoD. Trust in the work that is being done by the JCO is necessary to ensure the C-sUAS mission for the DoD is successfully carried out, but there also must be verification of the products that come from the JCO. With that verification having to be accomplished at the individual Service level, any disagreement or disconnect with the JCO poses the risk of either one of the Services being disconnected from the rest of the DoD in the sUAS fight, or the rest of the DoD operating with bad guidance from the authoritative source. The C-sUAS acquisition strategy for the Air Force could fall victim to this same weakness. If that strategy fails to verify on the feasibility and enaction of initiatives set by the JCO, then the acquisition strategy may focus on initiatives that never come to fruition.

3. Opportunities

Untapped opportunities exist for the Air Force in utilizing the elements found in this research to help as it develops its C-sUAS acquisition strategy. The greatest opportunity that exists for the Air Force is setting the DoD-standard for C-sUAS acquisition across the Joint Force. For the Air Force to realize this opportunity, it must recognize the individual opportunities for the elements of this research and then further synchronize those opportunities into the collective C-sUAS acquisition strategy. This process stars with how the Air Force conducts C-sUAS acquisition operations.

Keeping with the overall opportunity to the DoD-standard for C-sUAS acquisition, and starting with Big “A” acquisition, the Air Force can define for the Joint

Force what the needs are for C-sUAS acquisition and what the events will be in acquiring those solutions through the JCIDS and DAS respectively. As the Air Force develops its C-sUAS acquisition strategy, it will need to determine what precisely the need is to be filled from a C-sUAS solution. The JCIDS process will help the Air Force with this process through the identification, assessment, validation, and prioritization of capability requirements for C-sUAS (DAU, 2022a). As the Air Force navigates the DAS to determine what pathway of the AAF that it wants to use, it again will have the opportunity to set the DoD-standard for a best-practice by employing the most-streamlined process in acquiring C-sUAS. Using an example to support this argument, the Air Force C-sUAS acquisition strategy and its research could determine that the MTA is the fastest, most technically feasible and cost-effective way by which to acquire C-sUAS. As other branches within the DoD, or perhaps the JCO itself, my recognize the efficiencies in this pathway and follow suit with the same approach.

When considering C-sUAS functions, the Air Force has the opportunity in its C-sUAS acquisition strategy to prioritize those functions in a specific way that best combats the sUAS threat. By setting priorities for C-sUAS functions, the Air Force has the opportunity to exploit sUAS own vulnerabilities and employ those functions that best accomplishes that feat. If the Air Force acquisition strategy were to prioritize a function such as blocking, it could acquire C-sUAS that are noted for their blocking functions and capabilities that keep sUAS from entering the air space owned by the Air Force and its installations. C-sUAS functions and how the Air Force prioritizes them in its acquisition strategy represent only one half of the opportunity that the Air Force has in setting a DoD-standard for C-sUAS acquisition. The second half of that opportunity rests in the system itself that is actually acquired. The Air Force has a unique opportunity to offer and provide investments into the U.S. commercial sector to develop a C-sUAS that is uniquely tailored to meet the C-sUAS needs and requirements specifically defined by Air Force. Working with private industry, the Air Force has an opportunity with its acquisition strategy to leverage the most refined technology advances and business acumen to deliver a C-sUAS solution that could potentially better deliver C-sUAS capabilities that the DoD is capable of independently producing. Whether the C-sUAS acquisition strategy chooses to acquire one of the COTS systems previously noted in this

research, developing an entirely new system or capability, that C-sUAS solution has the potential to be universally adopted across the DoD. Regardless of the C-sUAS solution that is acquired, if the Air Force's acquisition strategy is properly prepared and executed, it will have identified the system best poised to defend against the sUAS threat. It is in the summation for the Air Force's C-sUAS acquisition strategy of setting a priority of C-sUAS functions and selecting a C-sUAS that delivers those functions all of which can best combat the sUAS threat.

Given the emergence and proliferation of both sUAS and C-sUAS, a number of opportunities exist for the *C-sUAS Strategy* and JCO to capitalize on new technologies and capabilities. The *C-sUAS Strategy* has the opportunity to align the entirety of the DoD in the C-sUAS mission whereby all of the branches can be synchronized in their C-sUAS efforts. Seeing the opportunity actualized would recognize the DoD readying the force by sharing sUAS threat information that reaches all the branches and installations without any delays or gaps in the information that is provided. All C-sUAS testing would be standardized across the DoD so that once C-sUAS are fielded, they meet the objectives and thresholds. The force could be defended thanks to the C-sUAS DOTmLPF-P spectrum being aligned in all facets across the DoD. One final opportunity for the *C-sUAS Strategy* can be recognized when C-sUAS capabilities are not just shared across the DoD, but with ally partners abroad as well as contingent locations. This sharing of capabilities would be more than just a one-way relationship but would allow for those partners to further advance the fight against sUAS through threat and information sharing, increased funding for testing, development, fielding and employment of those systems, and providing lessons learned from sUAS encounters. The Air Force's C-sUAS acquisition strategy equally has the same opportunity to account for the C-sUAS DOTmLPF-P spectrum in its own document. By accounting for all aspects of C-sUAS acquisition in the Air Force's acquisition strategy, it can help to prevent vulnerabilities or weaknesses from being introduced elsewhere in the Air Force's C-sUAS mission.

The JCO has the forum to capitalize on and actualize all the opportunities listed for the *C-sUAS Strategy*. As the focal point for all C-sUAS within the DoD, the JCO can place itself as a receiver and distributor of information on C-sUAS matters that might not

otherwise be shared with the larger DoD. An example for the scenario would be recognized as the Air Force identifying a specific sUAS brand that was responsible for multiple incursions on Air Force installations across the United States. The Air Force could share with the JCO, the specific brand of the sUAS and the frequency that it operated on. From there the JCO could share that threat and trend with the rest of the DoD whereby the rest of the branches could ensure that their C-sUAS had the information on the sUAS in question, and which would then ensure their own C-sUAS are calibrated and equipped to detect and counter that specific threat all in hopes of preventing similar incursions occurring elsewhere in the DoD. Information sharing represents one of the greatest opportunities for the JCO to further C-sUAS capabilities for the DoD. This equally applies to the Air Force's acquisition strategy. As the Air Force develops its strategy, the opportunities will be continually present to adapt and incorporate sUAS and C-sUAS information into the Air Force's own strategy. Capitalizing on available information from the JCO will allow the acquisition strategy to be as current and relevant as possible once it is enacted. While there are plenty of opportunities for the *C-sUAS Strategy* and JCO to advance the capabilities of C-sUAS for the DoD, there are also threats that pose the potential to offset those opportunities and undermine the efforts of the C-sUAS mission for the DoD.

4. Threats

Not only must the DoD protect itself from the sUAS threat, but it must also protect itself from associated threats that could undermine or pose a detriment to the C-sUAS mission for the DoD. There is one threat that this research identified as a ubiquitous threat to all of the elements identified by this research. Obsolescence. DoD Big "A" acquisition, the AAF itself, C-sUAS functions, and C-sUAS themselves all face a threatening reality of becoming obsolete in comparison to the sUAS threat that they are trying to combat. For example, if new acquisition processes are developed, but not adopted as formalized practices, existing ones may become antiquated and fail to achieve their missions at a pace and through processes commensurate with ones that exist but have not been accepted by the DoD. Current C-sUAS functions and systems represent advanced capabilities against sUAS. However, if those functions and systems are not

continually innovated and refined, the sUAS threat then has the potential to advance its own capabilities beyond those elements. The Air Force's C-sUAS acquisition strategy must recognize this threat and account for the need to keep its C-sUAS from becoming obsolete.

A similar argument is applied to the *C-sUAS Strategy* whereby not only does the strategy have to keep itself from becoming outdated, but it also must keep pace with advancements made by sUAS threats in order to keep a competitive advantage against that threat. As an open-source and easily accessible document, there is little concern for physical threats to the *C-sUAS Strategy*. The biggest threat to the *C-sUAS Strategy* is existential in nature, and that threat is relevancy specifically, the speed of relevancy. sUAS and C-sUAS technologies are among the most rapidly developing technologies of the modern age. In order to keep pace with these ever-evolving technologies, the *C-sUAS Strategy* must be reviewed and updated in a corresponding fashion. Adjustments to the *C-sUAS Strategy*, must not be made so frequently as to leave the document in a perpetual state of revision. From this, the threat of the speed of relevancy for the *C-sUAS Strategy* translates into a revision cycle that must keep pace with sUAS and C-sUAS technology and capability developments but must also allow time for the DoD to posture itself to meet the intents and charges that are set by the strategy. These exact arguments can be applied directly to the Air Force's C-sUAS acquisition strategy. Keeping the acquisition strategy relevant but keeping from uninterrupted revisions is a balance that the Air Force must balance as it publishes and revises its C-sUAS acquisition strategy.

The JCO faces a similar kind of threat whereby the JCO itself could be recognized as one of its own biggest threats. As the authoritative source for C-sUAS within the DoD, the JCO has established itself as the dominant producer of C-sUAS information and threat sharing, the body that sets C-sUAS policy, testing, acquisition, employment, and support standards, as well as the formal point of contact for the C-sUAS DOTmLPF-P for the DoD. The threat posed by this reality comes from the fact that the JCO can potentially miss opportunities to pass pertinent threat data, share actionable but inaccurate information, or misallocating funding and investments to C-sUAS that could be better utilized elsewhere. This small list of examples of how the JCO could be a detriment to the C-sUAS mission for the DoD illustrates some of the issues having a single,

authoritative body responsible for C-sUAS for the DoD. In that position, any failings by the JCO could be transferred to the DoD and its C-sUAS mission. From this reality, the JCO must be thorough, prompt, and accurate in the actions it takes for C-sUAS to keep sUAS from carrying out any successful operations against the DoD. As the guiding strategy for the Air Force's C-sUAS acquisition, the guidance created by the Air Force must be as informative, accurate, and efficient as possible. Discrepancies in these elements, or in any other part of the acquisition strategy may detrimentally affect the C-sUAS capabilities that the strategy is charged to deliver.

D. CONCLUSION

The findings of this research have noted how the *U.S. Department of Defense Counter-sUAS Strategy* and the Joint Counter-Small Unmanned Aircraft Systems Office have come to represent the guiding forces for C-sUAS within the DoD. The *C-sUAS Strategy* provides a codified framework for how the DoD can accomplish its C-sUAS mission while the JCO has been established to embody a source of authority for C-sUAS within the DoD. A SWOT analysis of DoD acquisition, the AAF, C-sUAS functions, C-sUAS, the *C-sUAS Strategy* and JCO helped to identify areas where each of these elements could succeed or fail in executing the C-sUAS mission for the DoD and, more specifically, the Air Force. Through these elements, the Air Force can align itself and its own C-sUAS acquisition strategy to not just protect its own installations and resources, but to further enable the C-sUAS mission for the DoD. In order to help achieve this mission, the Air Force must recognize the utility that these elements can provide as well as recognizing the strengths, weaknesses, opportunities for and threats posed against those elements. From that recognition and analysis, the Air Force can best posture itself in its C-sUAS acquisition and strategy. The following and final chapter of this research provides both a conclusion and offers recommendations by which the Air Force can specifically accomplish such feats.

V. RECOMMENDATIONS AND CONCLUSION

The threat that sUAS poses against the Air Force is not something that can be ignored. This research has highlighted a number of examples that sUAS could be used for malicious means against the resources, assets, and personnel of the Air Force. Fortunately, this research has also identified C-sUAS capabilities and systems that can be acquired and employed to combat this threat. Further, the DoD has created a strategy specifically aimed at countering the sUAS threat as well as created an office for the Joint Force that serves as authority for C-sUAS within the DoD. The Air Force must align itself with the capabilities that C-sUAS provide, the *C-sUAS Strategy* that provides a framework for addressing the sUAS threat, and the initiatives by the JCO to be successful in combatting that same threat and protecting its installations. This chapter provides recommendations for ways that the Air Force can synchronize its C-sUAS efforts with the DoD and its authoritative sources as well as offering concluding thoughts. The first of those aspects covered is explored through the recommendations for the Air Force's C-sUAS activities. The recommendations are meant to address the main problem of this research on how the Air Force cannot adequately defend itself against the sUAS threat without an acquisition strategy for counter-small, unmanned aircraft systems (C-sUAS) that delivers those capabilities. Also, without any kind of formal C-sUAS acquisition strategy, formal programs of record for C-sUAS for the Air Force cannot be established. This returns to the original problem identified by this research as to how the U.S. Air Force cannot adequately defend itself against the sUAS threat without an acquisition strategy for C-sUAS that delivers those capabilities to today's warfighter. Further, without that an acquisition strategy, formal C-sUAS acquisition programs of record for C-sUAS cannot be established. The following recommendations provide solutions to the problems originally identified in this research.

A. RECOMMENDATIONS

There are multiple levels and elements that the Air Force can align itself with in order to provide the best sUAS defense possible for its installations. The levels that the Air Force must look to in order to synchronize its C-sUAS efforts are strategic,

operational, and tactical. The elements that the Air Force can align to at those respective levels are represented by the *C-sUAS Strategy*, the JCO, and DoD acquisition of C-sUAS. A top-down approach is subsequently recommended for how the Air Force can align with the aforementioned levels and elements. By integrating its C-sUAS efforts at those different levels and with the different elements, the Air Force can help itself and the Joint Force to codify and conduct a standardized approach in the fight against the sUAS threat. Considering all the aspects covered in the preceding chapters, there are recommendations that can be provided from each of the respective elements to help the Air Force develop its C-sUAS acquisition strategy.

Recommendations made herein are not meant to be prescriptive as that is not the purpose of a strategy. Rather, these recommendations are meant to help shape the Air Force's C-sUAS acquisition strategy by using the elements discussed in this research as strategy-shaping tools. The first of those tools comes from how the C-sUAS acquisition strategy will navigate the DoD's Big "A" acquisition system. Starting with the DAS and, more specifically, the AAF, the C-sUAS acquisition strategy must research, identify, and incorporate the acquisition pathway that will deliver C-sUAS capabilities to the Air Force. That pathway should be able to provide a C-sUAS capable that represents the best balance of cost, schedule, and performance for that system. Additionally, as the Air Force considers and ultimately selects an AAF pathway, its strategy should include courses of action that allow the adoption or utilization of alternative acquisition pathways, should they later be identified as being a better way of delivering C-sUAS capabilities. As previously mentioned in the SWOT analysis, the C-sUAS acquisition strategy must identify, prioritize, and document the needs that C-sUAS can fulfill. The JCIDS process will specifically meet this initiative. Using JCIDS, the C-sUAS acquisition strategy must focus subsequent acquisition efforts to on meeting the needs identified in the strategy. Using PPBE, the C-sUAS acquisition strategy must determine, and be able to plan the budget and resources allocated to the program for no-less than the 5 years that follow the initiation of the program. A failure by the strategy to account for these planning processes could cost the program, resources, time, and money with a set-back in any one of these areas not only harming the program, but also adversely affecting the C-sUAS capabilities that are delivered to the Air Force.

Similar to avoiding prescriptive recommendations for Big "A" acquisition, this argument also applies to how this research recommends that the C-sUAS acquisition strategy determines its C-sUAS functions and the systems that can provide those functions. Also, similar to the preceding paragraph, the argument here for these elements calls to the SWOT analysis as to how the Air Force's acquisition strategy must prioritize and document the C-sUAS functions and systems that it wants to pursue and provide. As the strategy and sets its priorities for both of these elements, the subsequent acquisition efforts for C-sUAS must be built around meeting the priorities for functions and systems set by the strategy. These elements noted by this research represent strategy-shaping tools for the larger strategy itself. There are also external elements that the acquisition strategy must adhere to in order to deliver C-sUAS capabilities. The top level of that fight starts at the strategic level, with the C-sUAS Strategy.

1. C-sUAS Strategy

The DoD has provided a framework that its Services can study and apply to their C-sUAS operations. That framework is found in the *C-sUAS Strategy* and its three LOEs. As a strategic framework, the document purposefully avoids providing prescriptive means and actions that the Joint Force must adopt to their C-sUAS operations. Rather, the strategy provides flexibility in how the Services of the DoD can meet the general intent of the strategy. The strategy offered that the fight against the sUAS threat will require more than a singular reliance on the employment of a materiel solution but rather, will require a solution across the DOTmLPF-P spectrum. The Air Force must adopt this same notion. For example, the Air Force must publish its own doctrine and policy regarding C-sUAS. The Air Force currently publishes and mandates compliance with the AFMAN for sUAS operations, AFMAN 11-502 *Small Unmanned Aircraft Systems* which addresses the operations of sUAS operations on Air Force installations by authorized forces and users (Secretary of the Air Force, 2019). This document fails to offer anything of significance regarding C-sUAS operations (Secretary of the Air Force, 2019). The Air Force must codify how it will doctrinally combat the sUAS threat and establish policy for how those operations will be conducted. Without such measures, Air Force installations will be left to piecemeal their C-sUAS operations and can easily leave vulnerabilities in

defenses against that threat. C-sUAS must be further applied across the rest of the DOTmLPF-P spectrum in order to avoid additional vulnerabilities such as what has been noted with a lack of doctrine and policy for C-sUAS for the Air Force. If the Air Force does not address C-sUAS by aligning with the strategic framework set by the *C-sUAS Strategy*, such as by incorporating a DOTmLPF-P approach, the force will be fragmented in its defenses.

The LOEs of the strategy offer general instructions that the Air Force can utilize to standardize its C-sUAS efforts. The first LOE of readying the force offered that C-sUAS systems employed by the DoD must be capable of providing actionable UAS reporting, identification, and dissemination of information capabilities (DoD, 2021). This requirement from the first LOE of the strategy provides a simple standard that the Air Force must comply with when acquiring C-sUAS by ensuring that they are capable of reporting, identifying, and displaying information sharing capabilities. The Air Force can also align with the first LOE of the strategy by providing its own investments, and contributing to joint investments for the DoD, into S&T initiatives and projects for developing C-sUAS technologies. Developmental and operational tests conducted by the Air Force and its chief test agency, the Air Force Operational Test and Evaluation Center (AFOTEC) should look to not only share its tests results of C-sUAS but look to integrate joint tests wherever possible. This course of action will allow the Air Force to share its successes and lessons learned for C-sUAS across the Joint Force to allow a more robust sUAS defense across the DoD, while also allowing the Air Force an opportunity to receive the same benefits from the sister Services. All of these actions would align the Air Force with a key principle of the *C-sUAS Strategy* of information sharing. By sharing data and information of developing C-sUAS systems and capabilities, test results of C-sUAS, acquisition practices and lessons learned, and any other elements related to C-sUAS, the Air Force can support the DoD in the fight against the sUAS threat while also garnering support of establishing its own sUAS operations.

The second LOE of defending the force continues this same notion that will allow the Air Force to shore-up its C-sUAS defensive capabilities. Aside from addressing the sUAS threat from a DOTmLPF-P approach which was previously discussed, the LOE called for identifying capabilities that allowed freedom of action and control of the air

domain (DoD, 2021). For the Air Force to meet the call of the LOE, it must look to acquire and employ dominant solutions (both materiel and non-materiel) that can be easily employed by C-sUAS users. Through the acquisition and employment of those solutions, the LOE argued that those capabilities should be synchronized and deliver a benefit to the Joint Force (DoD, 2021). The Air Force must adopt this same notion in its own acquisition and employment of C-sUAS. Putting this argument into practice calls for the Air Force to synchronize its acquisition of C-sUAS to no more than two C-sUAS that will represent the sUAS defense for the Air Force. This can best be achieved by establishing a formal acquisition program that is charged with acquiring and fielding those systems at every Air Force installation. Acquiring two systems will allow for redundant capabilities to avoid single-points of failure in C-sUAS operations while also providing layered C-sUAS defenses for Air Force installations. By limiting acquisition efforts to focus on no more than two C-sUAS, the Air Force can standardize its efforts against sUAS across the DOTmLPF-P spectrum. For example, Airmen trained on the maintenance and operations of those systems will be trained to maintain and operate those systems at any Air Force installation. This example could also be applied to the facilities and support for those C-sUAS that would also become standardized across the Air Force. No longer would installations have to rely on their own devices and support for their C-sUAS operations. Rather, the entire force would have standardized equipment, support, and facilities that could easily be shared to any and all installations. By establishing a formal acquisition program, the Air Force can remove itself from piecemealing its sUAS defenses across its installations and instead, provide a synchronized capability that not only standardizes operations across the Air Force, but also aligns C-sUAS operations and endeavors with the larger Joint Force. This argument is further highlighted in the third LOE of the *C-sUAS Strategy* in ways that the Air Force can build its internal C-sUAS team and also align with C-sUAS partners across the DoD.

As the Air Force looks to build on its own C-sUAS capabilities, one avenue that will help in expanding those capabilities can come from partners also in the sUAS fight. As this research has predominantly focused on how the U.S. Air Force and the rest of the DoD can achieve superiority against the sUAS threat through sound acquisition practices and a strategy of C-sUAS, there are also entities in the U.S. civilian sector that can offer a

beneficial relationship for C-sUAS. The third LOE of the *C-sUAS Strategy* of building the team noted how partnerships with NSIBs and NFEs must be built in order to capitalize on the technology producing capabilities of C-sUAS industry leaders who are also well established in manufacturing and producing of physical systems (DoD, 2021). This research argues in favor of such a relationship and further argues that the Air Force and DoD cannot rest with mere acquisition of C-sUAS from commercial vendors. The Air Force and DoD must offer investments into those vendors advancing their products and their capabilities through initiatives such as funding into S&T and R&D projects and aiding with T&E efforts such as providing access to test ranges, offering services of professional testers for the DoD, and providing units and installations to serve as operational test beds for developing systems. By establishing a mutual beneficial relationship between the DoD and NSIBs and NFEs (as opposed to a buyer-seller relationship) will ultimately help to establish a shared base for innovation across all entities while also accelerating how C-sUAS solutions are developed, acquired, and fielded in the sUAS fight. As the Air Force extends funding and other support to civilian, commercial partners, the rest of the DoD will also benefit in that evolving relationship, which will also allow the other branches to build on their own C-sUAS partnerships and then share the fruits of those relationships across the DoD. It is imperative that the Air Force shares support in the forms of funding, research, testing, and developing technology not only to ensure that the Air Force receives those same benefits, but to help protect the entirety of the DoD against the sUAS threat. It is recommended that the Air Force organically and independently attempts to meet the calls of the *C-sUAS Strategy* and its respective LOEs, but the Air Force should further heed direction provided by the JCO along with any specific guidance regarding how the DoD will accomplish its C-sUAS mission.

An argument against the Air Force aligning itself with the *C-sUAS Strategy* would follow with information presented in the SWOT analysis from the previous chapter whereby the strategy could become outpaced by evolving sUAS and C-sUAS technologies. Additionally, the lack of prescription made by the strategy, and possible ambiguity in interpretation of the strategy could create undue problems for C-sUAS for the Air Force. If the *C-sUAS Strategy* fails to stay relevant, the Air Force would be forced

to employ its own framework to combat the sUAS threat. This would misalign the Air Force from the rest of the DoD in C-sUAS operations. This same argument could also hold true if the Air Force struggles with any ambiguity in the language or intent of the strategy. The combination of these two possibilities would argue that by aligning with the C-sUAS strategy and its own C-sUAS acquisition strategy and operations, the Air Force could become disconnected and hindered in how it conducts C-sUAS acquisition and operations.

Even despite those possibilities, this research argues in favor of the Air Force aligning itself with the *C-sUAS Strategy*. The reasoning behind this argument is that even though the previous examples exist, a greater threat even more concerning for the Air Force would be recognized in the form of being isolated from the rest of the DoD and C-sUAS for the Joint Force. Operating as an isolated entity would return the Air Force to a former state where the Air Force would be forced to rely on its own devices and ingenuity for C-sUAS acquisition and the strategy for those systems as well as their employment of those same systems.

It must be noted that the recommendation of the Air Force aligning itself with the *C-sUAS Strategy* is equally applied to its own C-sUAS acquisition strategy. As the Air Force works to align itself with the LOEs of the *C-sUAS Strategy*, the acquisition strategy will be the posture-setting document and guidance to meet this charge. The SWOT analysis of this research provided multiple areas where the Air Force and its C-sUAS acquisition strategy can align with the *C-sUAS Strategy.* The Air Force's C-sUAS acquisition strategy must repeatedly reference the *C-sUAS Strategy* to set acquisition priorities that align with the larger DoD C-sUAS priorities. The acquisition strategy must also have an understanding of what the Air Force's own C-sUAS general strategy will be so that it can posture itself to adopt a solution that best meets the needs of that mission. The acquisition strategy must explicitly identify the priorities for its C-sUAS functions and systems. Those priorities should align with the LOEs of the *C-sUAS Strategy.* As priorities are set, the acquisition strategy should also place an emphasis on investing in and working with private industry to help develop C-sUAS technologies and capabilities that the Air Force may lack technical competencies in. As the C-sUAS acquisition strategy addresses all aspects for this capability, it must continue with that trend and

provide guidance as to how the DOTmLPF-P spectrum will be affected by C-sUAS acquisition. By addressing DOTmLPF-P for C-sUAS within the Air Force, the acquisition strategy will provide a wholistic approach as to how C-sUAS capabilities are delivered to the Air Force. Finally, the C-sUAS acquisition strategy must set a balance and schedule that allows it to be relevant and current, but not in a constant state of revision that could adversely impact acquisition efforts.

2. JCO

Even with the U.S. Army being named by the Secretary of Defense as the EA for C-sUAS across the DoD, the Air Force can still align itself with the initiatives set by the JCO, in the same way that it aligns itself with the *C-sUAS Strategy*. The JCO was established to synchronize C-sUAS activities across the DoD and the responsibilities of the Office require development and oversight of C-sUAS doctrine, requirements, materiel, training standards, and capabilities (DoD, 2021). By standardizing these efforts across the Joint Force, a common architecture in joint solutions will be provided to the DoD (DoD, 2021). It is in the recognition of the duties of the JCO that this research argues that the Air Force must actively follow C-sUAS guidelines set by the JCO and engage in initiatives established by that Office. By following the lead of the JCO, the Air Force will allow itself to ensure that there is consistency for the Service, and with the rest of the DoD in C-sUAS approaches, technologies, operational constructs, and joint C-sUAS solutions (DoD, 2021). Further, aligning with the JCO will allow the Air Force to prevent unnecessary redundancies in C-sUAS solutions and capabilities, all while avoiding duplication of efforts. This will ultimately allow for the DoD to maximize efficiencies and effectiveness of C-sUAS programs and streamline developmental efforts (DoD, 2021).

There is a counter to this argument that must be considered. That argument is that the Air Force could prioritize its own C-sUAS efforts and initiatives over what the JCO has set. Under this argument, the Air Force could allow itself to become specialized on C-sUAS needs for the Air Force. This approach would allow the Air Force to tailor C-sUAS across the DOTmLPF-P spectrum to best fit the needs of the Air Force. Under such an approach, the Air Force would design, develop, and employ C-sUAS elements that

would allow the Service to become highly specialized, trained, and knowledgeable of the C-sUAS that is protecting Air Force installations and resources. Also under this approach, the Air Force would have a greater sense of autonomy and freedom in C-sUAS acquisition and operations.

Despite the above considerations, this research still argues in favor of the Air Force aligning with the JCO. The argument against individual Service priorities and preferences finds that by synchronizing C-sUAS activities and efforts across the DoD, the Joint Force can better protect its collective self from the sUAS threat. By providing consistency in C-sUAS acquisition and operations, the Air Force opens itself to support from the rest of the DoD for any struggles that it may face in the C-sUAS arena. Garnering C-sUAS support would likely not be as feasible if the Air Force were to prioritize its own C-sUAS activities. By aligning with the JCO, the Air Force will be positioned to avoid R&D, T&E, acquisition, and employment of C-sUAS actions that could have already been undertaken and accomplished by DoD partners. As the other Services of the DoD engage in and share information of C-sUAS endeavors, the Air Force can help the Joint Force in maximizing the benefits and outcomes of such activities by openly receiving that information, sharing its own, and producing more effective and efficient C-sUAS acquisition for the Air Force and DoD. It is the joint efforts between the Air Force and the rest of the DoD that will ultimately provide the Joint Force with the best C-sUAS materiel and non-materiel solutions against the sUAS threat.

This research previously mentioned accomplishments that have already been made by the JCO. Those accomplishments were highlighted by the publishing of the *C-sUAS Strategy*, selecting a set number of C-sUAS for further investment from the DoD, providing doctrine and other written guidance for C-sUAS to the Joint Force, and testing efforts and accomplishments of C-sUAS (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). The JCO has also identified future endeavors for C-sUAS for initiatives such as providing additional doctrine and guidance on C-sUAS, extending testing and training with Joint and international partners, improving monitoring of sUAS incidents and, developing and distributing sUAS threat assessments for the DoD (U.S. Army, Deputy Chief of Staff, G-3/5/7, 2021). From the work already accomplished by the JCO, and the work remaining, the Air Force can support the JCO in each one of these initiatives.

One of the biggest ways the Air Force can support the JCO and garner future support form that Office is by helping to provide funding to tests, development, acquisition, fielding, and support of C-sUAS. As the Air Force provides financial support to the JCO as it selects and acquires C-sUAS, the Air Force can in turn expect to receive proven systems, that can be integrated across installations and Services systems that have established support networks and programs (such as what could be created through a formal acquisition program of record that is built from a guiding C-sUAS acquisition strategy) that will make the acquisition and employment of these solutions much less cumbersome for the Air Force. The Air Force can identify and establish formal methods of communications for all C-sUAS testing and training that it conducts (whether independently or jointly with agencies). Data and information sharing between the Air Force and JCO should also be formalized for sUAS incidents and threat reporting. The premise behind formalized, open, and reciprocally flowing information between the Air Force and the JCO is that assumptions will be avoided, information will be accessible by all parties, and the resulting products that result from these endeavors will yield the most capable C-sUAS solutions across the DoD.

The Air Force's C-sUAS acquisition strategy will echo aligning efforts with the JCO. The acquisition strategy must utilize the subject-matter-experts and strategic-level experts at the JCO as the acquisition strategy is developed and refined. As the acquisition strategy is being developed, it must also follow-up with the JCO as well as have supporting research conducted that verify the feasibility of initiatives set by the JC all to ultimately ensure that a likelihood of those initiatives coming to fruition and acquisition efforts by the Air Force not being wasted. The JCO represents a premiere information generating and sharing source for sUAS and C-sUAS matters. The Air Force's C-sUAS acquisition strategy must capitalize on this fact and continually update the acquisition strategy as information is produced and shared by the JCO. Conversely, as the Air Force C-sUAS acquisition strategy is developed and refined, it must be capable of being shared with the rest of the DoD to help with other Services own C-sUAS acquisition efforts. Finally, as the JCO must be timely, informative, accurate, and efficient in the information it shares, so too must the acquisition strategy. By following suit with the JCO in the

manner by which information is shared, the C-sUAS acquisition strategy will serve as its own authoritative source for C-sUAS acquisition within the DoD.

B. CONCLUSION

The U.S. Air Force is lacking a strategy for its acquisition of C-sUAS. The lack of an acquisition strategy leaves the Air Force and its installations on its and their own in the fight against the sUAS threat. Without an acquisition strategy that internally aligns C-sUAS within the Air Force, and one that synchronizes C-sUAS acquisition with the rest of the DoD, not only can sUAS vulnerabilities be exploited, but the Air Force will waste time, effort, and money.

This research has shown the problem that exists for the Air Force in the form of a lack of an acquisition strategy of C-sUAS. This problem generated the purpose of this research to analyze the current state of DoD acquisition of C-sUAS capability and then recommending a specific strategy for the Air Force by aligning its acquisition efforts to meet the intent set by the *DoD's C-sUAS Strategy* and the Joint C-sUAS Office. In order to further highlight the problem and corresponding purpose for this research, examples were given on the UAS threat posed against the Air Force and its resources. These examples heled to establish the magnitude of concern for the threat posed by sUAS against the Air Force. Understanding how sUAS can conduct some of the described illicit acts was accomplished by describing the different types of UAS.

The research then transitioned to providing a base-level understanding to Air Force C-sUAS acquisition through the employment of the DAS and AAF. The AAF and the DAS provide the DoD with tailorable and adaptative solutions for acquisition and are commonly recognized in association with the MTA. The ultimate purpose behind all of these elements was identified in support of the NDS by helping to ensure a lethal force through technological innovations such as C-sUAS and the acquisition of those systems and technologies. Exploration of C-sUAS technologies was identified through describing the various functions that those systems are capable of providing. This was further highlighted in four different C-sUAS that the JCO has identified as qualifying for investments by the DoD in the development and possible acquisition and employment of those systems.

The methods that were undertaken to complete this research were next explored. Those methods focused largely on how research was conducted in support of this research and that research was accomplished through a comprehensive literature review focusing on C-sUAS, acquisition of those systems, the strategy behind those systems acquisition for the larger DoD and the entities that are best poised to serve as the focal point for C-sUAS within the DoD. From that, research identified two separate elements that were deemed vital to the success of C-sUAS acquisition for the U.S. Air Force. They were the DoD's *C-sUAS Strategy* and the Joint C-sUAS Office. Analysis behind these two elements identified measures that have been accomplished, current and future work, and how all of those elements can support the DoD in the fight against the sUAS threat. A SWOT analysis was also conducted to identify four distinct avenues where the Air Force's *C-sUAS Strategy* could be exploited.

Finally, recommendations have been provided as to how the Air Force can align itself and, its acquisition strategy, practices, and efforts not just to improve its own C-sUAS defenses, but to better protect the DoD. It is from those recommendations that this research closes with two final calls. The first is for further study to be executed for C-sUAS acquisition and acquisition strategy for all of the branches within the DoD. The final call is for the Air Force and its leaders to recognize and act on the strategic consequences the sUAS threat poses, as well as the corresponding need for synchronized acquisition strategy and practices for the systems that are directly purposed to defeat that threat.

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