AUVSI
RESEARCH

AUVSI UNCREWED INSIGHTS

2024 Volume 2

KEELY GRIFFITH
VP Strategic Programs,
AUVSI

As the uncrewed systems industry experiences unprecedented growth, understanding the intersection of defense spending and industry investment is crucial. While significant investment remains on defense applications, the ripple effects extend far beyond, shaping the entire ecosystem of uncrewed technologies. The articles in this publication delve into several key areas where friction, often seen as an obstacle, must instead be leveraged as a catalyst for innovation and growth. This friction—whether in policy, budget allocation, or industry standards—represents the dynamic tension that drives progress.

Key highlights include:

- An analysis of the FY 2025 Department of Defense (DOD) Budget for Uncrewed Systems Procurement and Research, Development, Test, and Evaluation (RDT&E) highlights over $10 billion for uncrewed vehicle programs. This influx of capital supports military needs and drives innovation and development in key technologies such as sensors, autonomy, and simulation environments.
- An overview of Counter-UAS technology, defense spending, and industry activity— with a staggering 90% compound annual growth rate in government contract spending on C-UxS technologies from FY 2020 to FY 2023, it is clear that the private sector is crucial in meeting the demands of our defense strategy.
- An exploration of the broader implications of uncrewed systems on the economy and workforce and the need for a comprehensive sustainability and economic framework to guide future investments and policy decisions in commercial operations.

As we look ahead, it is imperative that we continue to confront friction within our defense industrial base and harness them to build a more resilient, innovative, and capable industry. Through the examination of these trends, we gain insight into how defense spending catalyzes broader industry investment, driving innovation and growth across the uncrewed systems landscape.

TABLE OF CONTENTS

ADVOCACY UPDATE

Hill Day 2024 Recap

In June, AUVSI brought together over 100 of our Advocacy members, Board Members, and Chapter leaders to meet with lawmakers on Capitol Hill for our annual Hill Day.

The day kicked off with remarks from Representative Rick Larsen, Ranking Member of the House Transportation & Infrastructure Committee.

Member groups representing all domains - across the commercial, defense, and civil sectors – met with lawmakers to discuss about key issues facing our industries, including strengthening manufacturing capacity, infrastructure needs for uncrewed systems integration, defense appropriations, and implementation of the 2024 FAA Reauthorization Act.

Advocacy Committees Formalize and Elect Leadership

In May, AUVSI's **Defense Advocacy Committee** held its first leadership elections following the Committee's launch in September 2023. Since launch, Committee membership has grown to approximately 120 companies who advocate for policies and funding for uncrewed and autonomous systems in the Department of Defense. Learn more.

The Committee brings together diverse industry perspectives across operational domains to focus on challenges the industry faces; seize opportunities across the DOD, service branches, and Congress; and support a strong defense industrial base to ensure that the U.S. remains at the forefront of autonomous defense technologies.

Elected Leadership:

- Chair Steve Boraz - Business Development Director, Maritime, Leidos
- Vice Chair Joe Bartlett - Director of Federal Policy, Skydio
- Vice Chair LTC (Retired) Matt Dooley - Defense Strategy Initiatives Lead, Forterra

In June, AUVSI's **ground domain Working Group** formalized as an Advocacy Committee, approving bylaws and hosting its first leadership elections. Going forward, the Ground Advocacy Committee (GAC) will set AUVSI's legislative and regulatory priorities in the ground domain. Learn more.

The GAC is composed of a diverse group of member companies, including those in automated goods movement, ground robotics, ground defense, and more. Members work intimately with leadership in the Department of Defense, lawmakers in the Legislative Branch, as well as state, local, and tribal officials to help scale Uncrewed Ground Vehicles in a meaningful way.

Elected Leadership:

- Chair Pat Acox – Head of Government Growth, Forterra
- Vice Chair Jason Brown – General Manager, Government, Applied Intuition Defense

FY 2025 DOD BUDGET FOR UNCREWED SYSTEMS RDT&E

Major Investments and Priorities

Author:
David Klein, Research Analyst for Systems, Technology, and Defense, AUVSI

Key Takeaways

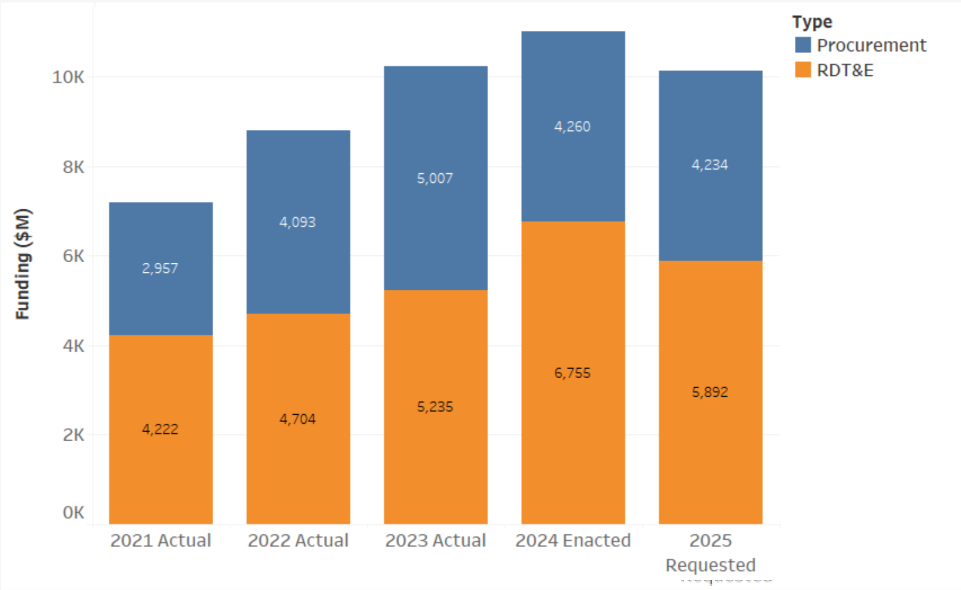
- Suggested Congressional changes to the original FY 2025 budget request represent a net increase of over $2 billion for uncrewed vehicle programs.
- Increased investments in counter-UAS solutions support the urgent need for these technologies in international conflicts as allied forces face a rapidly evolving threat from adversarial uncrewed systems.
- The Navy's budget for research, development, and acquisition of uncrewed vehicles exceeds all other organizations with significant efforts ramping up in the Army and Air Force.
- Funding trends indicate rapid acceleration of enabling technologies for uncrewed systems including sensors, autonomy, teaming capabilities, and simulation environments.

Introduction

Each year, AUVSI's research team collects and analyzes information on the budget for the United States Department of Defense (U.S. DOD) relative to support for procurement and research, development, test, and evaluation (RDT&E) of uncrewed systems. Through this research, we hope to offer industry and military stakeholders a better understanding of the future landscape of uncrewed system technologies while identifying the priorities of the U.S. government, assessing how threats to national security are being mitigated, and reporting where investments are being made in this growing technology sector.

Charting the budget from the last five years (Figure 1) shows a total estimated investment of over $47 billion in support of the RDT&E and procurement of uncrewed systems. While there was a slight decrease between the FY 2024 appropriations and the FY 2025 request, total funding has seen steady growth in recent years. Additionally, the versions of the FY 2025 National Defense Authorization Act (NDAA) and Appropriations bill released thus far from the Senate and House committees have shown strong support of uncrewed systems. These pieces of legislation suggest changes to the original amounts from the President's Budget (PB) request and are then reviewed by Congress to form the final versions of each. If all changes are accepted in the final versions of the NDAA and Appropriations at the maximum amounts, an additional $2.2 billion would be added to the top line of the FY 2025 budget in support of uncrewed systems (Figure 2). Furthermore, AUVSI's advocacy team has actively advocated for strong support of the DOD's Replicator initiative with the goal of accelerating funding and procurement of autonomous uncrewed systems across all domains of operation. With the passage of the Senate Appropriations Committee's FY 2025 defense spending bill in early August 2024, potentially $500 million will be added to the budget to acquire these systems[1].

Figure 1: Total RDT&E and procurement budgets for uncrewed systems in the past 5 years.



Sources: DOD Budget Request, AUVSI Research

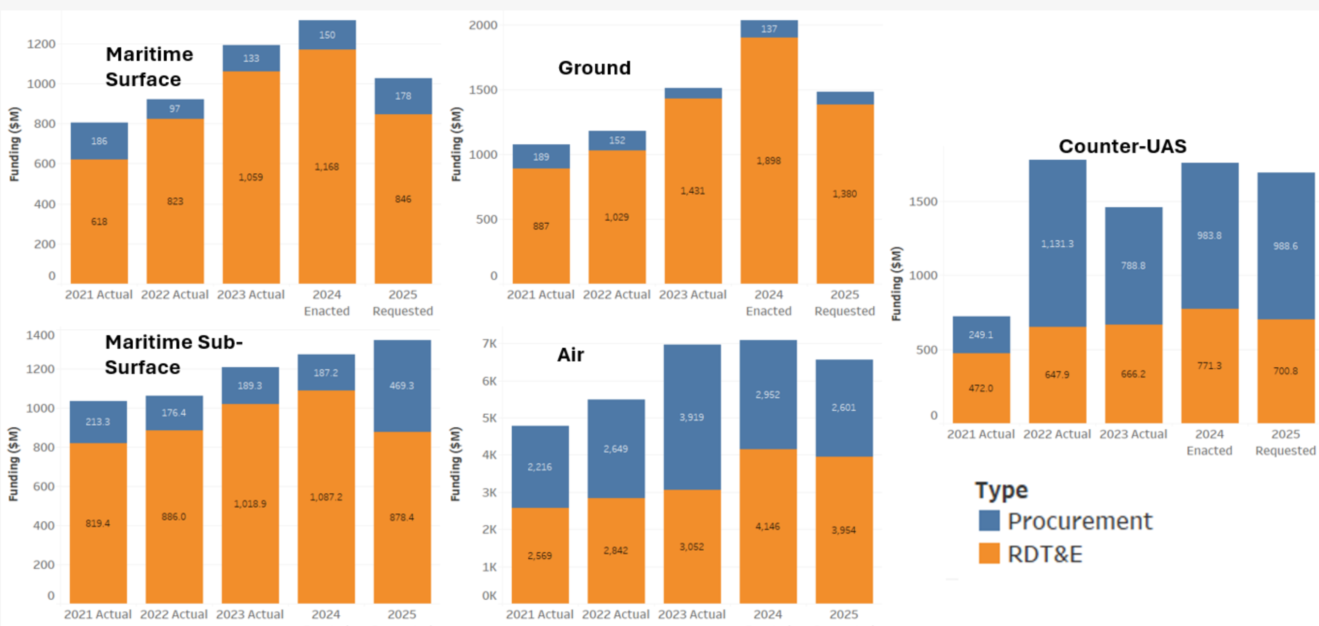
Figure 2: Suggested Congressional changes for uncrewed vehicle programs relative to the PB25 budget request.

Sources: Congressional Legislation, AUVSI Research

Investments in Uncrewed Systems Favor RDT&E in all Domains but C-UAS

Figure 1 also shows that RDT&E funding has exceeded procurement investments each year since FY 2021. Separating this funding by domain (Figure 3) provides some further insight and shows how skewed the ground and maritime domains are towards RDT&E. This can likely be attributed to the maturity of technologies in these domains as capabilities and concepts of operation continue to advance to the point where they can be implemented for widescale deployments. On the other hand, systems in the air domain have a well-founded historical presence on the battlefield and have proven their effectiveness in support of a range of missions across each of the DOD core services from logistics to surveillance and offensive strike. There also remains significant potential for further research and development to improve the performance and effectiveness of UAS. As such, the funding for these systems is much more evenly distributed between RDT&E and procurement. Counter-UAS (C-UAS) is the only category from Figure 3 where procurement funding consistently exceeds RDT&E. This is likely a function of the urgent need for these technologies as adversarial UAS pose an increased threat to U.S. and allied forces. These threats have been further reinforced through recent international conflicts in Ukraine and the Gaza Strip. C-UAS solutions will continue to play an increasing role in contested environments and associated funding is expected to see corresponding growth in the future. In fact, approximately half of all potential funding increases from Congress (~$1.1 billion) is associated with these technologies. For more information on C-UAS, reference the article on this topic which is featured in a later section of this publication titled *Overview of Counter-UAS technology, Defense spending and Industry activity.*

Figure 3: Distribution of RDT&E and procurement funding for each domain.

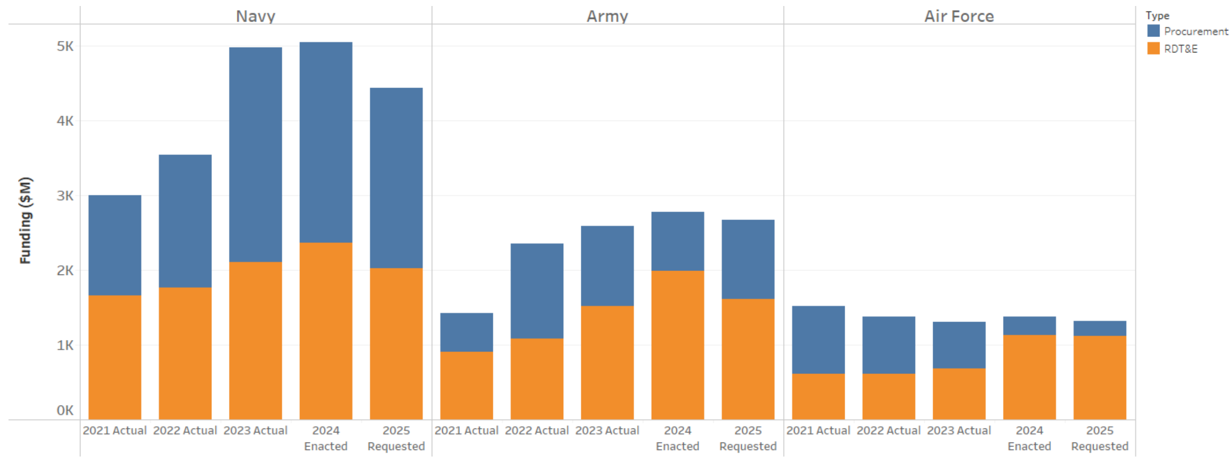


Sources: DOD Budget Request, AUVSI Research

Uncrewed Systems funding dominated by Navy; Army catching up

Analysis of the U.S. DOD's budget for uncrewed systems by organization shows that the Navy has been the primary source of funding from FY 2021 to FY 2025 (Figure 4).

Figure 4: Distribution of RDT&E and procurement funding for the core DOD services.



Sources: DOD Budget Request, AUVSI Research

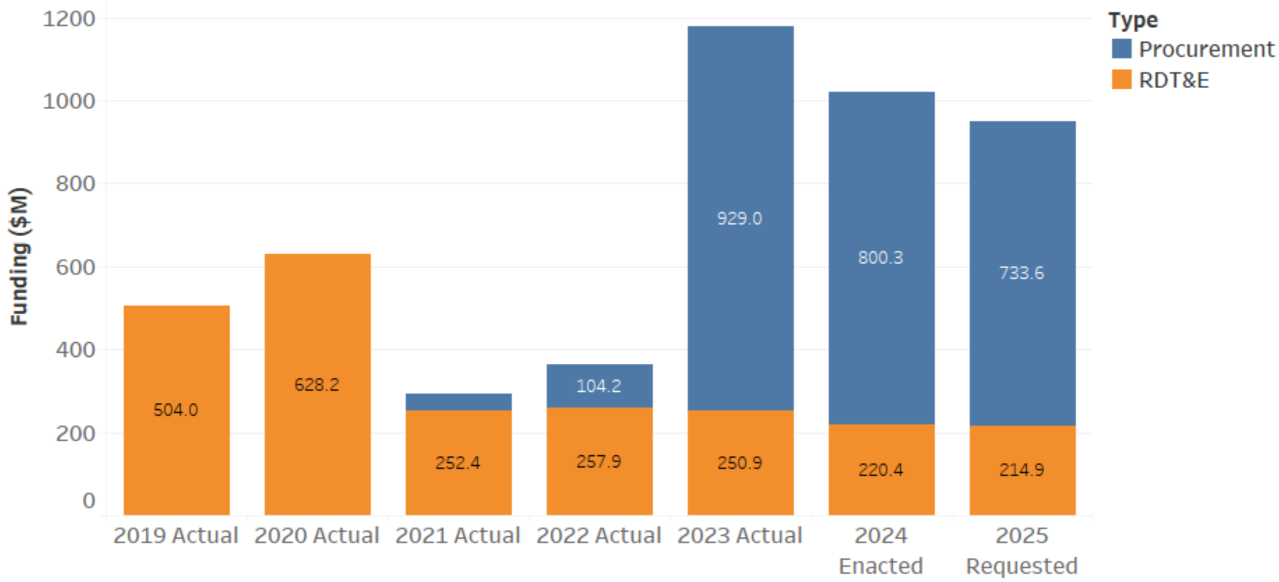
Much of that funding can be attributed to two core projects:

1. **The MQ-25 Air System:** with just over $4.4 billion in funding since FY 2019, the MQ-25 fills a current gap in carrier-based refueling as its primary mission while also supporting organic ISR capabilities. FY 2025 plans include integration with the Ground Control Station as well as ground and flight testing through delivery of a static test article, four engineering development models, and a system demonstration test article (SDTA). Two other SDTAs will be used to complete the build of the vehicle and then be delivered for testing in FY 2026. Plans also involve the continued integration of software capabilities for carrier suitability and mission systems evaluations.

Figure 5: The Boeing MQ-25 Stingray UAS executing a refueling mission.

Sources: Boeing's website, https://www.boeing.com/defense/mq25

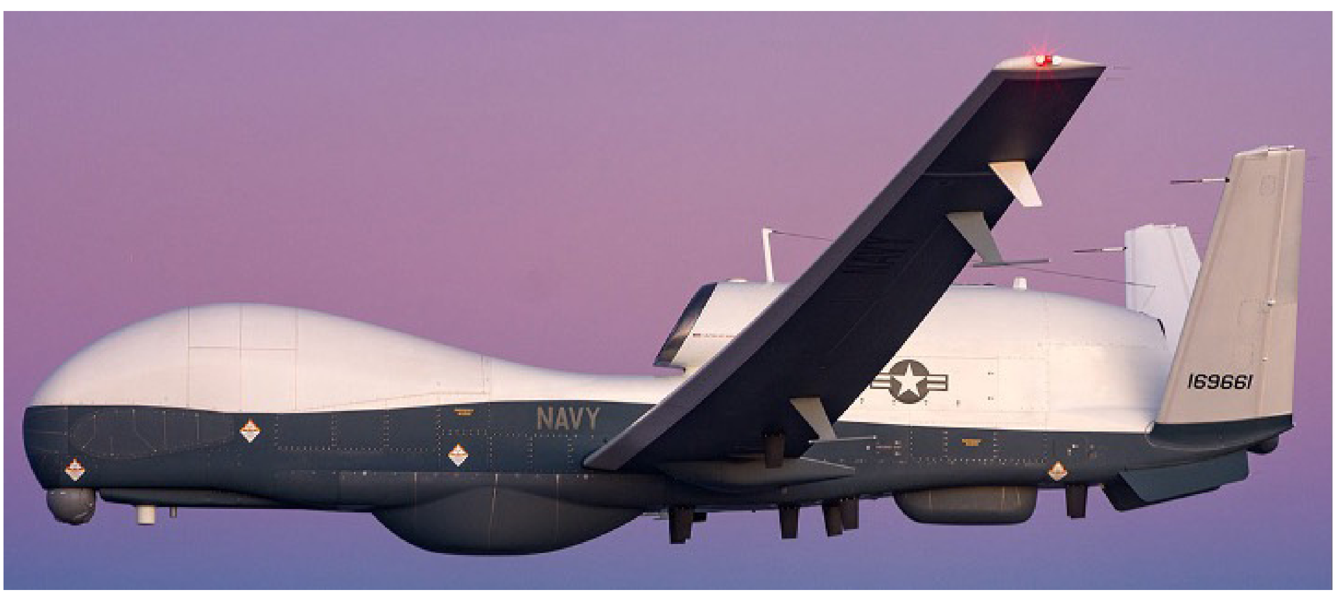
Figure 6: Funding for the MQ-25 including the associated UMCS program.



Sources: DOD Budget Request, AUVSI Research

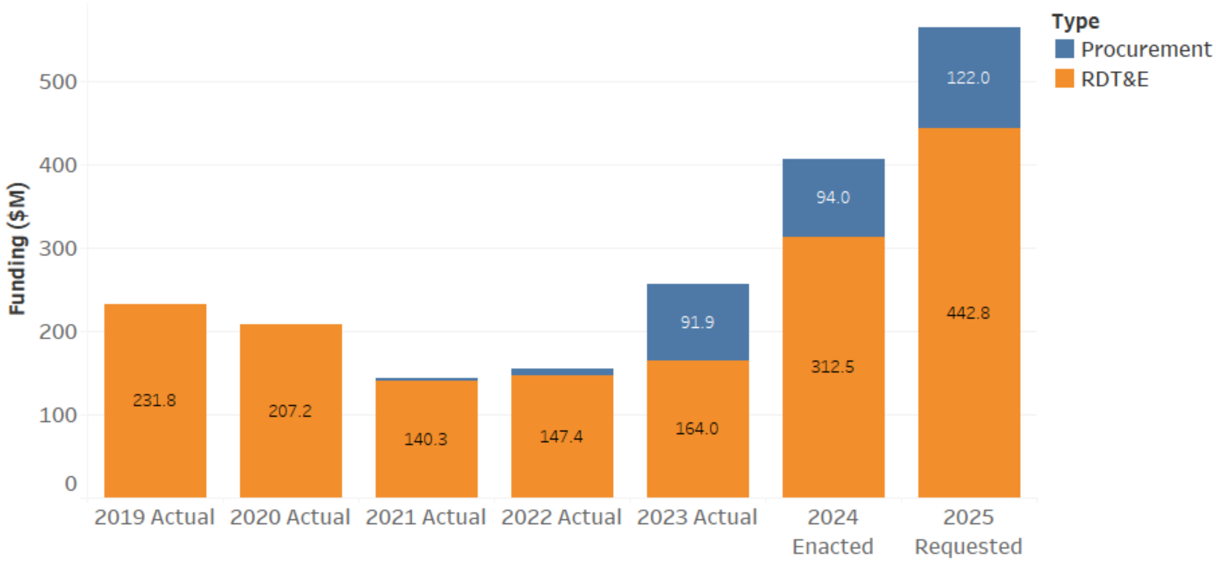
2. **RQ-4 Modernization:** with a significant ramp up of funding in FY 2024 and FY 2025, this program accounts for over $1.5 billion since FY 2019. The Navy's RQ-4 Modernization program is supporting upgrades to the MQ-4C Triton UAS with investments being made to provide advanced radar modes inclusive of Ground Moving Target Indicator (GMTI), and enhanced Electro-Optic/Infrared (EO/IR) detection in support of Geographic Intelligence (GEOINT) for increased maritime domain awareness, among other improvements to sensors and communication systems.

Figure 7: The Northrop Grumman MQ-4C Triton UAS



Sources: Northrop Grumman's website, https://www.northropgrumman.com/what-we-do/air/triton

Figure 8: Funding for programs related to the MQ-4C Triton UAS.



Sources: DOD Budget Request, AUVSI Research

Other Navy programs of note include:

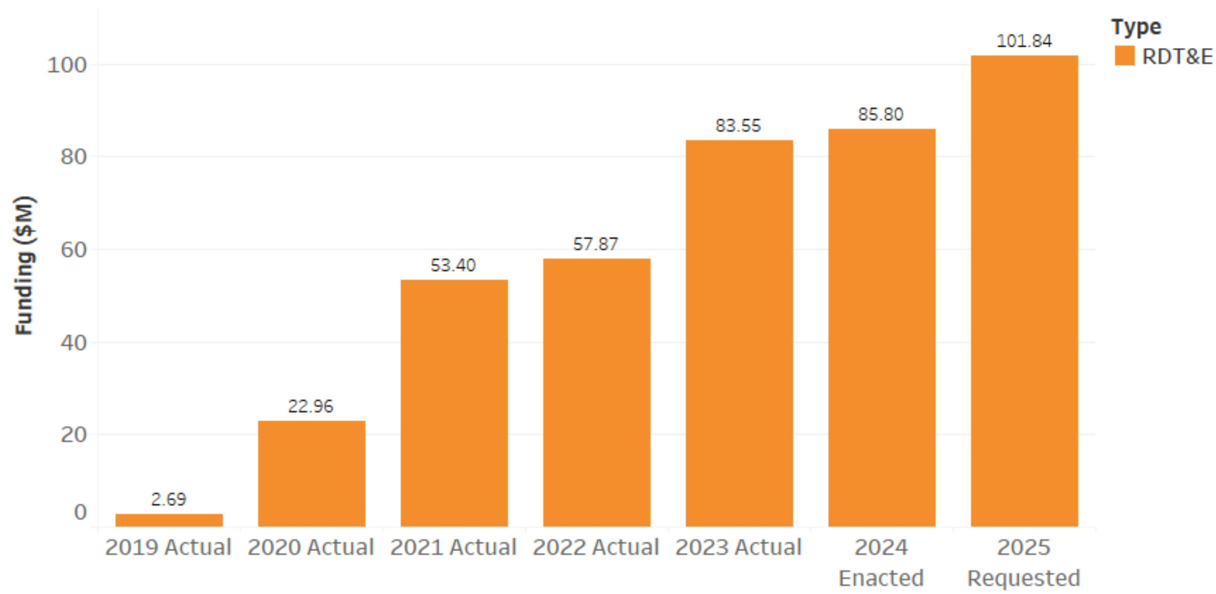
1. **Medium Unmanned Surface Vehicle (MUSV)** which integrates military payloads with robust and proven commercial vessel specifications to provide increased capabilities and expanded capacity to the Navy's surface fleet. The primary mission of MUSV will be battlespace awareness and FY 2025 is a critical period for technology development and risk reduction efforts. FY 2025 plans include testing and maturation of the Integrated Warfare Systems as well as Command, Control, Communication, Computers, and Intelligence (C4I) in laboratory environments. Also of key importance will be hardware and software developments for shipboard integration, payloads, and required control system interfaces.

Figure 9: The Sea Hawk medium displacement USV.

Source: News Website,
https://www.defensenews.com/naval/2023/01/12/us-navy-more-certain-of-role-for-medium-surface-drones-following-tests/

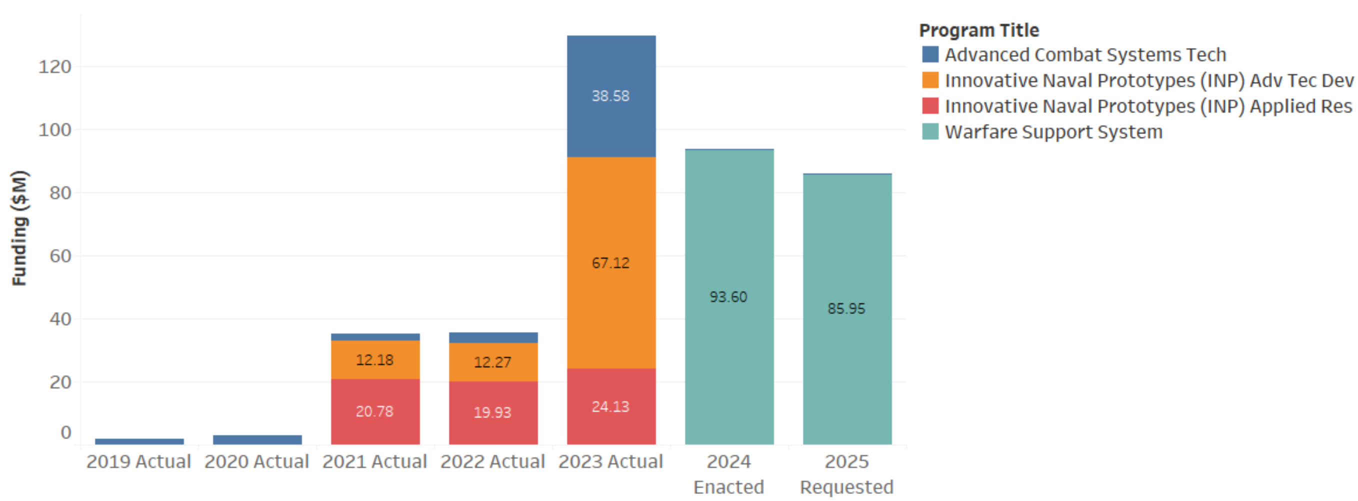
2. **Expeditionary Loitering Munitions Capability Development** accounts for $179.5 million between the FY 2024 appropriated and FY 2025 requested budget. This program was founded in three separate programs prior to FY 2024 (Figure 11) under the LOCUST effort and was officially realigned from the Advanced Combat Systems Technology program in the last two budget cycles. Prior to the realignment, the focus of LOCUST was on the demonstration of UAS swarms and associated payload developments to degrade threat Integrated Air Defense Systems (IADS) in support of follow-on manned system operations. Through the new program, the Navy is seeking commercial-off-the-shelf (COTS) systems with autonomous government-supplied software and launcher systems to enable deployment by small teams. This program is being executed under two projects named GOALKEEPER and WHIPLASH to fulfill an urgent Geographic Combatant Command Requirement.

Figure 10: Funding for programs related to the MQ-4C Triton UAS.



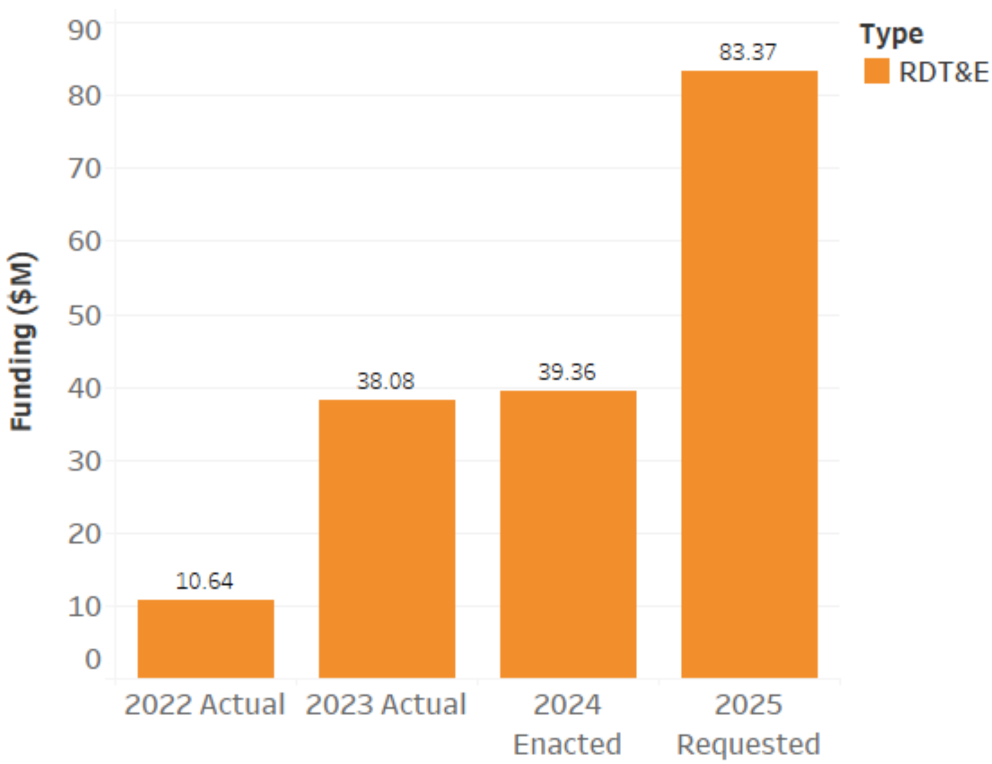
Sources: DOD Budget Request, AUVSI Research

Figure 11: Funding for the Navy's development of Expeditionary Loitering Munitions.



3. **Long Endurance Electronic Decoy (LEED) project** (Figure 12) under the program Ship Self Def (Engage: Soft Kill/EW) was initiated in FY 2022 to deliver an expendable long endurance autonomous off-board decoy Countermeasure system, comprised of a flight vehicle and Radio Frequency (RF) payload for electronic warfare missions. The FY 2025 funding request supports the completion of integrated system testing, EDM delivery, and continued LEED integrated countermeasure development at the prime contractor. This includes material purchases, system/subsystem integration, and early prototype system demonstrations that support rapid design improvement. The FY 2025 funding increase supports the design's completion, government testing, and product support elements to enable rapid fielding in accordance with Fleet priorities.

Figure 12: Funding for the Long Endurance Electronic Decoy Project.



Sources: DOD Budget Request, AUVSI Research

The DOD organization with the next highest funding for uncrewed systems is the Army which has seen an 87% increase in funding from FY 2021 to FY 2025. From an RDT&E perspective, two programs accounting for a large amount of that funding are displayed in Figure 13.

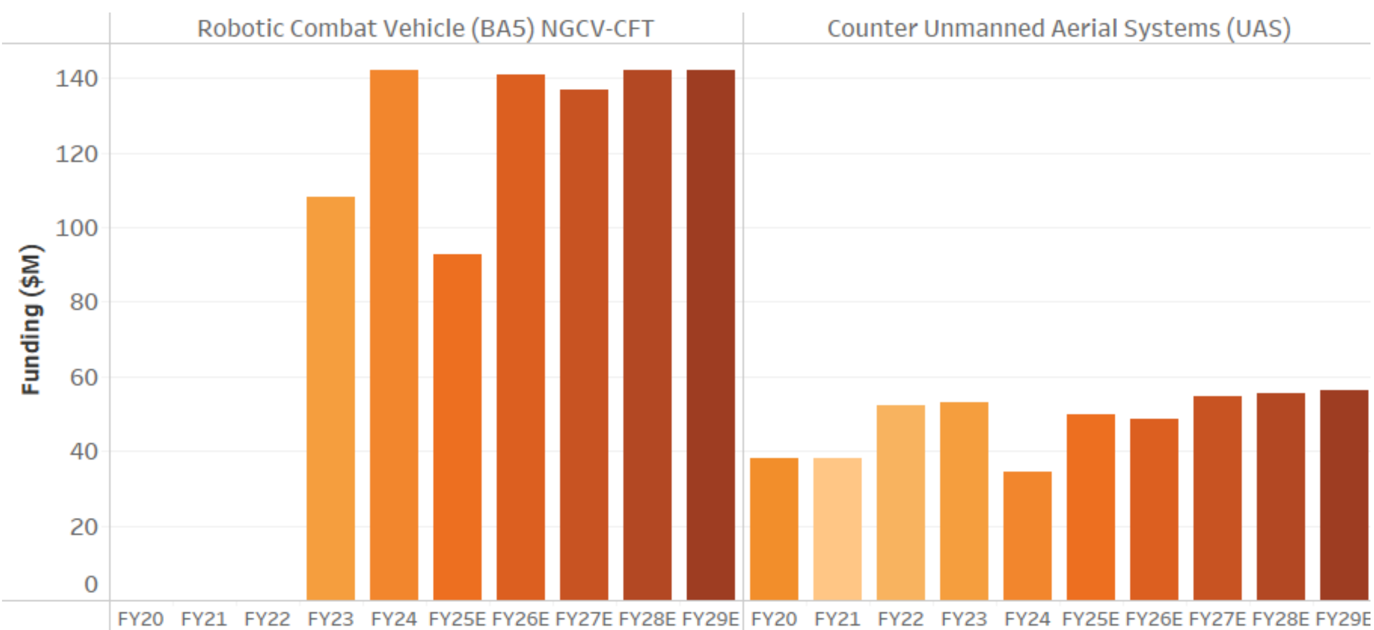
1. Robotic Combat Vehicle (BA5) NGCV-CFT is a program working to develop a remotely operated ground platform that will be used both as a scout and escort for manned combat vehicles. The original development strategy involved a family of systems separated into three classes: Light, Medium, and Heavy. However, in August 2023 reports emerged[2] that the Army, while still interested in robots of various sizes, will focus on a single vehicle with a common chassis for RCV. Based in the light class (RCV-L) with an intended weight of less than ten tons, system developments will concentrate on hardware and software architectures, platform design, new equipment training for prototype testing, and integration of Modular Assured Position, Navigation, and Timing System (MAPS). FY 2025 will also involve the conclusion of the open competition and full system prototype (FSP) contract award for Phase II which will result in the selection of a single vendor for the delivery of nine or more FSPs.

2. The Army's Counter Unmanned Aerial Systems (UAS) program accounts for an estimated $425 million from FY 2020 to FY 2029 which funds the development of cross-domain capabilities to identify, classify, track, and defeat Group 1-3 UAS threats through fixed, mobile, and handheld solutions. The majority of FY 2025 investments will support prototyping efforts, integration of emerging technologies, and assess performance against future threats to Army forces. The program was initiated in response to a joint urgent operational need but in FY 2022 was transitioned to "formalized acquisition approach" representing five acquisition categories:

    a. Fixed Site Low, slow, small Unmanned Aircraft System (UAS) Integrated Defeat System (FS-LIDS)
    b. Mobile-Low, slow, small UAS Integrated Defeat System (M-LIDS)
    c. Ku-band Radio Frequency System (KuRFS) Family of Radars
    d. Coyote Launchers and Interceptors
    e. Handheld/Dismounted Systems

Counter-UAS systems are a critical capability on the battlefield as soldiers face an emerging and rapidly evolving threat from adversarial UAS. The Secretary of Defense has designated the Army as the Executive Agent for Counter-small UAS with the goal of minimizing unnecessary duplication and redundancy in the development of associated technologies. The criticality of these systems was further reinforced in the most recent Defense Appropriations Act emerging from the Senate Committee on Appropriations (SAC) on August 1st which adds $1 billion more than the PB request for counter-drone capabilities[3]. A more in-depth discussion of C-UAS technologies can be referenced in a later section of this publication.

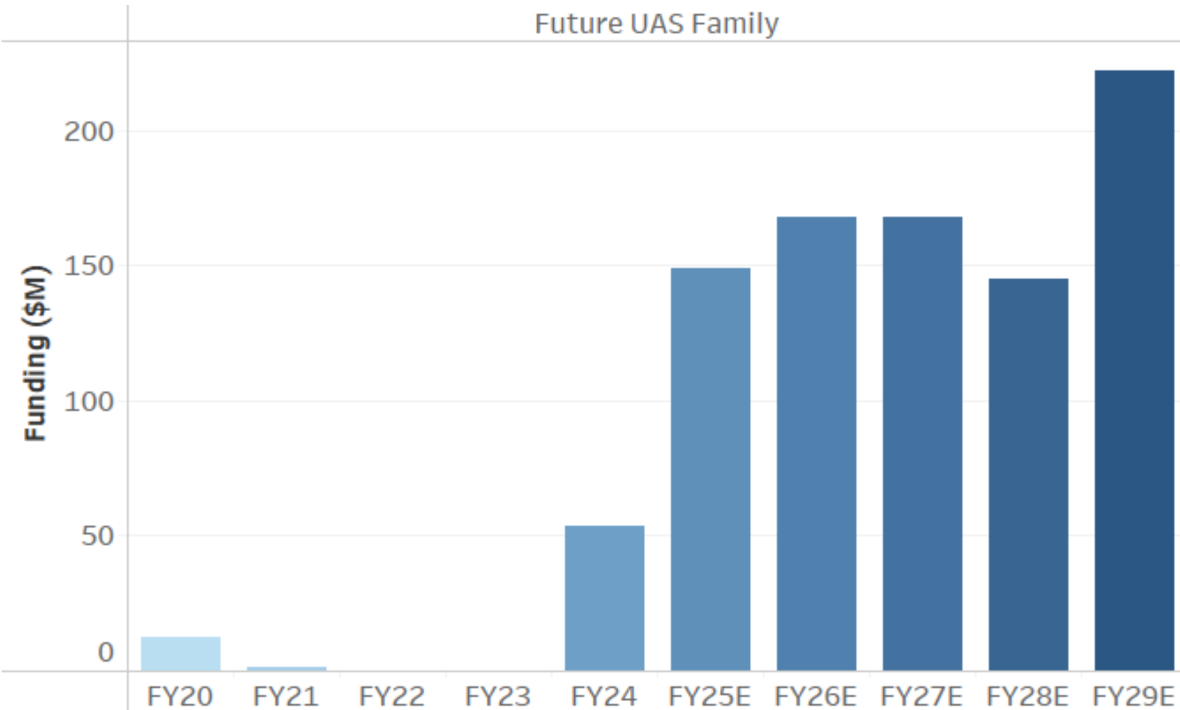
Figure 13: Funding for the Army's RCV and C-UAS programs.



Sources: DOD Budget Request, AUVSI Research

From a procurement perspective, significant funding is ramping up for the Army's Future UAS Family (Figure 14). The program in FY 2021 and before funded demonstrations for a Future Tactical UAS that would replace the RQ-7Bv2 Shadow TUAS. Funding was then cut for the next two years, and in FY 2024 the program was designated as a new start with support for four Future Tactical UAS (FTUAS) and new equipment training. FY 2025 funding requests procurement of seven additional FTUAS as well as an Air Launched Effects (LE) capability that employs teaming and swarming effects to detect, decoy, jam radar and communications, conduct cyber-attack, spoof and jam Global Positioning System (GPS), and provide kinetic engagement.

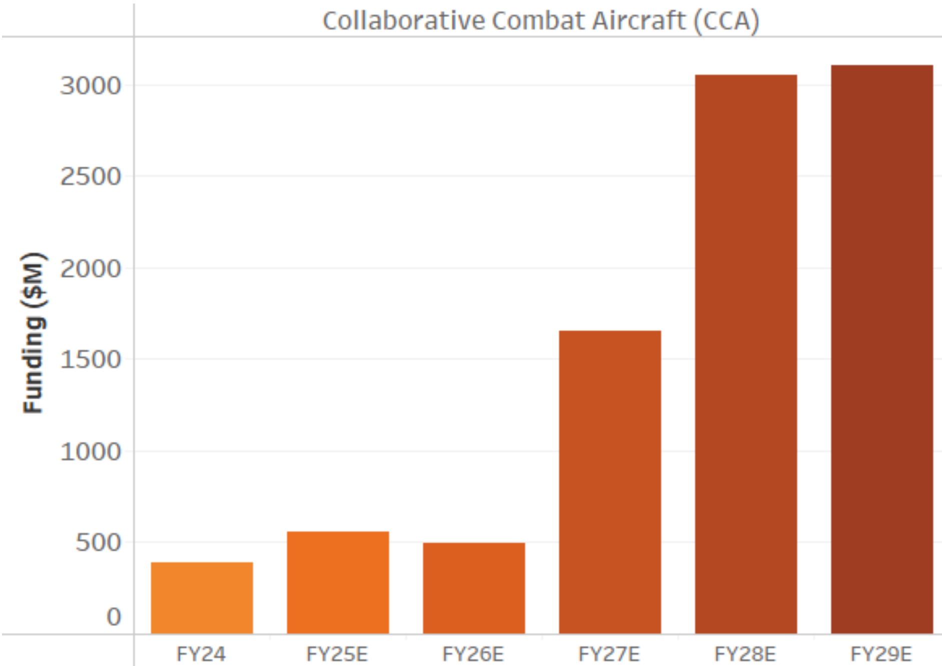
Figure 14: Funding for the Army's Future UAS Family.



Sources: DOD Budget Request, AUVSI Research

As was shown in Figure 4, Air Force funding for uncrewed systems has declined slightly in the last five budget cycles ranging from a high of about $1.5 billion in FY 2021 to a low of $1.3 billion. Interestingly, in that time, the distribution of funds has shifted from procurement to RDT&E. This is somewhat counter-intuitive as one would expect the opposite to occur as technologies mature and are advanced from a research and development phase to an acquisition phase. However, this shift is likely more a product of operational needs where previous procurement funding was dedicated to systems like the MQ-9 Reaper and associated modifications or weapon systems. Prior to FY 2022, significant portions of the procurement funding for the MQ-9 were appropriated for Overseas Contingency Operations (OCO) – a category of funds used to support U.S. forces in foreign conflicts. OCO funding has not been required for Air Force uncrewed systems procurement in the years since and in mid-2021 reports emerged that the MQ-9 fleet at that time was "sufficient to support current and future operational and training requirements."[4] The Air Force is also working to define what role the next generation of uncrewed systems will play in future operations. One program which was initiated in the FY 2024 budget to advance these concepts is the Next Generation Air Dominance RDT&E effort with the project Collaborative Combat Aircraft (CCA) representing a potential of more than $9.2 billion in funding through FY 2029 (Figure 15). Key CCA efforts involve mission-integrated autonomy and multi-platform interoperability. The Air Force also initiated a related program in FY 2024 with a value of about $110 million which will mature autonomous operational concepts.

Figure 15: Funding for the Air Force's CCA program.



Sources: DOD Budget Request, AUVSI Research

DOD Investment Trends in Technologies

Previous sections of this article have demonstrated the ability to filter our research by the organizations that have requested funding and the domains that funding would support. Another primary filter available to users of our research tool relates to the systems and technologies which are being developed and procured. Overarching categories include:

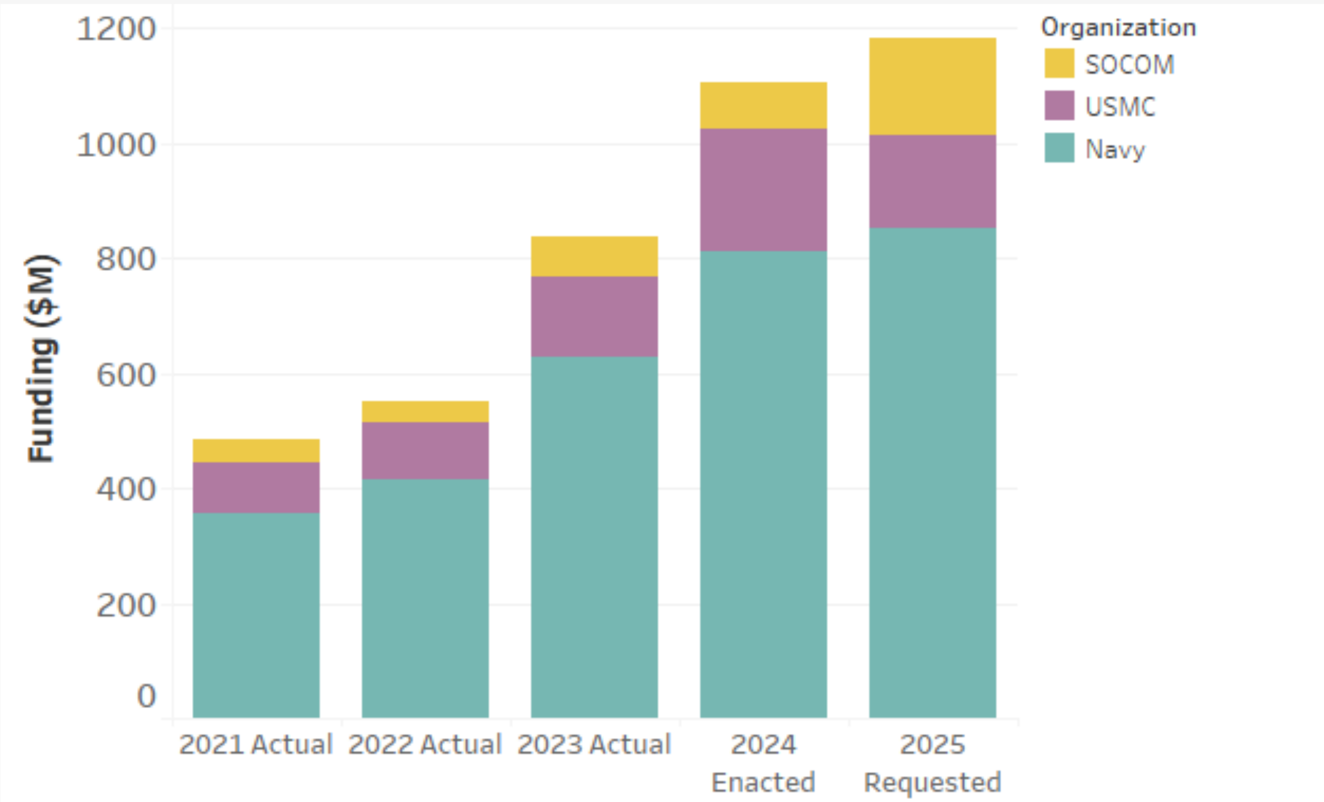
- Autonomy
- Communications / Data Management
- Cyber
- Electronic Warfare
- Mobility
- Manned-Unmanned Teaming (MUM-T)
- Navigation / Control
- Platform
- Propulsion / Energy
- Sensors / Payloads
- Simulation
- Training
- Weapons
- Other Support

In this section, we will investigate some of these categories to assess areas in which RDT&E investments are experiencing growth and which will serve as critical enabling technologies in the future of uncrewed systems.

Significant support for RDT&E of UAS sensors and payloads

With a direct relationship to the missions that a given platform can support, sensors and payloads represent the category where most funding for uncrewed systems is currently dedicated. Focusing on three organizations which are allocating significant investments in the air domain (Figure 16), we see that funding has more than doubled in the last five years. Key initiatives include some of the programs covered earlier like the Navy's RQ-4 Modernization and LEED. Additionally, the U.S. Special Operations Command (SOCOM) has funded the Adaptive Airborne Enterprise (A2E) program which requests $52.5M in FY 2025 to initiate efforts that develop modular payloads for future large UAS. These payloads will enable small UAS and payloads such as loitering munitions to be air launched and employed in contested and denied environments.

Figure 16: Funding for RDT&E of UAS sensors and payloads by Navy, USMC, and SOCOM.

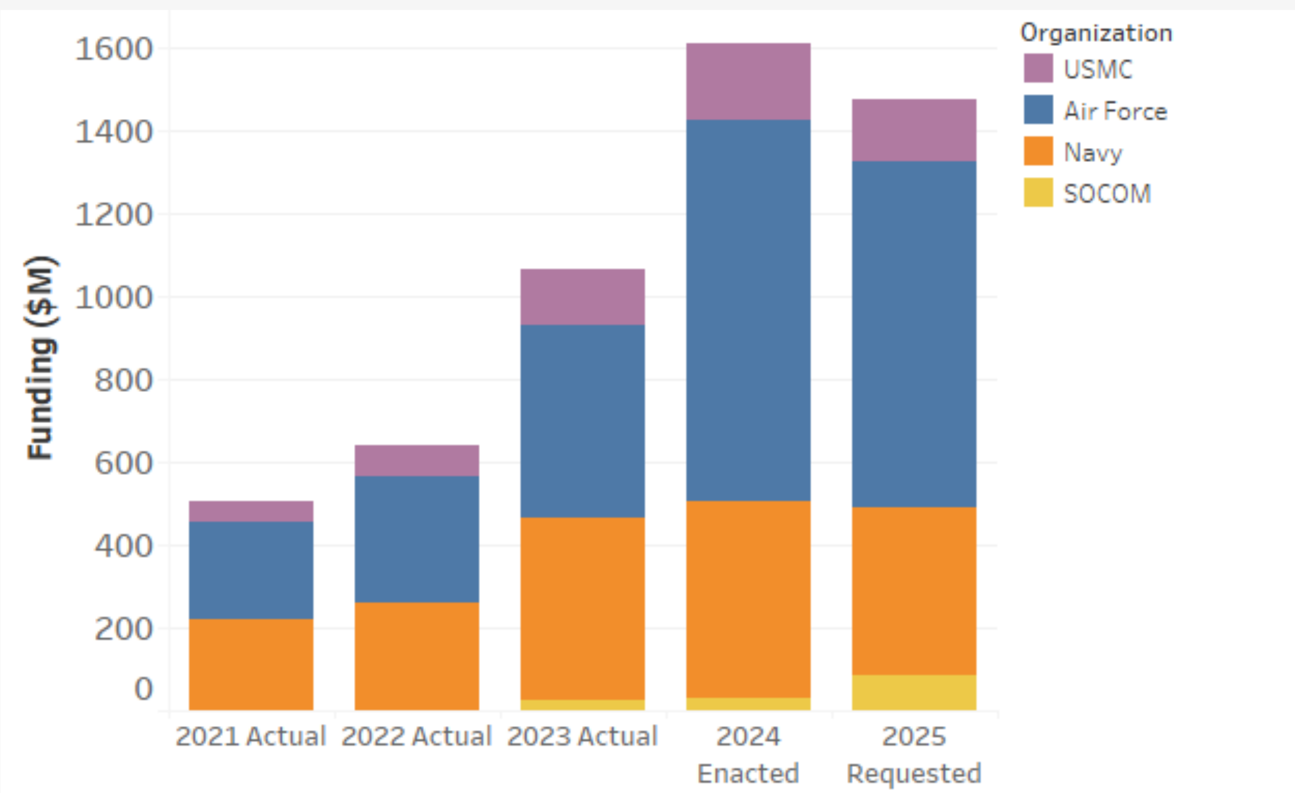


Sources: DOD Budget Request, AUVSI Research

Continued acceleration of autonomous capabilities on UAS

Another technology category that has experienced rapid growth in recent years is integrated autonomy on UAS. Associated technologies and capabilities will provide increased onboard intelligence and allow for operations in more complex and hostile environments. Autonomy will also serve to reduce the operator burden and improve both the efficiency and effectiveness of operations. As noted earlier, the CCA program is investing heavily in mission-integrated autonomy which accounts for much of the Air Force's funding in Figure 17. In the Marine Corps, the Unmanned Expeditionary Systems program is supporting the Tactical Resupply UAS with the goal of reaching Initial Operational Capability (IOC) in October of FY2024. In FY 2025 the Program will continue development of GPS Denied and Sense and Avoid capabilities. Additionally, the program supports the Medium Aerial Resupply Vehicle-Expeditionary Logistics (MARV-EL) which is an autonomous UAS capability that can carry a logistic payload between 300 and 600lbs to a combat radius from 25 to 100 nautical miles (NM). The system will support a logistics distribution mission at the tactical edge for resupplying forward deployed ground forces.

Figure 17: Funding for UAS autonomy by USMC, Air Force, Navy, and SOCOM.

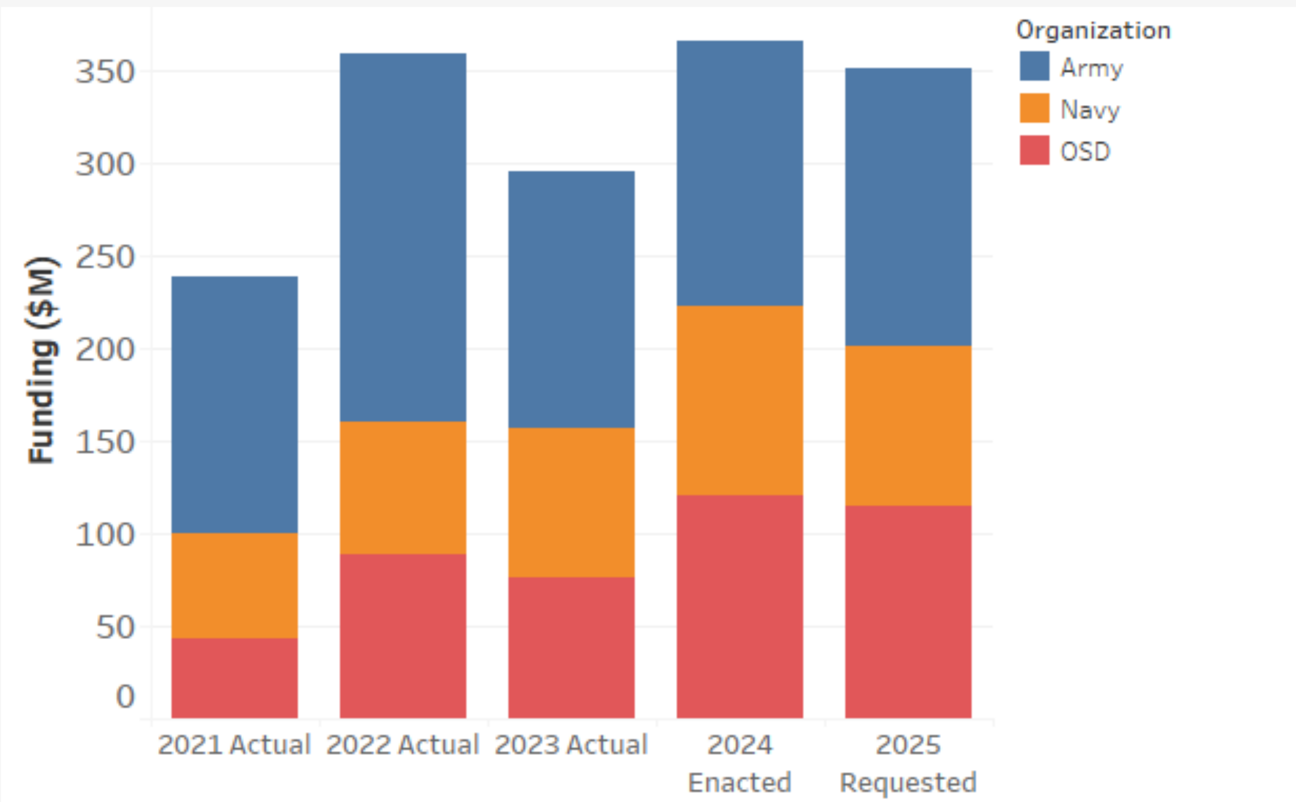


Sources: DOD Budget Request, AUVSI Research

Growing need for teaming solutions between uncrewed vehicles and soldiers

In the ground domain, MUM-T technologies will be of critical importance as uncrewed systems shift from operator-controlled systems to collaborative teammates of soldiers. One of the programs with the strongest support for these capabilities is the Unmanned Maneuver initiative under the Combat Vehicle Robotics Advanced Technology project. This program is working to improve and demonstrate coordinated movements including both robotic platforms and Soldiers for zone-based surveillance. It will also continue to improve performance and demonstrate autonomous maneuver in degraded or hostile environments. Funding for these solutions is primarily originating from the Army, Navy, and the Office of the Secretary of Defense (OSD) with associated funding levels charted in Figure 18.

Figure 18: Funding for Ground MUM-T by Army, Navy, and OSD.

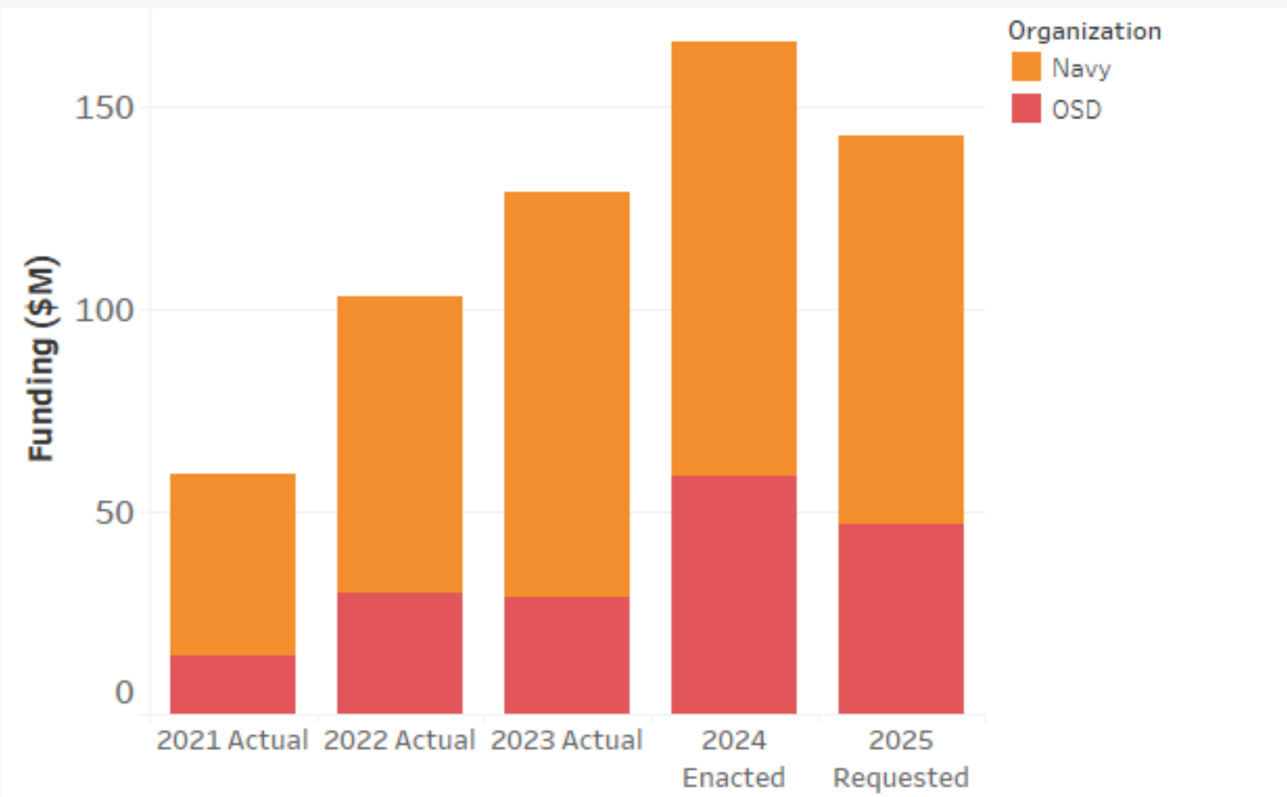


Sources: DOD Budget Request, AUVSI Research

Advanced simulation systems ensure effective employment of subsurface platforms

Simulation solutions are of high importance for the DOD's employment of autonomy and uncrewed systems to ensure these new technologies are properly assessed and validated prior to full-scale integration. Despite a small drop from FY 2024 to FY 2025, funding has steadily increased in support of the development of simulation systems for maritime subsurface uncrewed vehicles in the last five years with primary support from the Navy and OSD (Figure 19). A program that is employing simulation tools for subsurface platforms is the Navy's Full Spectrum Undersea Warfare program with FY 2025 plans involving the initiation of Large uncrewed undersea vehicle (UUV) virtual twin operability validation as well as continued virtual experimentation to evaluate 3rd generation UUV modular resilient design tool concepts within model-based systems engineering framework.

Figure 19: Funding for maritime subsurface simulation by Navy and OSD.



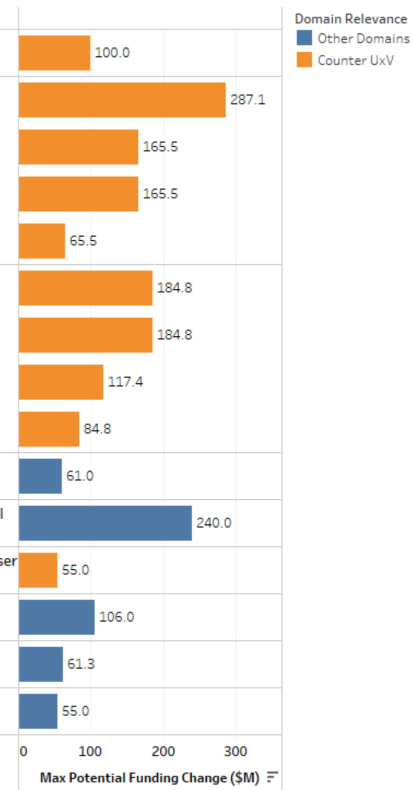
Sources: DOD Budget Request, AUVSI Research

Continued progress being made towards a final FY 2025 budget

As was mentioned in the introduction for this article, the funding values displayed throughout are primarily based on the PB request given that a finalized budget for FY 2025 has not yet been established. However, AUVSI's research team has tracked the budget as it advances through the range of Congressional reviews before being passed into law. Thus far, two versions of the authorization and appropriation bills representing mark-ups from the associated House and Senate have been analyzed which captured more than 240 potential changes to the original budget request. If all changes are accepted in the final bill, it would increase the top line for uncrewed systems by between $1.866 billion on the low end to $2.23 billion on the high end. While it is unlikely that every change will be implemented, this does, however, provide some insight into the importance that Congress is placing on uncrewed technologies. Furthermore, only 44 changes represent a net decrease to the originally requested amounts whereas 186 changes support increases (as well as 11 transfers). The specific items that are supported by these increases also indicate a focus on counter-UAS. Of the 15 items with a potential increase of greater than $50 million, nearly 73% of their total funding is attributed to C-UAS, almost all of which supports the procurement of these systems (Figure 20).

Figure 20: Top funding changes from House and Senate versions of the authorization and appropriation bills.

Type	Organization	Program Name	Item Name	Max Potential Funding Change ($M)
PROCUREMENT	AIR FORCE	AIR FORCE PHYSICAL SECURITY SYSTEM	Counter uncrewed systems for Africa Command	100.0
	ARMY	COUNTER SMALL UNMANNED AERIAL SYSTEM (C-SUAS)	Counter unmanned aerial systems	287.1
			Counter unmanned aerial systems (emergency)	165.5
			Army UPL #2	165.5
			Army cUAS radars—Army UFR	65.5
		COUNTER SMALL UNMANNED AERIAL SYSTEM INTERCEP	Army UPL #1	184.8
			Additional interceptors and launchers	184.8
			Counter unmanned aerial systems interceptors and launchers	117.4
			Army cUAS interceptors—Army UFR	84.8
		FAMILY OF LOW ALTITUDE UNMANNED SYSTEMS	SB600 production increase	61.0
		MQ-1 UAV	MQ-1C Gray Eagle 25M aircraft for the Army National Guard	240.0
RDT&E	DEFENSE-WIDE	COMBATING TERRORISM TECHNOLOGY SUPPORT	C-UAS development including directed energy and laser technology	55.0
	NAVY	SHIP SELF DEFENSE (ENGAGE: SOFT KILL/EW)	Accelerate Long Endurance Electronic Decoy (LEED)—Navy UFR	106.0
		SMALL AND MEDIUM UNMANNED UNDERSEA VEHICLES	Accelerate Subsea and Seabed Warfare (SSW) ROV—Navy UFR	61.3
	USMC	USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)	One MQ-9B SeaGuardian	55.0



Sources: DOD Budget Request, AUVSI Research

AUVSI will continue to track the authorization and appropriation bills as Congress works towards a final budget for FY 2025 and further updates can be referenced in our defense budget visualization tool as that information becomes available.

Want to learn more?

Access to this data is available for those interested in conducting further investigations into the DOD's budget. For more information, please visit AUVSI's website: https://www.auvsi.org/federal-defense-spending-reports or contact AUVSI's Research Analyst, David Klein (dklein@auvsi.org).

Appendix: Budget Release Schedule

The Department of Defense (DOD) releases their budget each year in multiple stages.

1. The first version is known as the President's Budget (PB) which provides information on the requested funding from each department and agency. The PB includes detailed justification documents which discuss specific plans for each program as well as requested funding amounts. AUVSI collects data on all programs involved in the procurement as well as the research, development, test, and evaluation (RDT&E) of initiatives supporting uncrewed vehicle systems and associated technologies. Investigations into these initiatives offer insights into current and future developments of uncrewed vehicles across all domains.

2. The next stage of the budget involves the release of legislation from congressional committees that authorize and appropriate funding relative to the initial PB request. The committees will either confirm or suggest changes to the requested amounts. The legislation will also include provisions which detail committee-directed briefings, reports, and recommendations related to uncrewed systems.

3. The final stage of the budgetary process is the release of the National Defense Authorization Act (NDAA) and the Appropriations bill which are then signed by the President and enacted into law.

Using these pieces of information, this article informs stakeholders involved in the research and development of uncrewed systems of current congressional and DOD priorities, how the threat landscape is evolving in military operations, and where investments are being made to counter these threats.

Terminology was used throughout that reference the hierarchical funding structure of DOD's budget (i.e. program elements, projects, and sub-projects). Further details can be referenced in the section below.

Additionally, full access to this data can be acquired using our integrated visualizations resource which offers details on more than 300 program elements, 600 projects, and 1200 sub-projects that offer support for uncrewed vehicles. To learn more, please click here.

Appendix: Structure and Terminology

DOD RDT&E initiatives are detailed using a hierarchical structure as follows:

- Appropriation (RDT&E, Procurement, Operations & Maintenance, etc.)
    - o Budget Activity (1-8)
        - Program Elements (identified using an alpha-numeric code)
            - Project(s) (identified using an alpha-numeric code)
                - o Sub-Project (listed under each project which detail specific plans for the current and next fiscal year)

An example for a specific program is provided below for the Ground Technology program:

- Appropriation 2040: Research, Development, Test & Evaluation, Army
    - o Budget Activity 2: Applied Research
        - Program Element 0602144A: Ground Technology
            - Project BK7: Robotics for Engineer Operations Technology
                - o Sub-Project: Beyond-Visual-Line-of-Sight Teleoperated Engr Ops
                - o Sub-Project: Semi-Autonomous Engineer Operations
            - Project CA9: Predictive Maintenance
                - o Sub-Project: Predictive Maintenance
            - Project CG6: Ground Vehicle Power and Energy Concepts and Tech
                - o Sub-Project: Advanced Distributed Power for Autonomous Systems
            - Project CG8: Human Autonomy Teaming
                - o Sub-Project: Soldier-AI Team Mission Planning for Dynamic Complex Environments
                - o Sub-Project: Dynamic Soldier-AI Team Resource Allocation
                - o Sub-Project: Soldier Cognition-Centric Interface Technologies
                - o Sub-Project: Enabling Soldier-AI Technology Adaptation
            - Etc.

The DOD provides funding amounts for each of the bullets above at the Program Element and below. AUVSI uses the values at the sub-project level to formulate funding totals for the next Fiscal Year as this offers the most granular funding amounts as well as the specific plans that will be supported by that funding.

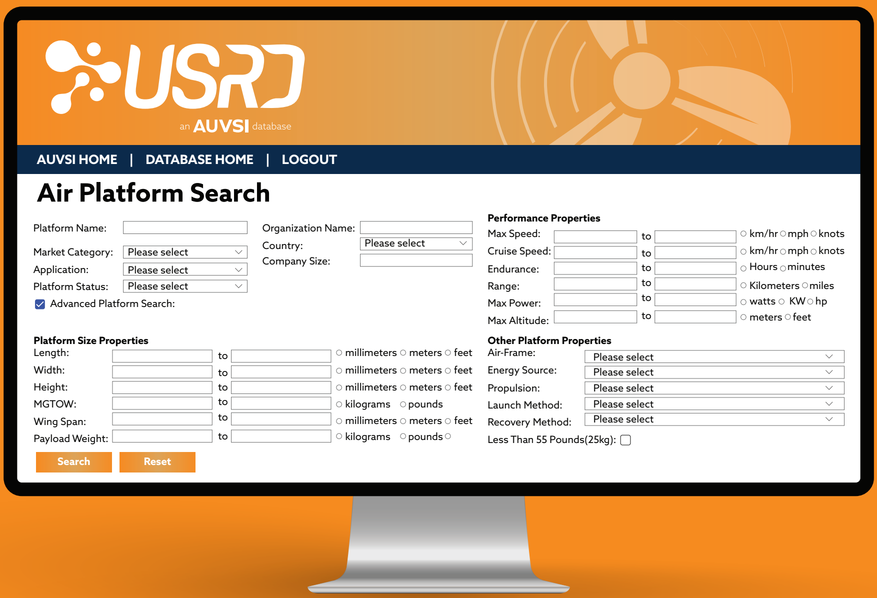
USRD™

an AUVSI database

Air • Land • Sea

UNCREWED SYSTEMS & ROBOTICS DATABASE

- **8,000+** Detailed technical listings
- Daily updates & additions
- Global platform coverage
- Custom search & export



Click or scan for more information

auvsi.org/usrd

OVERVIEW OF COUNTER-UAS TECHNOLOGY, DEFENSE SPENDING AND INDUSTRY ACTIVITY

Authors:
David Ambrozic, Junior Research Analyst
Glenn Dusing, Research Associate
Giosue Da Ponte, Research Associate

Key Takeaways

- 48 US companies identified as C-UAS manufacturers.
- Analysis of FY 2025 DOD budget shows over $1.6 billion requested for C-UxS technologies.
- Government contract spending on C-UxS technologies showing 90% CAGR from FY 2020 to FY 2023
- Mentions of C-UxS technology in the System for Award Management (SAM) have grown by 10% annually since 2018.

Introduction

As the use of uncrewed systems (UxS) expands across both military and civilian sectors, the necessity for counter-uncrewed systems (C-UxS) detection and mitigation has become increasingly critical. Over the past decade, significant strides have been made in counter-UAS technologies to address the proliferation and sophistication of UxS. The defense sector has witnessed rapid technological advancements, with the United States (U.S.) Department of Defense (DOD) actively testing and deploying directed energy weapons, such as lasers and microwaves, to counter UxS threats on the battlefield. Meanwhile, in the civilian sphere, the need for effective counter uncrewed aircraft systems (C-UAS) solutions has grown in areas such as critical infrastructure protection, event security, and law enforcement. To effectively address these challenges, organizations have developed a diverse range of C-UAS technologies globally. This article explores the key factors associated with the employment of these systems, the range of C-UAS technologies that are being developed and manufactured, the U.S. government's increasing investment in these systems, emerging global trends in this technology sector, and industry activities shaping the future of counter-UxS solutions.

Categorization of C-UAS

Overarching categories used in defining a particular C-UAS capability relate to both the application for which the system is being used as well as the specific technologies that are integrated. The primary applications for C-UAS are as follows:

Intelligence monitoring: Includes the use of pre-existing networks and analysts to report on current activity in the space of UAS threats. These can range from accessing existing signals like satellites and RF as a way of detecting a UAS presence in a given area, to scraping existing web data to keep up to date on advancements in UAS technologies.

Kinetic disable: Any kind of system that uses physical means to disable a UAS. These systems include ballistic weapons, nets, high power microwave (HPM) weapons, or any other physical system that damages or incapacitates a UAS.

Detection: Any sensor system that is actively searching for UAS within its range. These systems make use of RF, satellite, radar, sonar, acoustic, GNSS, or other technologies to determine when a UAS has entered a particular airspace.

Non-kinetic disable: Hacking or forcing a landing in a designated zone. It is important that these do not necessarily include other software and communications-based type I categories like jamming and disruption.

Validation and verification: These systems validate any UAS detected against its own library of UAS to classify and distinguish between UAS technologies and other non-UAS related objects like people and vehicles. These platforms are distinguished from detection platforms since they attempt to classify multiple objects instead of detecting only UAS.

Incident investigation: The capacity of a platform or service to identify digital forensics after a UAS incident occurs. This process is in hopes of identifying the drone's operator and is based around signal processing.

Location: These systems provide UAS coordinates, typically as part of detection. Some go further by predicting the UAS's trajectory based on data from detection platforms, distinguishing them from basic detection systems.

Disruption: These systems perform spoofing which is the process of creating decoy signals to confuse or override the operator's signals and may also include direct disruption to RF or GNSS signals. The decoy signals may force a landing or force a return to origin.

Jamming: Jamming platforms intercept any UAS signals to and from a given location or attempt to break the connection from sender to receiver. These platforms are closely related to disruption but may operate in different frequency bands from the disruption thus causing need for distinction.

The technologies integrated on C-UAS for detection and mitigation include:

Time Difference of Arrival (TDOA): TDOA technology estimates the location of a signal source by measuring the difference in time it takes for the signal to reach multiple sensors. It is commonly used in RF-based detection systems for geolocation. While primarily used with RF signals, TDOA is highly effective in accurately locating signal sources.

Radar (Radio Detection and Ranging): Radar transmits radio waves and analyzes the reflected signals to detect objects, determine their distance, and track their movement. It is a reliable technology for detection and location, especially effective in all weather conditions.

Laser: Laser technology emits focused light beams used for detection, precise location tracking, and non-kinetic disablement of targets. Lasers are also employed in validation and verification processes, with potential applications as directed-energy weapons.

Electro-Optic (EO): EO sensors capture and analyze visual and infrared imagery, enabling detection, location tracking, and both non-kinetic and kinetic disablement of UAS. These sensors are highly effective in various lighting conditions and are often used in conjunction with other systems like IR sensors for enhanced targeting.

Radio Frequency (RF): RF technology uses radio waves to detect, disrupt, and disable communication signals between a UAS and its operator. It plays a crucial role in jamming, intelligence monitoring, and geolocation, typically targeting the command-and-control links or GNSS signals used by UAS.

Acoustic: Acoustic sensors detect the sound waves produced by UAS engines or propellers. These sensors are useful in detection and location, particularly in environments where visual detection is obstructed or during low-visibility conditions. However, acoustic detection is often combined with other methods due to its limitations in noisy environments.

Infrared (IR): IR sensors detect heat signatures emitted by UAS engines or electronic components, making them useful for detection, location, and both kinetic and non-kinetic disablement. They are particularly effective in low-visibility conditions and are valuable in both day and night operations.

Drone Protocol Decoding: This technology intercepts and decodes the communication protocols used by drones, allowing for detection, disruption, incident investigation, and precise location tracking. It is a specialized form of RF signal analysis.

High-Power Microwaves (HPM): HPM systems emit powerful bursts of microwave energy designed to disable or damage the electronics of UAS, making them a form of kinetic-disable technology.

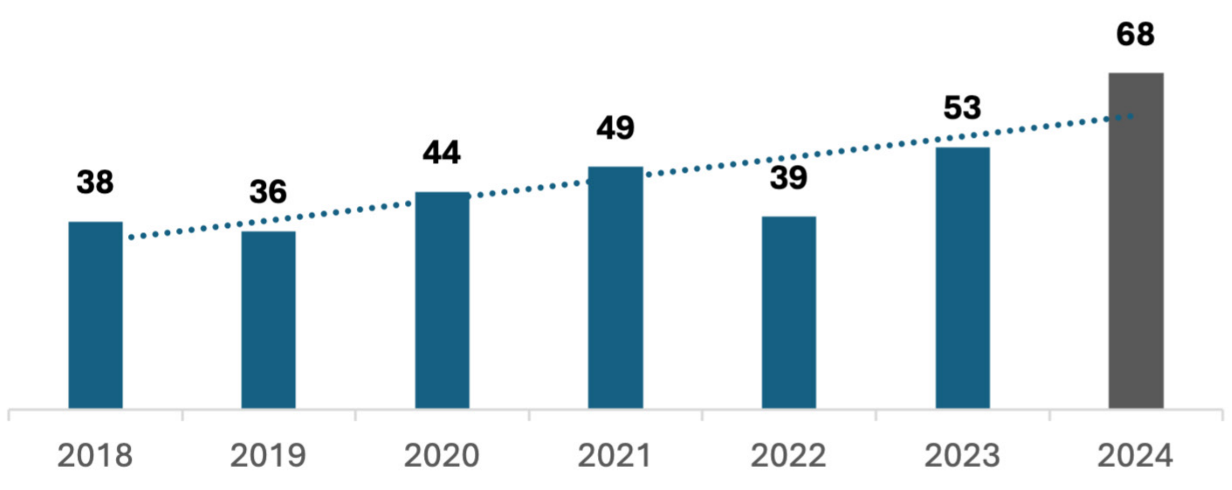
GNSS Signal: GNSS (Global Navigation Satellite System) signals provide precise positioning information. Disrupting these signals, particularly GPS, is used in jamming, detection, and location tracking of UAS, targeting the satellite navigation to interfere with the UAS's positioning.

Another key factor related to the employment of C-UAS is implementation. C-UAS implementation takes many forms from handheld devices to mounting on existing structures like walls and towers. These systems can also be deployed on mobile platforms for applications like convoy protection or can even take the form of uncrewed aircraft themselves which intercept or ensnare adversarial aircraft. It is important to note that some platforms are interchangeable across deployment capacity, such as a detector that can be mounted on a building but can also be carried by one individual. Due to the rapid advancements in uncrewed platforms, recent developments in C-UAS technology have prompted manufacturers to provide comprehensive solutions that integrate multiple detection and mitigation methods into a single central command system. This might include RF, GNSS radars, visual sensors, and kinetic mitigation capabilities deployed as a combined system. Such solutions are increasingly needed as some drones have become resilient to individual methods of mitigation.

U.S. government activity surrounding C-UxS technologies

An analysis of recent contract awards and solicitations by the U.S. government highlights the demand for C-UxS solutions both in the defense and civil sectors. The chart below shows the yearly frequency of mentions of C-UxS technologies in government solicitations from the System of Award Management's public notice (SAM.gov)[1]. Such mentions have been growing at an average of 10% since 2016. In this past year, the growth has been higher and activity on solicitations in 2024 is projected to grow a further 28%.

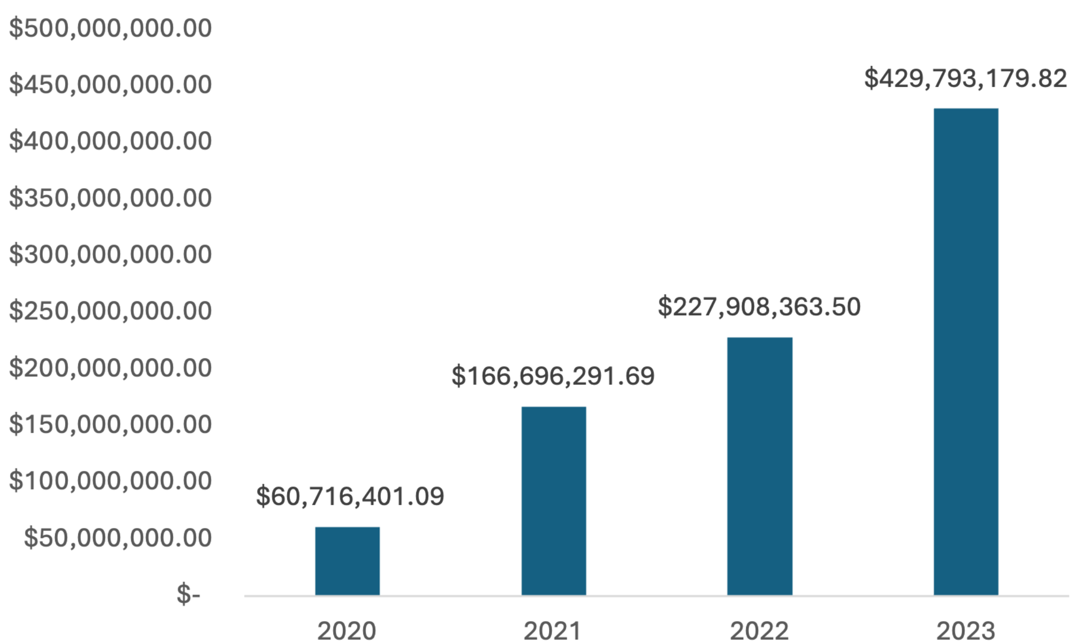
Figure 1: Mentions of C-UxS on SAM.gov



**2024 is projected, Source: SAM.gov, AUVSI Research*

Analysis of government contract spending on C-UxS technologies provided by Usaspending.org, the official open data source of federal spending information, also reveals rapid growth in contract awards in such technologies since Fiscal Year (FY) 2020. Investments in C-UxS have grown rapidly from 60.7 million in FY 2020 to 429.8 million in FY 2023. In that time frame, contract award spending has nearly doubled annually, with a CAGR of 92%.

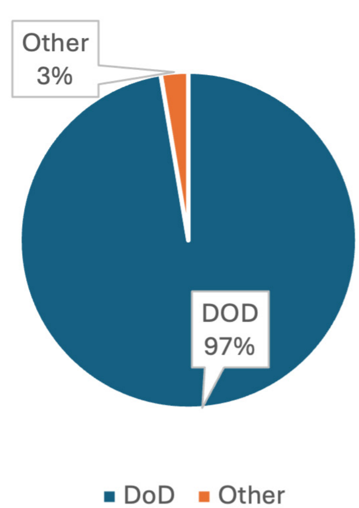
Figure 2: Contract award allocation for C-UxS spending from Usaspending.org



Source: USAspending.com, AUVSI Research

The majority of spending increases stem from the DOD, driven by heightened demand for C-UxS solutions in response to global conflicts that have featured increased usage of uncrewed systems. As the below chart highlights, since FY 2020, 97% of government C-UxS spending has come from the DOD.

Figure 3: Contract awards by $ value



Source: USAspending.com, AUVSI Research

A look at the top DOD awarding agencies on a sub-agency level in this category shows that since FY 2020 the Defense Microelectronics Activity (DMEA) has been the highest awarding agency within the DOD followed by the Air Force, Army, and Navy. However, DMEA is the agency that awards the contract, and the funding is sourced from a different department within the DOD.

Figure 4: Top DOD awarding sub-agencies* in C-UAS technology since FY2020

Defense Microelectronics Activity (DMEA)	$301,017,214
Department of the Air Force (USAF)	$249,358,852
Department of the Army (USA)	$245,681,636
Department of the Navy (USN)	$94,295,486
U.S. Special Operations Command (USSOCOM)	$21,709,838
Office of Procurement Operations (OPO)	$11,669,219
Defense Logistics Agency (DLA)	$10,303,913

Sources: USAspending.com, AUVSI Research

Four non-DOD agencies currently have statutory authority to use C-UAS systems

Of the non-DOD agencies, Department of Homeland Security ($12.7 million), Department of Justice ($5.5 million), and Department of State ($1.63 million) are the highest spenders, which reflects the fact that only four agencies (DHS, DOJ, DOD, and Department of Energy) currently have express statutory authority to conduct specified drone detection and counter-drone operations, including the use of detection, mitigation, monitoring, and tracking, and the use of reasonable force to damage or destroy a threatening drone[2]. As legislation in this area develops and allows more agencies to invest in this technology, we can expect significant growth in government investments, especially for detection technologies that have a primary purpose of awareness and mitigation at sites such as critical infrastructure, airports, prisons, and other areas that have an increased risk of UAS disrupting operations.

More signs of increasing demand for C-UAS technology

Increased demand for the latest highly advanced mitigation technology is evident in recent contract awards and requests for information (RFI) by the U.S. Government. Highlighted by recent contract awards to BlueHalo which was awarded $95.4M by the Army Space and Missile Defense Command (SMDC) to Advanced Directed Energy Technology[3], and Kratos which won a contract worth $50M to support C-UAS. Furthermore, a white paper request published by the U.S. Army Acquisition Support Center on July 10th shows a specific interest in directed energy laser weapons.

Interest is also high in the civil sector, as highlighted by a recent request for information (RFI) from the Department of Homeland Security, one of the few agencies currently allowed to operate C-UAS technologies in the United States. This RFI seeks information on UAS kinetic mitigation capabilities[4]. These RFIs signal that, although current legislation limits the extent of domestic C-UAS operations, agencies are preparing for changes in authorization that will allow broader use of such technology. This trend is underscored by a report published by the Government Accountability Office (GAO) in March of this year on C-UAS technologies, which showed that as of April 2023, 20 airports had submitted notices to the FAA for construction or alterations related to drone detection technologies[5]. Confirming the FAA's and TSA's ongoing research into the technology.

Worldwide Progress in Civil Counter-UAS Solutions

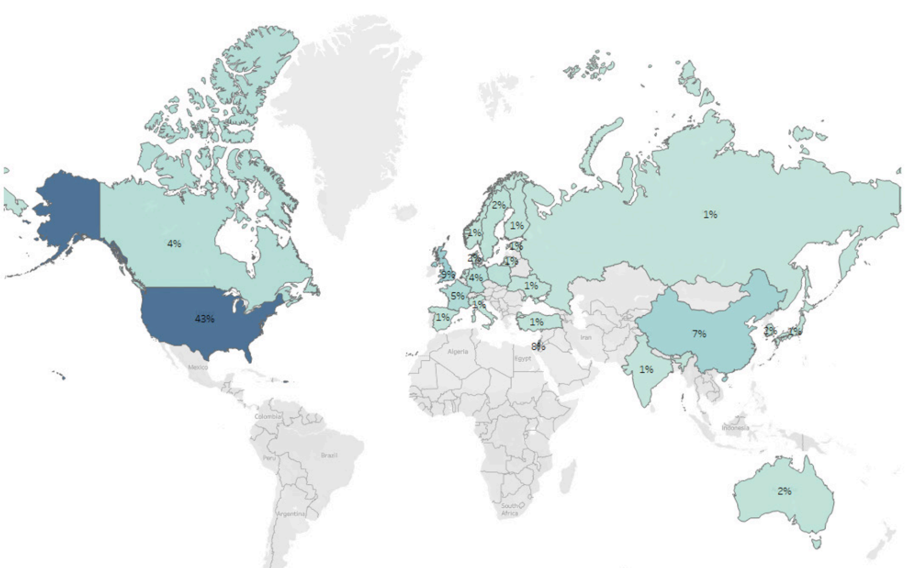
The relatively low investment in C-UAS technologies within the civil sector, compared to the defense sector, is primarily due to restrictive legislation. Current projections suggest that investments will significantly increase once legislation is clarified and provides more authorization for civil use. This expected increase in investment is supported by examples from other nations with more permissive C-UAS laws.

For instance, London Heathrow Airport in the United Kingdom has installed multiple permanent C-UAS solutions since 2020[6], and airports globally are following suit. Internationally, C-UAS technology has become standard at major sporting events and large gatherings. The EURO 2024 International Soccer Tournament in Germany featured handheld drone jammers[7], and similar technologies were deployed at the Paris 2024 Olympics[8].

Assessing Counter-UAS Industry Activity

The rise in usage and demand for Counter-UxS technologies is also reflected in a diverse range of manufacturers and service providers of Counter-UxS technologies. AUVSI has initiated research on this sector, and while research is still ongoing, preliminary analysis includes 112 organizations from 21 countries that offer C-UxS solutions. We have found 43% of these companies are based in the United States followed by 9% in the United Kingdom and 8% in Israel. On a continent basis 47% of C-UAS companies are in North America, followed by 30% in Europe, 21% in Asia, and 2% in Australia.

Figure 5: Map of Counter-UxS Manufacturers

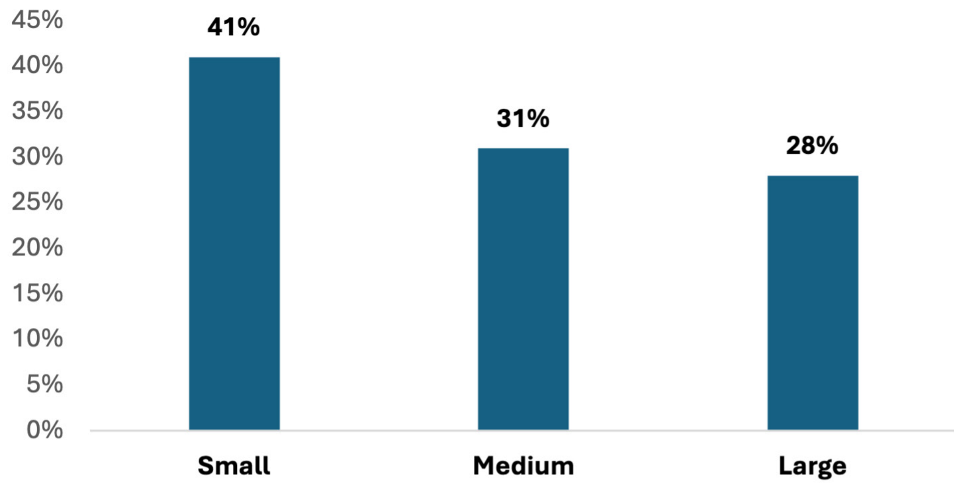


Source: AUVSI Research

Small-size organizations most common C-UAS makers

Analysis of C-UAS companies by size shows that 41% are small companies (less than 50 employees) followed by 31% medium (50 to 500 employees) and 28% large (over 500 employees). This aligns with the industry's infancy where smaller organizations are entering the market and are expected to scale as the industry matures.

Figure 6: C-UAS organizations by size



Source: AUVSI Research

Of the organizations we analyzed, 63% are primarily in the Defense Industry. However, an interesting trend emerges when we compare the distribution of defense companies relative to company size. As we can see with Large Organizations, 86% are defense focused. Whereas with organizations in the small category, the split is even at 50%. This highlights the trend that smaller companies are emerging with technologies focused on the civil and commercial sectors. In contrast, solutions used for defense applications have reached greater levels of maturity and implementation and are generally supplied by larger companies.

Figure 7: Counter-UAS organization by size and industry

	Defense	**Other**
Small	50%	50%
Medium	67%	33%
Large	86%	14%

Source: AUVSI Research

Positive signs for the industry

Among the companies analyzed, 19% are publicly traded. Additionally, there is noticeable innovation among smaller firms, which has garnered attention from venture capitalists and larger defense corporations. This trend is underscored by significant recent acquisitions of C-UAS technology companies.

- Booz Allen Hamilton acquired PAR Government Systems Corporation in June of 2024.
- Axon acquired Dedrone in May 2024.
- DZYNE acquired High Point Technologies in June 2024, which had previously acquired Flex Force and Liteye Systems in 2023 and 2024, respectively.
- Anduril acquired Blue Force Technologies in September 2023.
- BlueHalo acquired Verus Technology Group in April 2023.

The recent acquisitions indicate a high degree of confidence in the sector's continued growth. They also show that drone manufacturers are keen to integrate C-UAS systems into their portfolios. This is crucial as it enables companies to mutually enhance both their drones' ability to evade C-UAS technologies and the C-UAS technologies themselves as drone performance and capabilities advance.

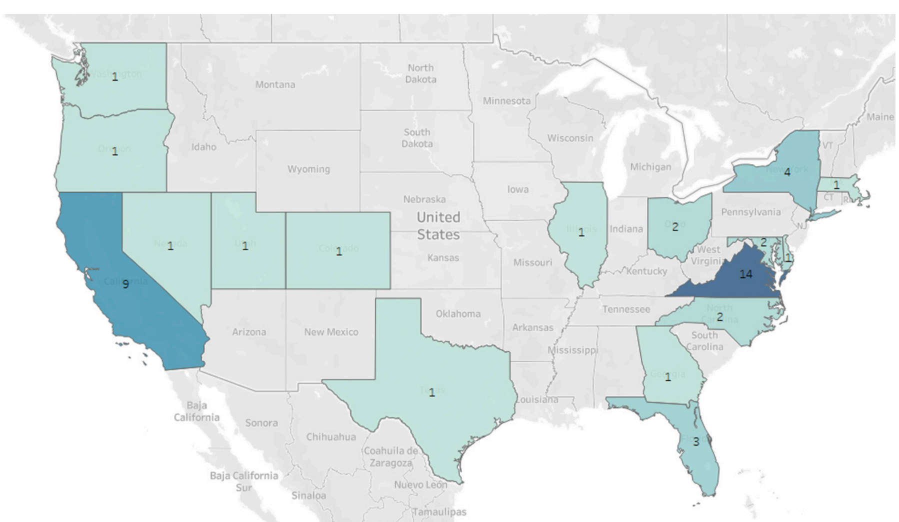
These acquisitions can also be seen as early strategic investments in a market that is less saturated compared to the traditional uncrewed vehicle market, potentially providing a more sensible entry point into the industry. The acquisition of Dedrone by Axon exemplifies this trend. Axon, primarily known for manufacturing tasers and body cameras, has now ventured into the uncrewed market. As the use of C-UxS technologies increases in the United States, we can expect a rise in non-defense focused companies offering comprehensive C-UxS solutions for civil applications, like what is observed in France and the U.K.

Regional trends

North America:

Despite limited domestic commercial and civil application, we have found 48 Companies based in the United States that provide counter-UxS products, which is a positive signal for the industry overall. Significant investments in C-UAS technologies within the defense sector are reflected by the fact that most organizations are based in Virginia and California, home to some of the largest defense manufacturers. However, the dataset represents a diverse range of organizations from 19 different states.

Figure 8: Map of U.S. Counter-UAS manufacturers

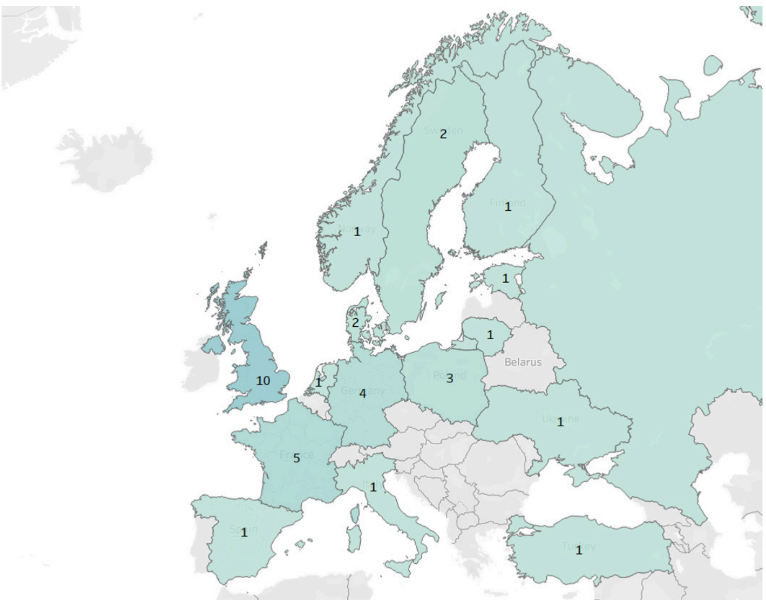


Source: AUVSI Research

C-UAS trends in Europe

A closer look at Europe reveals a recent trend of manufacturers emerging across the continent. In Western, Northern, and Eastern Europe, smaller companies have surfaced as producers of Counter-UxS technologies. This development is often a response to the growing need for such technology, driven by the unprecedented usage of sUAS in battlefields, particularly in the ongoing conflict in Ukraine. As we can see, the Baltic and Nordic regions have companies that manufacture C-UAS technologies. Countries such as Estonia, Lithuania, and Finland, that do not have a tradition of defense manufacturing have developed systems to bolster their defense capabilities and supply allies with C-UAS solutions. Such trends showcase the responsive nature of C-UAS technologies. Central and Western Europe also have large defense manufacturers and newer commercial entities providing C-UAS solutions with France, U.K., and Germany having the largest shares.

Figure 9: C-UAS manufacturers in Europe



Source: AUVSI Research

Asia:

In Asia, Israel leads in C-UAS technology, with a focus on counter-drone dome solutions. D-Fend Solutions' EnforceAir system exemplifies this by using RF technology to detect, identify, and safely land unauthorized drones. The system creates a protective "dome" around a given area, adaptable for stationary or mobile deployment, and is used to secure military bases, critical infrastructure, and public events.

Companies based in China, while dominant in the global commercial UAS market, have a limited presence in the European and North American C-UAS markets. This can be attributed to several factors.

Cost Asymmetry

Counter-UAS (C-UAS) solutions are significantly more expensive than small uncrewed aerial systems (sUAS). C-UAS systems often include a range of sophisticated hardware and software components. For instance, comprehensive C-UAS providers offer a combination of jamming (non-kinetic) and kinetic solutions, along with centralized command and control software that integrates various radars and sensors. This level of integration and complexity often requires specialized regional vendors with expertise in specific C-UAS applications.

Market Position of North American and European Companies

U.S. and European companies hold a strong position in the C-UAS sector, largely due to the predominant use of these technologies in defense applications. This mirrors the early adoption phase of UAS, where defense needs drove technological development. Additionally, regulatory and political factors, such as preferences for domestic or allied suppliers for critical technologies due to security concerns and trade policies, also play a crucial role. This preference reinforces the dominance of established regional providers in both defense and civil sectors.

Focus on Innovation

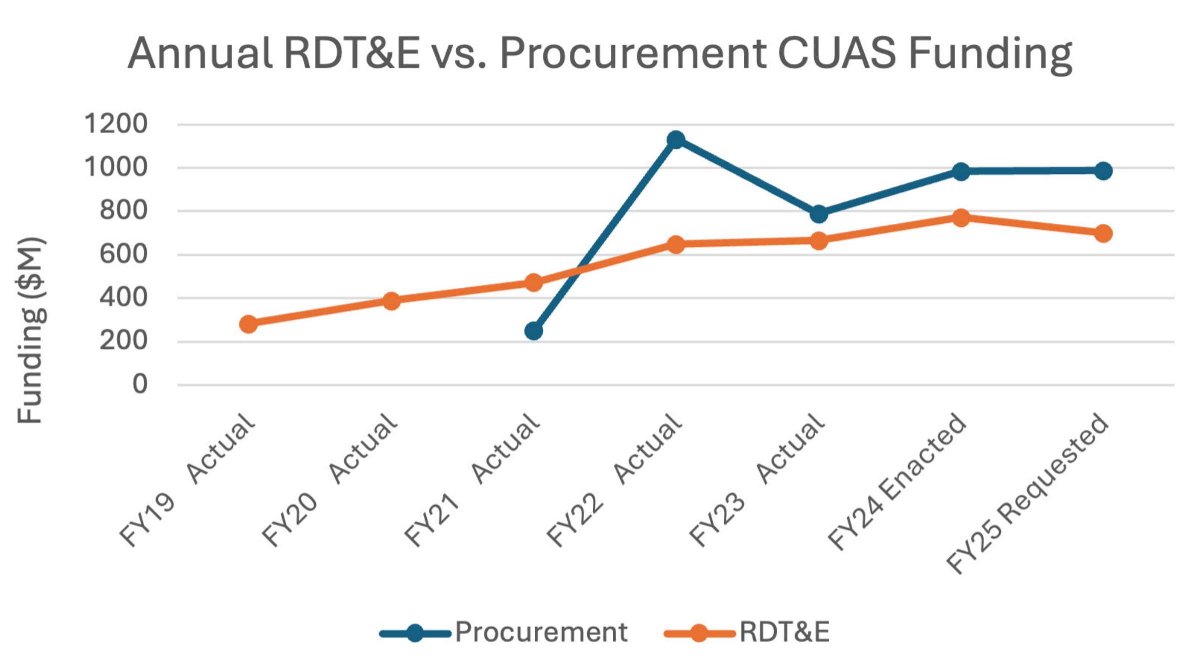
Unlike consumer-grade technologies such as sUAS, price is not as decisive a factor in the procurement of C-UAS systems. This aspect benefits U.S. and European manufacturers, allowing them to focus on innovation and the development of sophisticated technologies tailored to C-UAS applications. Moreover, a significant portion of C-UAS technology is being developed by legacy defense and uncrewed systems companies, providing them with a technological advantage that fosters further innovation in the C-UAS sector.

Counter-UxS Defense Budget Analysis

Introduction

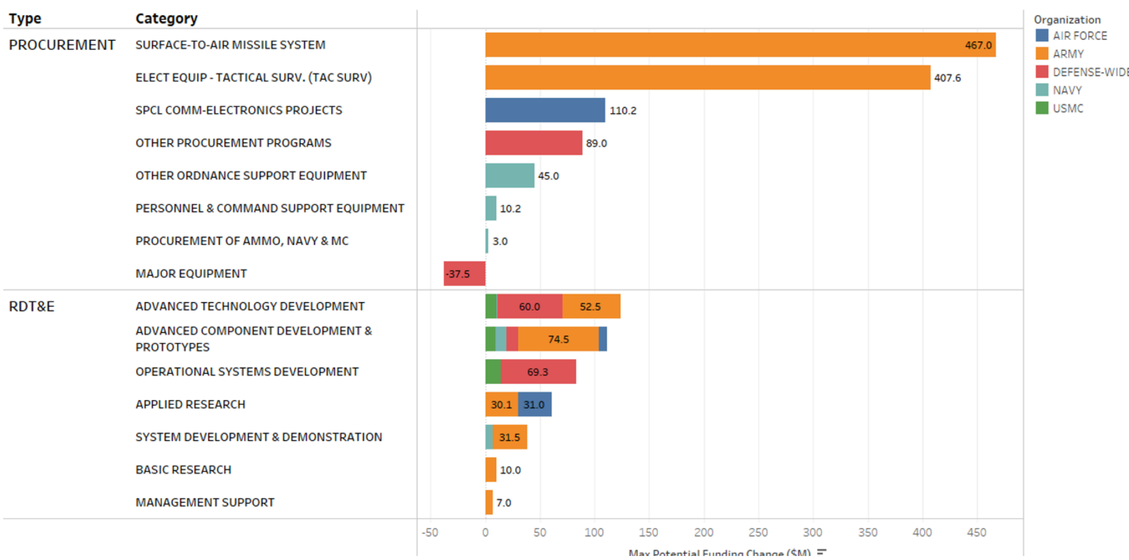
Investments in Counter-UxS technologies are being made across most organizations under the DOD, for both procurement and RDT&E. By developing new solutions and upgrading old ones to support Counter-UxS capabilities, the various sectors of the U.S. military are responding to the increased threat from UAS. The following section will highlight the investments into some of these efforts while pointing out the technology they employ. Most investments are in Counter-UAS specifically, but Counter-UxS solutions in other domains are also being developed and will be mentioned as well.

Figure 10: Annual RDT&E funding vs. Procurement funding



As the DOD is seeing increased UAS activity with conflicts in Ukraine and the Gaza Strip, Congressional authorizations and appropriations are supporting significant increases to C-UAS initiatives both from from a procurement and RDT&E perspective. Figure 11 shows the potential funding changes for associated technologies. If all recommended changes are implemented, budgetary support for C-UAS would see an increase of over $1.5 billion.

Figure 11: Potential Funding changes for C-UAS technologies



Sources: Congressional Legislation, AUVSI Research

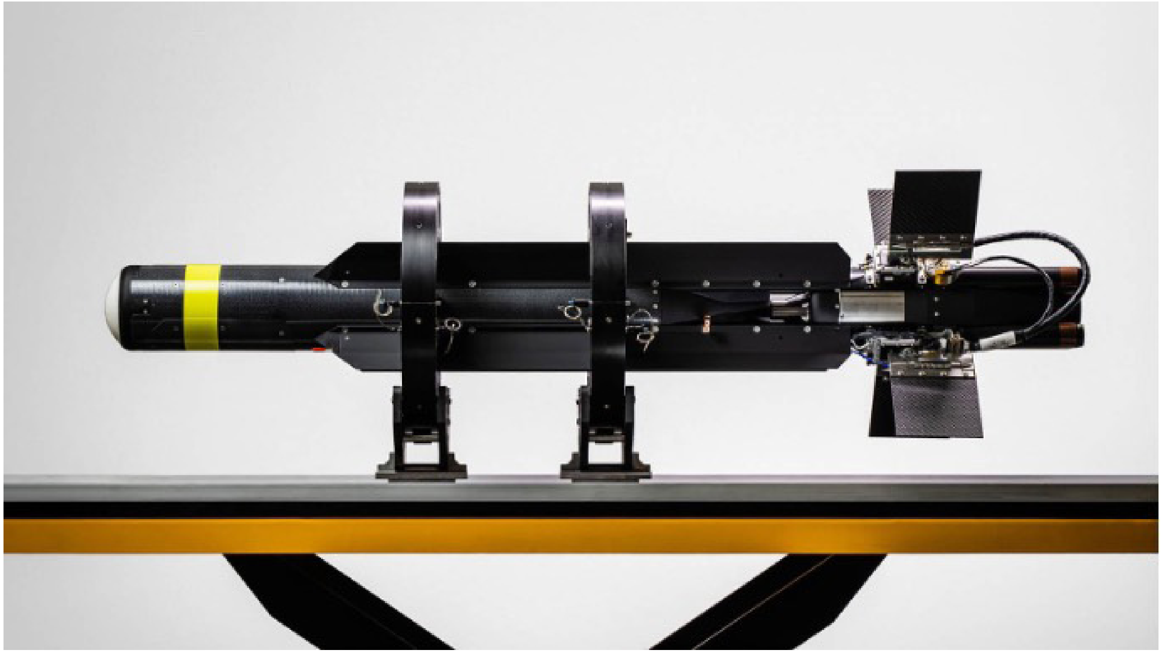
Procurement

In the U.S. DOD's budget request for FY 2025 (also referred to as the President's Budget (PB25)), funds for the procurement of C-UAS related technologies ($988.647 million in total) are primarily in support of the Army, which requested an estimated $531 million. The funded programs focus significantly on countering Group 1-3 UAS threats representing all uncrewed aircraft weighing less than 1,320 pounds, operating at less than 18,000 feet, and at speeds below 250 knots.

United States Army Programs

A combined $117.424 million in FY 2025 requested funding supports the Army's C-sUAS Intercept program to procure 690 kinetic and 12 non-kinetic variants of the Coyote interceptor, as well as cover the other expenses related to equipping, training, and fielding. The Coyote is a ground-launched, radar-guided interceptor manufactured by Raytheon[9] that is designed to defeat Group 1-3 UAS threats. The Coyote system, comprised of interceptor and launcher, can be configured for both fixed and mobile platforms, adding valuable versatility in C-UAS operations. The Coyote is a key component of the U.S. Army's LIDS (Low, slow, small, unmanned aircraft Integrated Defeat System) which is actively being deployed as a C-UAS solution[10]. Additionally, a related program titled Counter Small Unmanned Aircraft Systems (C-SUAS) has requested the largest investment in C-UAS equipment with a total of $280.086 million in FY 2025. This funding line supports "the procurement, training, and equipping of fixed, semi-fixed, mounted, dismounted, and handheld C-UAS capabilities for U.S. forces and strategically important DOD facilities worldwide." The majority of the funds would be allocated to procuring the other components of the LIDS system, including six KuRFS (Ku-band Radio Frequency Sensor) for $65.395 million. The KuRFS is a radar that, in this case, when paired with the Coyote kinetic interceptor, uses active electronically scanned array (AESA) technology to precisely steer the interceptor towards a threat[11]. Together, they form a key component of the LIDS system, to detect and defeat UAS threats.

Figure 12: Coyote interceptor by Raytheon

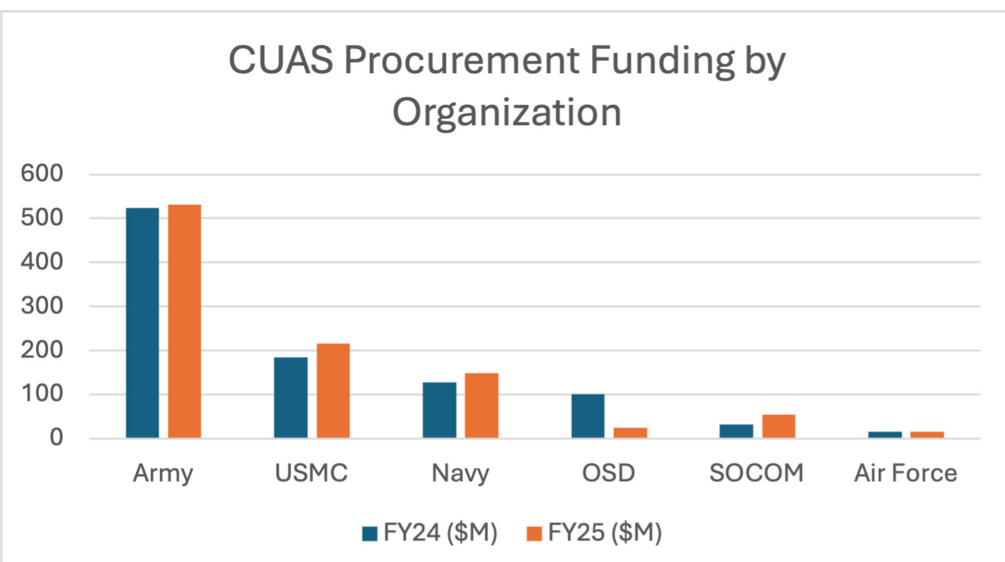


Sources: https://www.rtx.com

United States Marine Corps Programs

The distribution of procurement funding in the FY 2024 appropriations bill and the FY 2025 requested budget are provided in Figure 13. This shows that the Army exceeds the combined funding from the other departments in FY 2025.

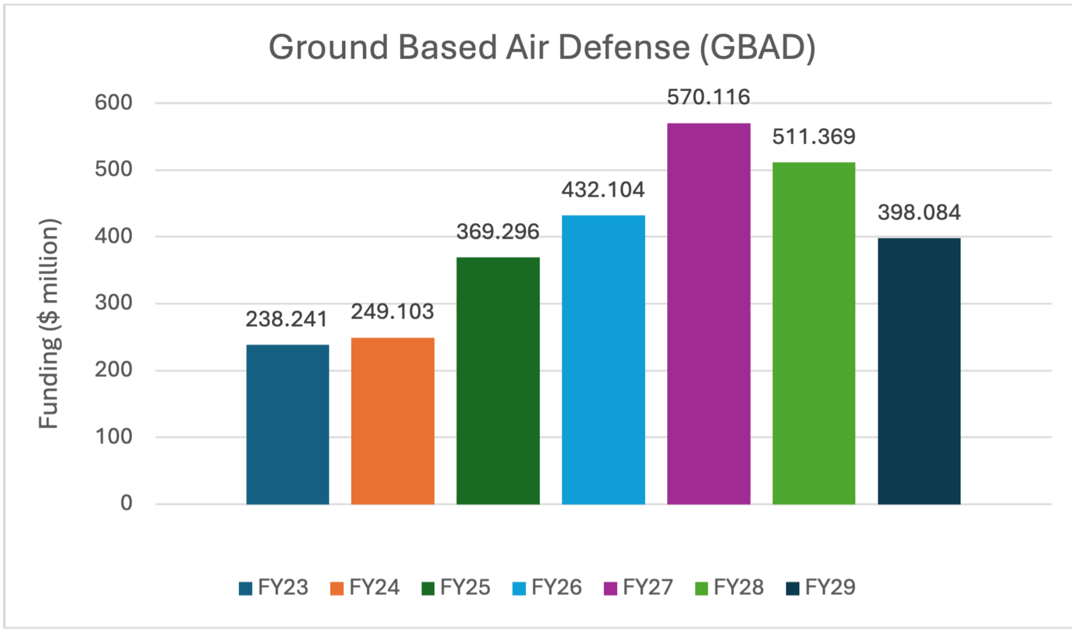
Figure 13: Total C-UAS Procurement funding by organization for FY 2024 and FY 2025



Sources: Congressional Legislation, AUVSI Research

The C-UAS efforts of the United States Marine Corps. are also well supported in the PB25. Notably, the Ground Based Air Defense (GBAD) program requests $369 million in FY 2025, of which an estimated $185 million is devoted to C-UAS, a nearly 200% increase from FY 2024.

Figure 14: Funding for the Ground Based Air Defense USMC program by year



Sources: Congressional Legislation, AUVSI Research

This increased funding is significant because it supports the procurement of several key C-UAS technologies that make up the USMC's solution against increasing uncrewed aerial threats. This includes the MADIS (Marine Air Defense Integrated System) and L-MADIS (Light MADIS), which are allotted $171.454 million and $33.242 million of the total funds in FY 2025, respectively. This supports the procurement of 13 MADIS Increment 1 systems, five L-MADIS systems, and covers other expenses such as integration labor and technical support, integrated logistics support, training, and training systems. MADIS is a compact ground-to-air defense system used by Low Altitude Air Defense Battalions to counter threats from UAS, as well as traditional fixed/rotary wing aircraft. The system consists of two paired Joint Light Tactical Vehicles working together. One vehicle is equipped with detection equipment, while the other carries weapons for engagement. MADIS incorporates various components, such as radar for tracking, missiles for intercepting aerial targets, and equipment for coordinating these operations. The system was successfully tested in December 2023 and continued live-fire testing for new equipment training, system verification testing, and initial operational test and evaluation for the rest of FY 2024, prior to the start of fielding[12].

A $53.177 million dollar portion of the Ground Based Air Defense (GBAD) program also supports the procurement of hardware and covers other necessary costs for the I-CsUAS (Installations-Counter Small Unmanned Air Systems) effort. Currently operating under an Urgent Statement of Need (USON) but eventually transitioning into its own Program of Record, the I-CsUAS system protects USMC critical assets and installations from sUAS threats. Like the LIDS system and the MADIS FoS, the I-CsUAS addresses the critical demand for both kinetic and non-kinetic solutions against UAS, especially commercial-off-the-shelf drones. In February, the USMC published a solicitation for the development of I-CsUAS technology solutions which stated that "an installation security capability gap exists regarding the detection, tracking, identification, and defeat of sUAS operating under the vicinity of covered facilities and assets." The USMC solicitation underlines the unique challenges that the sUAS threat poses to military installations specifically. When combined with the challenges the DOD is confronting, which are reflected in its investments in C-UAS, it is clear that sUAS present threats of various types to many sectors of U.S. national defense[13].

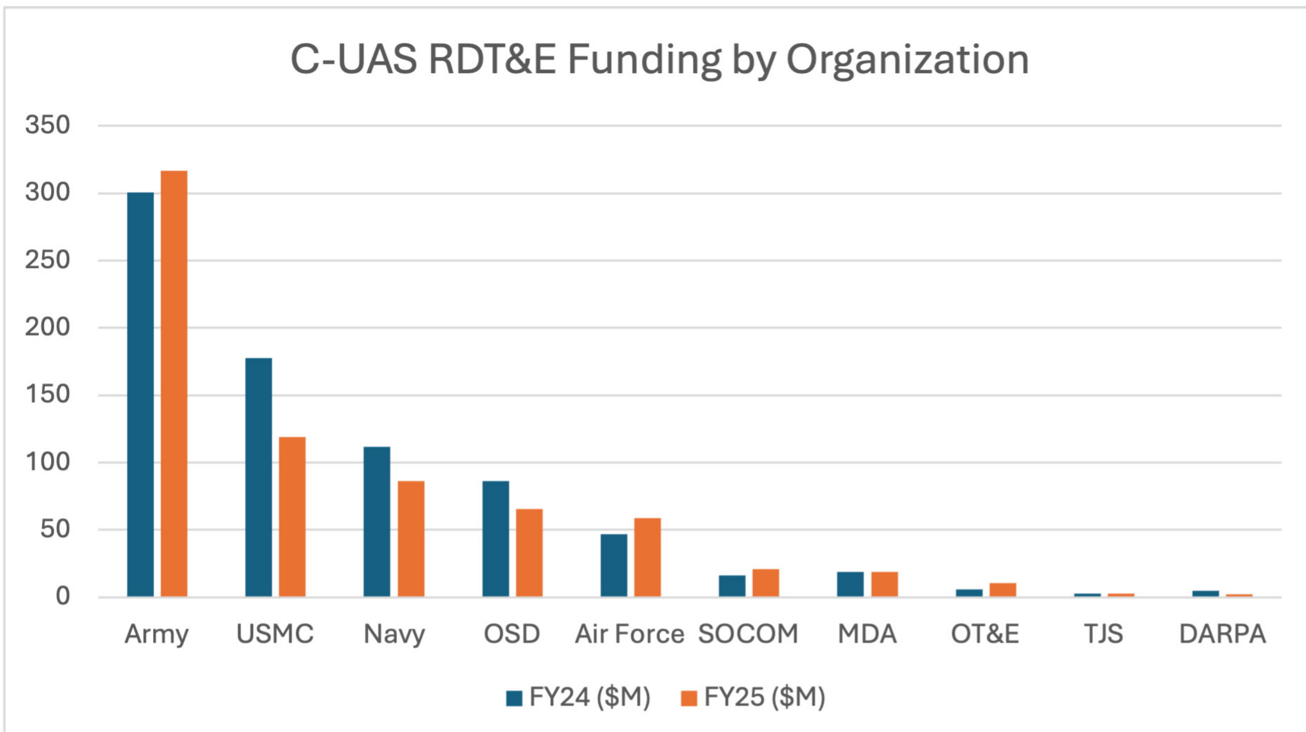
United States Navy Programs

Finally, the Navy has requested approximately $35 million over two programs mainly focused on the procurement of C-sUAS solutions. Current solutions to defeat UAS and protect Navy installations and critical assets include the CORIAN-based non-kinetic, electronic attack neutralization capabilities, handheld jammers like the DroneDefender and DroneBuster, and other Electronic Warfare systems like DRAKE 2.0.

RDT&E

The U.S. DOD has requested an estimated total of $701 million to advance the research, development, test, and evaluation (RDT&E) of C-UAS technologies.

Figure 15: Total CUAS RDT&E funding by organization for FY 2024 and FY 2025



Sources: Congressional Legislation, AUVSI Research

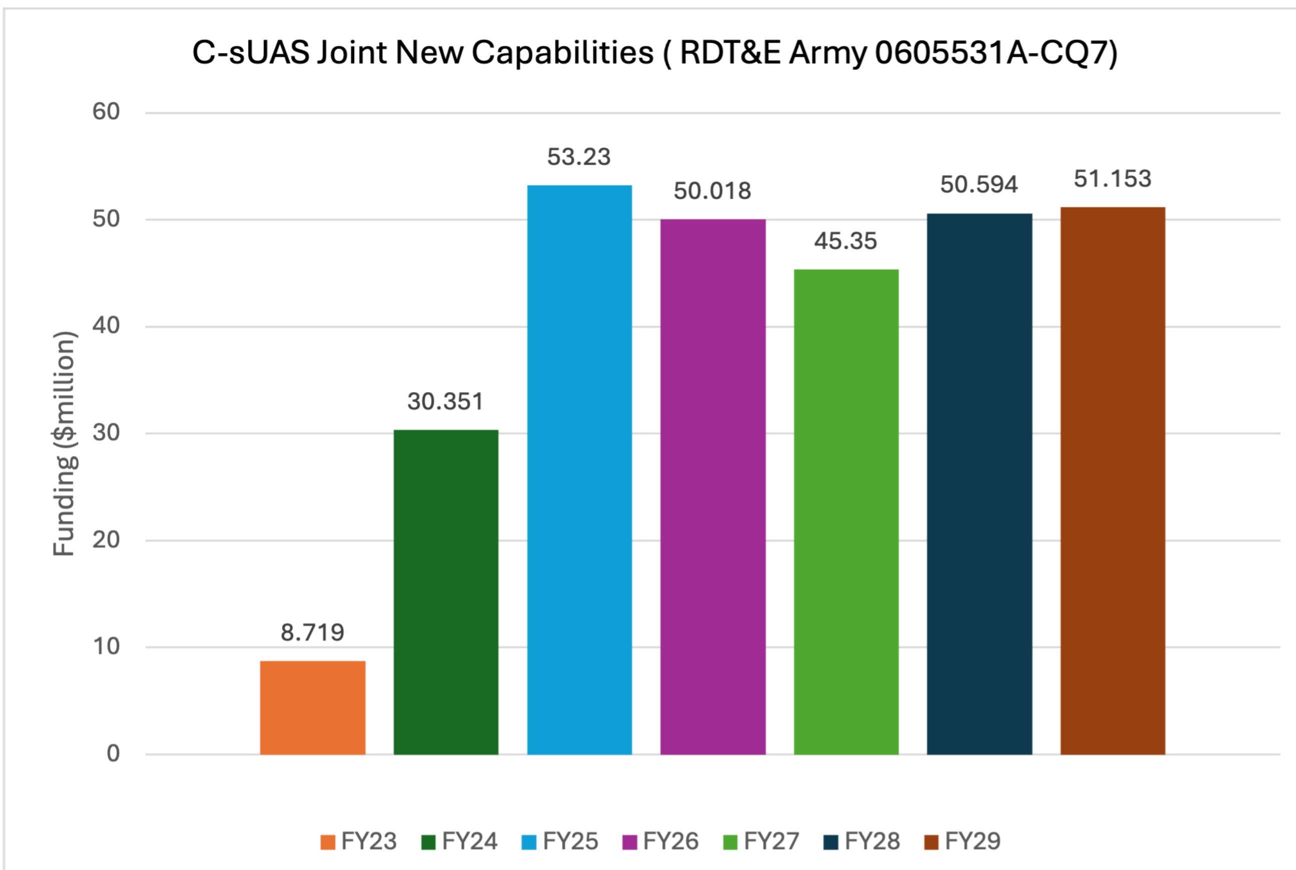
United States Army Programs

In FY 2025, requested funding initiates the 30mm Anti-Personnel and Counter UAS program which supports the Army's effort to develop and test a High Explosive Proximity munition. This munition provides increased lethality due to airburst effects and can be employed against small boats and sUAS. The Government will offer a contract award for development and testing in FY 2026.

Additionally, the Army is requesting an estimated $53.23 million to support development, testing, evaluation, and integration of new capabilities into C-sUAS platforms already in use. Specifically, developments include the Advanced Kinetic Defeat system, which incorporates an improved sensor package to enhance efficacy against Group 3 sUAS, and the integration of the Advanced Precision Kill Weapons System (APKWS) with the Common Remotely Operated Weapon System (CROWS). The Army is also looking to enhance the Forward Area Air Defense Command and Control (FAAD C2) system to reduce operator burden, increase situational awareness, and improve interoperability. This includes a FY 2025 increase of $15.560 million to support the integration of Roadrunner and APKWS with FAAD C2. The Roadrunner is an operator-supervised autonomous high-explosive interceptor built for ground-based air defense that can rapidly launch, identify, intercept, and destroy aerial threats — or be safely recovered and relaunched at near-zero cost[14].

Finally, the Army aims to allocate $7.694 million to develop new C-sUAS kinetic missile interceptors with increased range, reduced reaction time, and improved lethality. Focusing on small, lightweight, and low-cost interceptors, the project looks to provide maneuver forces with quick-response capabilities against Group 3 sUAS operating at higher altitudes and greater standoff ranges.

Figure 16: Funding for the C-sUAS Joint New Capabilities Army program by year



Sources: Congressional Legislation, AUVSI Research

Figure 17: Roadrunner Twin-Turbojet VTOL Autonomous Air Vehicle

Sources: https://www.anduril.com/roadrunner/

United States Marine Corps Programs

Under the MARINE CORPS AIR DEFENSE WEAPONS SYS program, funds support RDT&E for I-CsUAS to address the proliferation of sUAS threatening military installations. The $8.836 million increase from FY 2024 to FY 2025, for a total of $10.784 million, funds operational testing to validate the system's capabilities. This testing will assess the I-CsUAS's ability to detect, track, identify, and defeat Group 1-3 UAS threats in various operational environments. The investment supports the development of integrated hardware and software solutions, including radar systems, electro-optical/infrared sensors, and electronic warfare components[15]. By evaluating the I-CsUAS against current and projected UAS threats, the DOD aims to field a robust, scalable C-UAS solution for fixed and semi-fixed sites. The increased funding accelerates the transition from prototype to full-scale deployment. Additionally, this effort will inform a future PoR for the replacement of the Stinger missile, the primary effector against short range air defense threats, by providing an interceptor with improved target acquisition, range, and lethality to address evolving threats.

United States Navy Programs

In FY25, $1.686 million in requested funds also support the Navy's effort to enhance the 30mm MK 38 MOD 4 Gun Weapon System (GWS) to gain counter UAS and USV (Uncrewed Surface Vehicles) capabilities. This upgrade builds upon the MK 38 MOD 3 Machine Gun System's C-UAS capabilities. The MOD 4 system integrates an advanced fire control system, a more capable 30mm gun, improved targeting sensors, and direct integration with the AEGIS combat system to significantly enhance accuracy, lethality, and effective range.

Development of the MOD 4 system includes a comprehensive testing regime. Funds will support these tests that aim to validate the system's performance and integration with existing ship systems. The MOD 4 upgrade will be deployed on all DDG 51 Flight IIA and Flight III AEGIS Destroyers, providing a standardized and cost-effective solution for ship self-defense against UAS threats.

Concurrent with the MOD 4 development, the Navy is upgrading fielded 25mm MK 38 Machine Gun Systems to the MOD 3 configuration with C-UAS capabilities, upgrading the electro-optical/infrared sensor, hardware, and software. This two-pronged approach—upgrading existing systems and developing new ones—represents the most rapid and cost-effective strategy to field critical C-UAS ship self-defense capabilities across the fleet. The upgrades address not only current threats but also incorporate flexibility to counter evolving UAS and USV technologies through incremental improvements in cybersecurity and system operability.

DOD organizations have the opportunity to partner with the DIU (Defense Innovation Unit) and bolster the effort to innovate against evolving threats. The DIU links the military to the commercial sector and in so doing accelerates the adoption of commercial technology for national defense. To mitigate the cost of defending military and commercial vessels against UAS, it recently partnered with the Navy and put out a solicitation for a shipborne "kinetic defeat solution for group 3+ UAS" that is more "cost effective than current traditional air defense solutions."[16]

Other domains

Several initiatives within the DOD allocate funds to develop countermeasures against uncrewed systems across maritime, ground, and air domains. The Navy, for example, seeks to employ RDT&E funds to "continue the development of the capability to track, assess, and mitigate multiple simultaneous threat UUVs in harbors and approach channels." This includes improving harbor security sonar capability to detect Unmanned Underwater Vehicles (UUVs) to integrate increased volumetric coverage, passive detection and tracking algorithms, and new classification algorithms to address more capable threats. Similar projects also seek to develop Automated Target Recognition algorithms for small air, surface, and subsurface threats. Finally, modernization efforts by the US Special Operations Command System have expanded the operational capabilities of MM-ECM equipment across multiple Special Operations Forces (SOF) mission areas, including counter-uncrewed systems for both mounted and dismounted MM-ECM systems.

AUVSI SUBMITS PUBLIC COMMENTS FOR NEW SOC CODES IN THE UNCREWED INDUSTRY

Authors:
David Ambrozic, Junior Research Analyst

The Association for Uncrewed Vehicle Systems International (AUVSI) has recently submitted public comments in support of new Standard Occupational Classification (SOC) codes tailored to the uncrewed industry. These proposed codes include **Commercial Uncrewed Aerial Operators, Robotics Engineers, Robotics and Automation Technicians, and Aviation Dispatchers**. These roles are crucial to the growing uncrewed sector, and their inclusion in the SOC system will ensure they are accurately recognized and categorized in national workforce data.

The development of the SOC code for **Commercial Uncrewed Aerial Operators** represents a significant collaborative achievement led by a working group managed by the Uncrewed Aircraft Systems Collegiate Training Initiative (UAS-CTI). For the past two years, this effort was spearheaded by Diana Robinson, Project Manager and Lead of the UAS-CTI at FAA, and Dr. Wing Cheung, Professor at Palomar College. Their leadership was instrumental in driving the project to completion. The full comment is available to read here:

https://www.regulations.gov/comment/BLS-2024-0001-36773

The culmination of this work was a public comment that garnered the endorsement of 60 individuals, reflecting widespread support for the proposed SOC code. This project underscores the critical importance of collaboration among industry, academia, and government, as well as the need for accurate classification and support for this emerging field within the workforce.

In addition to these industry-specific roles, AUVSI also supported SOC codes submitted by other organizations that acknowledge the increasing use of drones as essential tools in various professions. These codes include:

- **Geographic Information Systems Scientists and Technologists**
- **Geographic Information Systems Technicians**
- **Remote Sensing Scientists and Photogrammetrists**
- **Remote Sensing Technicians**

These occupations are integral to geospatial analysis and remote sensing, fields that increasingly rely on drone technology for data collection and analysis. It is important to properly classify jobs that are critical to the advancement of both the uncrewed systems industry and the broader technology landscape.

The SOC system, managed by the SOC Policy Committee, serves as a federal statistical standard for classifying workers into occupational categories. Accurate classification is essential for understanding employment trends, guiding workforce development, and informing policy decisions. AUVSI's submission during the public comment period underscores the need for these updates to reflect the dynamic nature of the uncrewed industry and its associated professions.

With the public comment window now closed, the SOC Policy Committee will review the submissions, with final decisions expected in 2025. AUVSI remains committed to advocating for the accurate representation of the uncrewed systems industry within the SOC framework. This effort aligns with AUVSI's broader mission to support the integration, safety, and innovation of uncrewed technologies across various sectors. As the industry continues to evolve, these new SOC codes will play a pivotal role in shaping the future workforce and ensuring that emerging occupations are recognized and supported at the national level.

XPONENTIAL 2024 RECAP: EVENT EXPERIENCES 10% GROWTH IN ATTENDANCE

Authors:
David Ambrozic, Junior Research Analyst

XPONENTIAL 2024, organized by AUVSI and Messe Düsseldorf North America, took place at the San Diego Convention Center from April 22-25. The four-day event attracted ~7,500 participants, marking a 10% increase in attendance.

The event showcased the growing interest in uncrewed technology, featuring several new highlights such as the Pacific Pivot Outdoor Air & Maritime Demonstrations, where attendees experienced live demonstrations of multi-domain warfighting, in addition to the XPO+ Launcher Start-Up Pavilion showcasing solutions from innovators news to the ecosystem. There was a heightened focus on innovation in the defense sector, as evidenced by attendee interest and panel participation.

THE EVENT

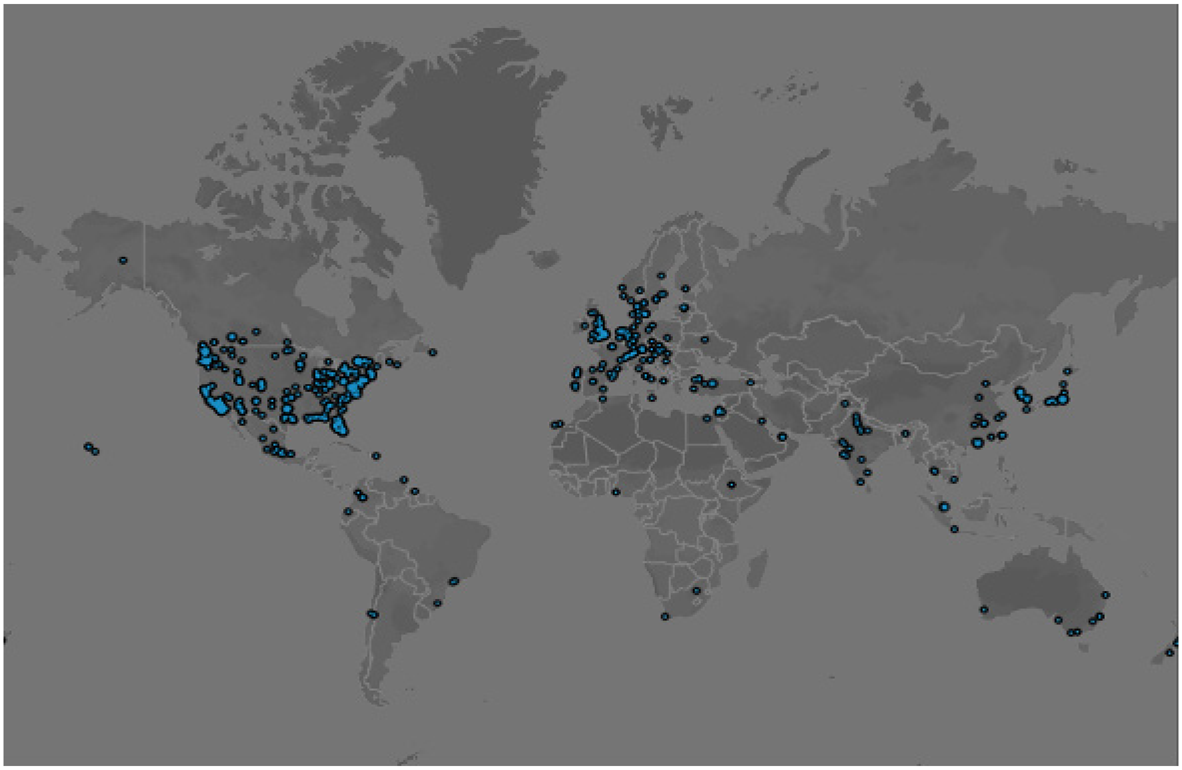
600	12	273
EXHIBITORS	KEYNOTE SPEAKERS	PANELS & PRESENTATIONS

THE ATTENDEES

61	3600	7500
COUNTRIES	ORGANIZATIONS	PARTICIPANTS

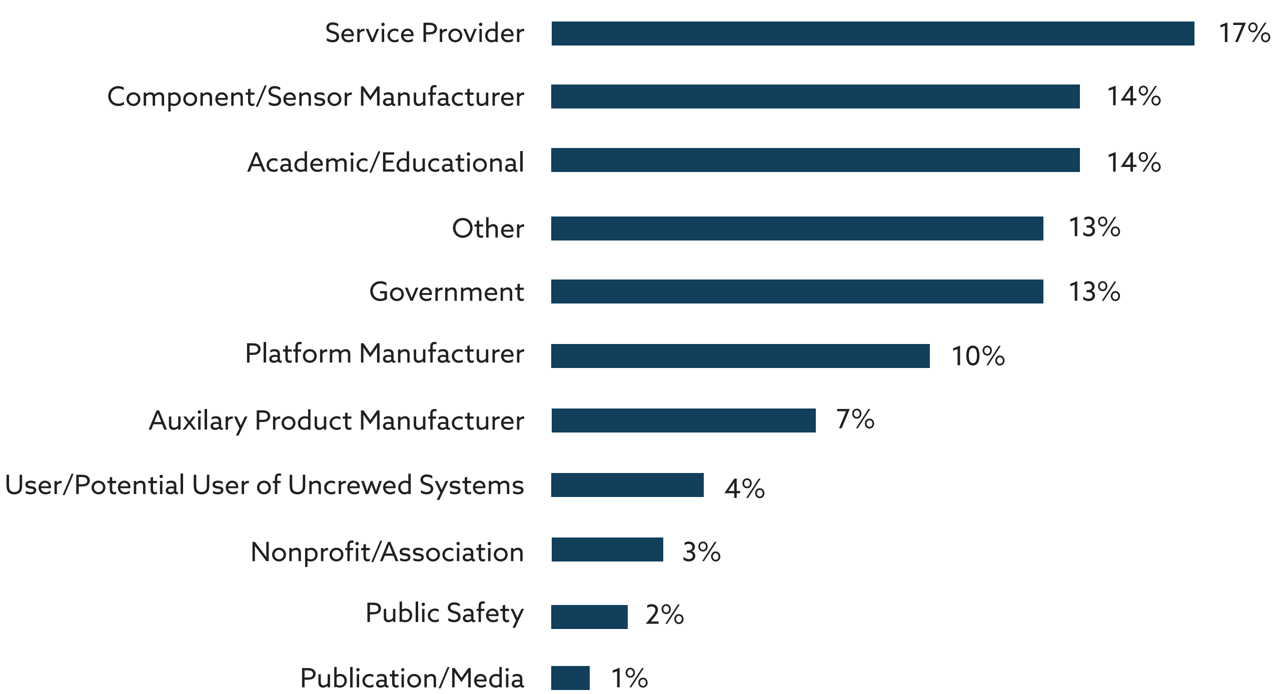
Of the 7,500 participants, 80% were domestic and 20% were international, up 17% compared to 2023. Participants from 49 U.S. states, 61 different countries, and six continents. Among international attendees, most were from Canada, Taiwan, the United Kingdom, and Korea.

Figure 1: XPONENTIAL 2024 attendees' locations



Among organizations, the most common types of participants were service providers with 17% and Component/Sensor Manufacturers, 14%. Followed by academic organizations and government entities. Notably, there was a 26% increase in participants from government organizations, highlighted by significant attendance from the Federal Aviation Administration and the Defense Innovation Unit. In terms of job titles of participants, the most common job titles were CEO and/or President and Director, highlighting the presence of key decision makers of companies in the uncrewed industry at XPONENTIAL 2024.

Figure 2: XPONENTIAL 2024 attendees by organization type



Educational Programming

XPONENTIAL 2024 also included nearly 300 sessions, such as panel discussions, technical presentations, working group meetings, and workshops. More than 2,200 unique registrants participated in educational sessions. Presentations on defense and policy were the most attended, followed by those on infrastructure/operations and public safety. The sessions with the highest attendance focused on BVLOS (Beyond Visual Line of Sight), advanced air mobility, and Counter-UAS for Military use cases.

Figure 3: XPONENTIAL 2024 education sessions attendance by topic

Figure 4: Top attended breakout sessions at XPO2024'

Lighting the Path to BVLOS	285
U.S. Navy Unmanned Industry Day Briefs	199
Counter UxS Systems	174
Transforming the Future Battlefield	165
Human Machine Integration (HMI)	162
Navigation Resiliency for the Masses - Redefining Anti-Jamming to Protect Ukraine and Beyond	144
Checking in on Replicator: Looking back on Day One, Looking forward beyond Year Two	134

Keynotes

XPONENTIAL 2025 also featured eight keynote addresses, all of which are available to watch on the AVILLE platform. Notable speakers included Defense Innovation Unit Director Doug Beck, Johns Hopkins University Distinguished Professor of Global Affairs Hal Brands, A.I. Artist Harry Yeff, Vice Admiral Bradley Cooper, Deputy Commander at United States Central Command, and an FAA leadership panel called "Getting to Go".

All keynote sessions are available on **AVILLE**.

CENTCOM Priorities
Feat. Vice Admiral Brad Cooper. Deputy Commander, United States Central Command

Watch on AVILLE

Looking Ahead: Robotics and Artificial Intelligence
Feat. Dr. Henrik Christensen, Qualcomm chair of Robotics

Watch on AVILLE

Operationalizing DIU 3.0
Feat. Doug Beck, Director, Defense Innovation Unit

Watch on AVILLE

A.I. Mentors, Collaborators and Opponents: The Art of Strategic Storytelling
Feat. Harry Yeff, A.I Artist and AI for Good Activist

Watch on AVILLE

Advancing Technologies and Their Role in World Affairs
Feat. Hal Brands, Henry A. Kissinger distinguished professor of Global Affairs

Watch on AVILLE

To Create, To Make, To Shape
Feat.Captain Michael Brasseur, Chief Strategy Officer, Saab Inc.

Watch on AVILLE

Solving Emerging Operational Problems
Feat. Michael Stewart, Director, Navy Disruptive Capabilities Office (DCO),
Vice Admiral Brad Cooper, Deputy Commander, United States Central Command

Watch on AVILLE

Getting to Go
Feat. Laurence Wildgoose, Assistant Administrator for Policy, International Affairs, and Environment, Federal Aviation Administration. Matt McCardle, Head of Global Regulatory Affairs and Strategy, Amazon Prime Air. Tim Arel, Chief Operating Officer, Air Traffic Organization, Federal Aviation Administration Marc Nichols, Chief Counsel, Federal Aviation Administration

Watch on AVILLE

A look at 2025

The inaugural edition of **XPONENTIAL Europe** will take place in Düsseldorf, Germany, **February 18–20**.

Followed by **XPONENTIAL 2025** in Houston, Texas **May 19-22**.

For more information and updates, visit www.xponential.org.


XPONENTIAL



XPONENTIAL


AEROLANE
Speed of Air at the Cost of Ground
XPONENTIAL

PROPOSAL FOR A COMPREHENSIVE SUSTAINABILITY AND ECONOMIC FRAMEWORK FOR UNCREWED SYSTEMS

Authors:
Marko Sudar, Research Intern, AUVSI

Proposal Takeaways

- Proposal to develop a framework and database to evaluate environmental and economic impacts of uncrewed systems.
- Support regulatory advocacy and provide insights for policy and industry practices while helping the uncrewed industry to expand faster.
- Establish sustainability and economic metrics for different uncrewed vehicles across various industries.
- Reduce the amount of time needed to establish new uncrewed operations (based on established framework and previous operations).
- Evolve with new data and technology and automate processes.
- Potential for collaboration with government, and other non-profits and companies to enhance impact and reach.

Introduction

The future integration of uncrewed vehicle systems (UxS) into various vertical markets is rapidly approaching, with significant opportunity for both environmental and economic benefits. This research and proposal, developed by Marko Sudar, a Research Intern at AUVSI, aims to propose the development of a Comparative Assessment Framework and Database for Uncrewed Systems.
The proposal's foundation is rooted in the belief that uncrewed operations can significantly transform industries by making them more sustainable and profitable. As the adoption of AI and uncrewed technologies continues to grow, there is an urgent need for a universal framework that can accurately assess the environmental and economic impacts of these systems. This framework will not only provide valuable insights for government stakeholders, but also offer substantial benefits to industry by helping them optimize their operations in a cost-effective and environmentally responsible manner. Development of this framework will support the industry expansion and offer valuable insights to inform policy makers and Congress about the viability and benefits of transition from crewed to uncrewed operations.

Additionally, this database could inform concrete recommendations for policy and regulations, helping to shape laws that promote the use of uncrewed systems in a manner that is both economically beneficial and environmentally responsible.

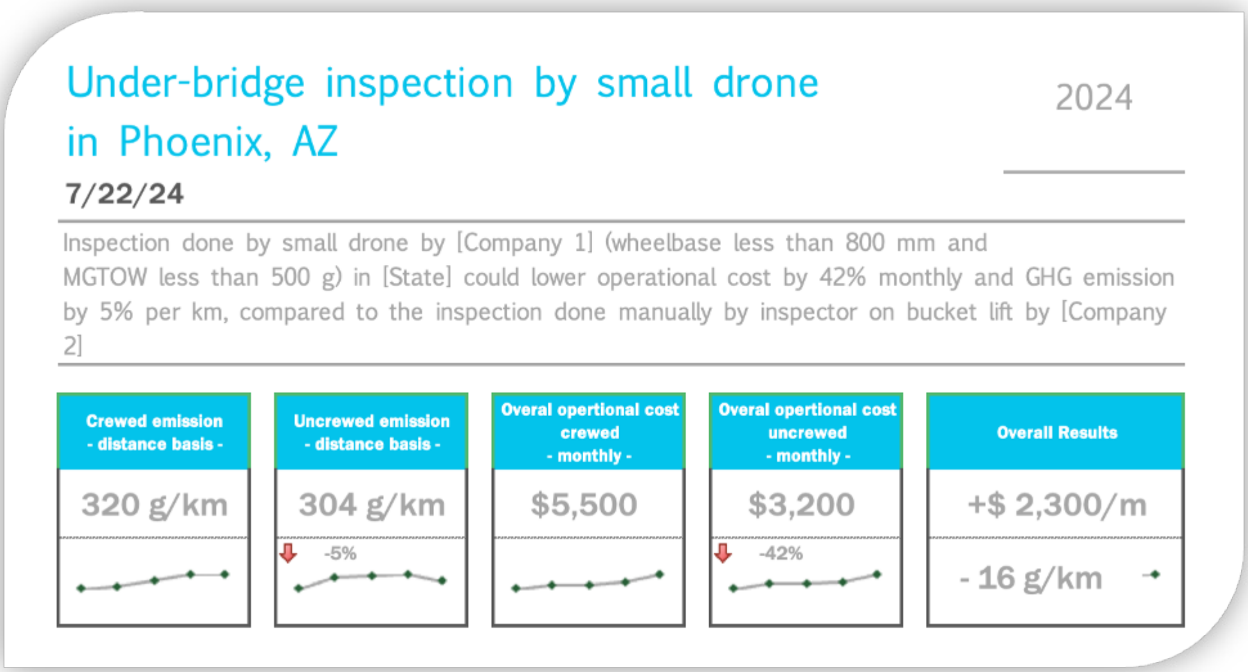
Project Overview

The framework development involves identifying key metrics and mathematical models to evaluate the sustainability and economic impact of uncrewed systems in today's economy. The initial focus was set on the delivery and logistics sector, but the framework has the potential to cover other industries such as agriculture, emergency response services, infrastructure inspection and maintenance, healthcare, and many more.

To develop a comprehensive and adaptable framework for assessing the sustainability and economic impact of uncrewed systems, our approach will be iterative and interdisciplinary, involving multiple key steps. We will start by analyzing existing research and data across various industries, such as agriculture, healthcare, and emergency response, to identify gaps and develop sector-specific metrics. Engaging with stakeholders from these industries will ensure the framework is tailored to their unique challenges and opportunities. We will then operationalize the framework by creating tools for automated data collection and analysis, accompanied by pilot programs to test and refine the system. This framework will be continuously updated, incorporating feedback and new data from industry partners, academic institutions, and regulatory bodies. By integrating diverse data sources and leveraging advanced analytics, the framework will offer a holistic and dynamic assessment tool, providing stakeholders with actionable insights to optimize the use of uncrewed systems.

Illustrated in Figure 1 is an example of one mock entry into the proposed economic and sustainability database derived from the frameworks. Using metrics such as wingspan, takeoff weight, payload, energy capacity, range, endurance, system cost, etc., this database would offer visibility into the potential impact of uncrewed systems on operations across the different sectors.

Figure 1: Data Example



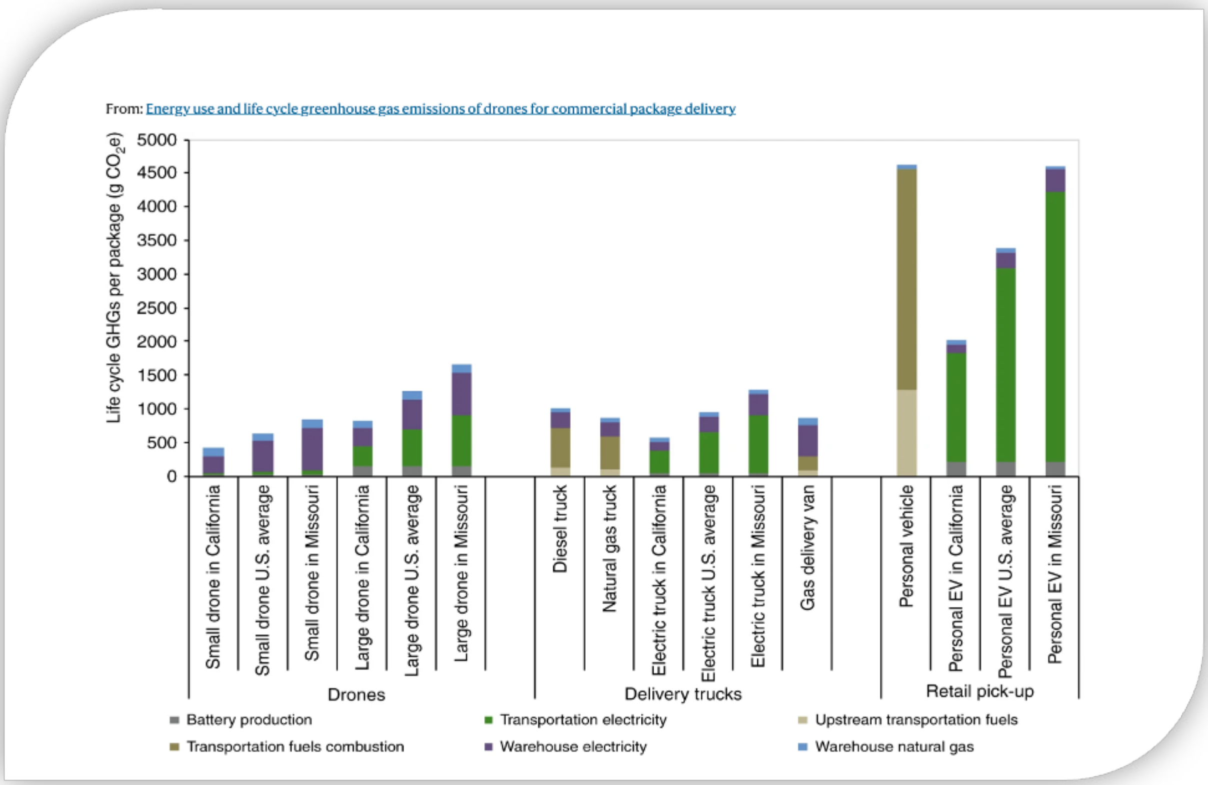
Sources: Numbers are placeholders and not the actual results

Industry-Specific Metrics

The initial assumption is that all industries will benefit to some extent from implementing uncrewed operations. To determine if this is the case for a specific operation, we first need to identify the associated metrics which relate to the sustainability and economic impact.

For instance, in the delivery sector, key sustainability metrics might include carbon emissions per package and noise pollution per mile. In the agriculture sector, metrics could focus on water usage and efficiency of pesticide or fertilizer application. As research progresses, new variables will be integrated into the framework, continuously refining and expanding its applicability. The framework must be flexible enough to accommodate these diverse metrics and continuously evolve as new data becomes available. In past, a few studies have been conducted (Figure 2) and results showed that drones have a huge potential to lower the Green-House-Gas (GHG) emissions significantly when compared to other vehicles used for different operations. Ongoing research will ensure that the framework remains relevant and accurate, providing valuable insights for various industries.

Figure 2: Example of the study done in past



Sources: https://www.nature.com

To accurately assess the sustainability and economic impacts of uncrewed systems, a thorough and multi-faceted approach is necessary. The process of determining key metrics will involve several strategies:

1

Reviewing Existing Research

The first step is to conduct a comprehensive review of existing studies and literature in the field. This will help identify previously established metrics and methodologies that have proven effective in evaluating similar systems. Understanding these foundational elements will provide a baseline for developing new metrics tailored to the unique characteristics of uncrewed systems.

2

Conducting New Research

Given the rapidly evolving nature of uncrewed technologies, primary research is essential. This includes field studies and controlled experiments to collect real-world data on various operational scenarios. Such research will provide insights into new metrics that might be more relevant to current and future applications, especially as technologies and their applications continue to evolve.

3

Consulting Industry Experts

Engaging with experts from the industry, including manufacturers, operators, and regulatory bodies, will be crucial. These stakeholders possess practical knowledge and experience that can help identify critical factors influencing the performance and sustainability of uncrewed systems. Interviews, surveys, and workshops with these experts will inform the development of a comprehensive set of metrics that are both practical and relevant.

4

Benchmarking Against Industry Standards

Comparing the proposed metrics against existing industry standards and best practices will help ensure that the framework aligns with current regulatory and market expectations. This benchmarking process will also highlight any gaps or areas where the framework can offer additional value.

5

Iterative Testing and Validation

Once preliminary metrics are established, they will undergo iterative testing and validation. This process involves applying the metrics to various case studies and operational scenarios to assess their accuracy, reliability, and practicality. Feedback from these tests will be used to refine and adjust the metrics, ensuring they are robust and applicable across different contexts.

6

Incorporating Technological and Market Trends

The framework must be dynamic and adaptable to incorporate new data and technological advancements. As the industry evolves, new metrics may become necessary to capture emerging trends and innovations. Regular updates and revisions to the framework will ensure it remains relevant and useful for industry stakeholders.

By employing these strategies, the proposed framework aims to establish a comprehensive, adaptable, and industry-acceptable set of metrics. This will enable a thorough assessment of the sustainability and economic impacts of uncrewed systems, providing valuable insights for policymakers, industry stakeholders, and researchers alike.

Sustainability Assessment Framework

Creating an effective sustainability assessment framework involves significant research and data collection. Studies conducted so far show that small drones are among the most sustainable options, while larger drones' efficiency varies depending on specific conditions such as energy grid and payload size. These findings highlight the importance of considering a wide range of factors when assessing the sustainability of uncrewed systems. The goal here is to develop a robust model that can accurately predict the environmental impact of uncrewed systems across various scenarios. This requires collaboration with manufacturers, field testing, and the integration of real-world data into the framework. While much of this data is already held by platform manufacturers, to elevate this project, we encourage all interested members to participate and share any data they possess regarding the life cycle assessment of their platforms. By continuously refining the model, the framework aims to provide precise and actionable insights for the industry.

The framework consists of two parts: 1) metrics and 2) equations to calculate final values. Initial research is focused on the delivery sector, specifically helicopter/multicopter aerial systems. Metrics for drone energy consumption include wind speed and direction, drone weight, payload weight, battery voltage and current, distance traveled, journey speed, air density, induced velocity, propeller area, and flying altitude. Additional factors such as carbon intensity and advanced warehousing networks are also considered. Field tests are required to gather region-specific data not provided by manufacturers. In collaboration with government and private laboratories and organizations interested in showcasing their technology, we are seeking partners for field tests.

Developing an industry-acceptable framework for advanced aerial systems is particularly challenging because it requires integrating a wide range of variables into a cohesive model. These variables are not only diverse but also interdependent, making it difficult to standardize measurements and predictions. This complexity underscores the importance of thorough data collection and testing to ensure the framework can accurately reflect real-world conditions and meet industry standards.

Calculation of Drone Energy Consumption

To accurately assess the energy consumption of drones, it is essential to consider the induced power, which is the power required to overcome gravity when a drone is flying at a hover speed in no-wind conditions. In this initial scenario, thrust and gravity are the only forces acting on the drone. Using the thrust, air density, total drone mass, and gravitational force, we can determine the induced force.

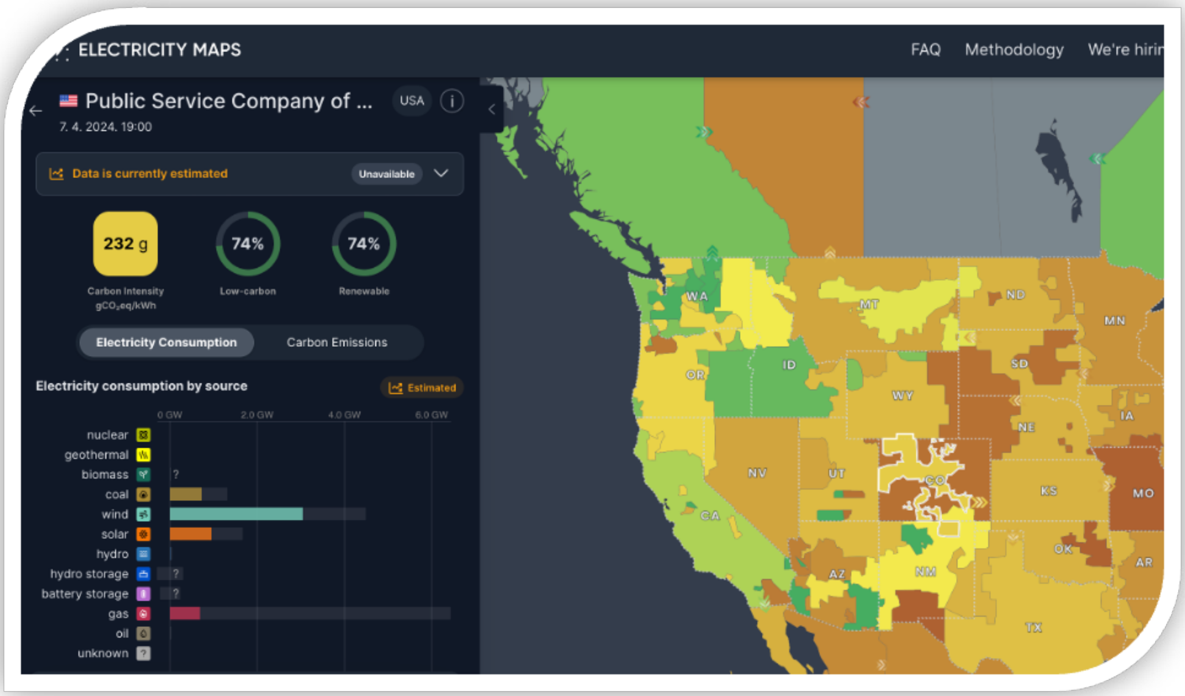
The total energy consumption of a drone is the sum of the energy used for take-off, cruising, and landing. The induced power is combined with other metrics, such as wind speed and direction, drone weight, payload weight, battery voltage and current, distance traveled, journey speed, air density, induced velocity, propeller area, and flying altitude, to calculate the drone's total energy consumption.

A challenge in deliveries using small drones is their limited range and payload capacity compared to human-operated vans. While a van can deliver multiple packages in one trip, a small drone typically needs to return to the warehouse for each package. This necessitates a well-calculated network of warehouses to cover entire cities and regions. Additional warehouses, however, contribute to GHG emissions. Established methods for calculating warehouse emissions will be integrated into the final results to present a comprehensive assessment to clients.

Furthermore, the geographical location of drone operations is a critical factor due to variations in the sustainability of the electric grid across different parts of the US. Therefore, the carbon intensity of specific locations (measured in gCO2eq/kWh) must be included in the analysis

Figure 3 (from Electricity Maps Website) displays itemized data about an electric grid in different parts of the United States. Data from this and similar websites could be used in this research as a reliable source of information for determining the carbon intensity of specific locations.

Figure 3: Electric Grid map in US



Sources: https://app.electricitymaps.com/zone/US-SE-SEPA)

Economic Assessment Framework

Developing an economic assessment framework involves analyzing the financial impacts of uncrewed systems from multiple angles. This includes direct costs, such as the purchase and maintenance of UVs, as well as indirect costs, like regulatory compliance and infrastructure investments. The framework must also account for potential savings and revenue opportunities, such as increased operational efficiency.

The initial research in the delivery sector identified several key cost factors, including the acquisition and operational costs of uncrewed electric helicopters/multicopters. By comparing these costs with traditional delivery methods, the framework provides a clear picture of the financial benefits and challenges associated with transitioning to uncrewed operations. This information is crucial for companies considering the adoption of uncrewed systems, as it helps them make informed decisions based on comprehensive economic analysis.

Finally, the framework captures the broad spectrum of costs and benefits when transitioning from crewed to uncrewed deliveries. It considers acquisition, operational, regulatory, infrastructural, environmental, and labor costs, along with opportunity and societal costs. Additionally, performance metrics, depreciation, and salvage values are examined. Data supporting this analysis is sourced from public databases, manufacturers, and field tests, providing a comprehensive perspective for businesses looking to embrace the future of uncrewed deliveries.

Further Research and Collaboration

This project highlights the need for ongoing research and collaboration to realize, refine and expand the Comparative Assessment Framework and Database for Uncrewed Systems. It is important to emphasize that further development of this project will depend largely on collaboration and partnerships with other private and public entities.

As new data and technological advancements emerge, the frameworks will evolve to incorporate changes to technology and other variables, ensuring its continued relevance and accuracy.
Furthermore, future research will focus on expanding the framework to cover additional industries and use cases. This involves identifying industry-specific metrics and developing tailored models to assess the sustainability and economic impact of uncrewed systems.

Potential collaborations with government agencies, industries, academic institutions and non-profits could further enhance the project's impact and reach. Additionally, partnerships can provide valuable data and resources, helping to accelerate the development of the framework, and increase opportunities to secure government grants and funding to offset research costs and support the project's long-term sustainability.

The future of the project also lies in automation. As the framework becomes more complex and incorporates more metrics, manual data collection and analysis will become increasingly challenging. Developing software tools to automate these processes will be crucial for maintaining the framework's accuracy and efficiency, and we see significant potential for collaboration in this area. By leveraging advanced technologies such as artificial intelligence and machine learning, the project can streamline data collection and analysis, providing more timely and accurate insights.

Conclusion

The proposed Comparative Assessment Framework and Database for Uncrewed Systems is a visionary project with the potential to transform various industries by promoting sustainable and economically beneficial practices.

The project's success hinges on continuous research, collaboration, and the integration of new data and technological advancements. It also strongly depends on data that could be provided by industry partners. By expanding the framework to cover additional industries and automating data collection and analysis, stakeholders can stay ahead of the curve and be provided with insights and cutting-edge solutions related to uncrewed systems.

In conclusion, this proposal represents a significant step forward in the quest for more sustainable and efficient uncrewed operations. With its focus on comprehensive assessment and continuous improvement, the proposal is poised to make a lasting impact on the industry and contribute to a more sustainable future.

If you and your organization are interested in collaborating with AUVSI on this initiative, please contact AUVSI's research team: research@auvsi.org

green uas™

BOLSTERING, SECURE, CAPABLE UAS TECHNOLOGY

Green UAS vets and validates commercial drones with a cybersecurity penetration test and ensures NDAA supply chain compliance.

Request Certification	Provide Information & Documentation	Complete Assessment	Review Initial Reports & Findings	Remediate Vulnerabilities	Resubmit Request	Achieve Green UAS Certification

Click or scan to learn more
AUVSI.org/Green-UAS

auvsi.org/research

Association for Uncrewed Vehicle Systems International