Unmanned Systems & Robotics in the FY2019 Defense Budget

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Introduction

In Fiscal Year 2019 (FY2019), the United States Department of Defense (DoD) has requested a total of $686 billion in funding. This is an increase of approximately $74 billion from FY2018 and will support the current United States national security and defense strategies. These strategies involve responding to growing international competition and threats from terrorists, regional dictators such as Iran and North Korea, and revisionist powers such as Russia and China[1]. Unmanned systems and robotics are key technology areas that enable the U.S. to counter the range of evolving threats posed on the modern battlefield. A comprehensive review of the budget documents for each service, department and agency in the DoD has been completed to identify all programs that support the operations of unmanned systems. The National Defense Authorization Act (NDAA) has also been reviewed for any changes relative to the initial requests in the President's Budget. This research will provide insight into the requested funding for both procurement and research, development, testing and evaluation (RDT&E) of unmanned systems and robotics.

Overview (All Programs)

It is estimated that the requested funding for unmanned systems and associated technologies in FY2019 totals $9.6 billion across all agencies in the DoD (approximately 1.4 percent of the total DoD budget). This represents unclassified programs from the DoD for procurement and RDT&E, including overseas contingency operations (OCO).

In Figure 1, the total requested funding between FY2017 and FY2019 has been separated into the three main services (Navy, Army, Air Force) and the other agencies in the DoD (ten of which have detailed plans to fund unmanned systems and robotics: Chemical and Biological Defense Program (CBDP), Defense Advanced Research Projects Agency (DARPA), Defense Logistics Agency (DLA), Defense Technical Information Center (DTIC), Defense Threat Reduction Agency (DTRA), Missile Defense Agency (MDA), Office of the Secretary of Defense (OSD), Special Operations Command (SOCOM), The Joint Staff (TJS), Washington Headquarters Service (WHS). Each service shows growth between FY2018 and FY2019 with the Navy experiencing the largest increase at over one billion dollars. Figure 1 also shows the number of programs for each service that provide support for unmanned systems between FY2017 and FY2019. Again, the Navy leads with 141 relevant programs followed by the Army (119), Air Force (67), OSD (23), SOCOM (14). Other agencies have ten or fewer programs.

[1] http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/FY2019_Budget_Request.pdf

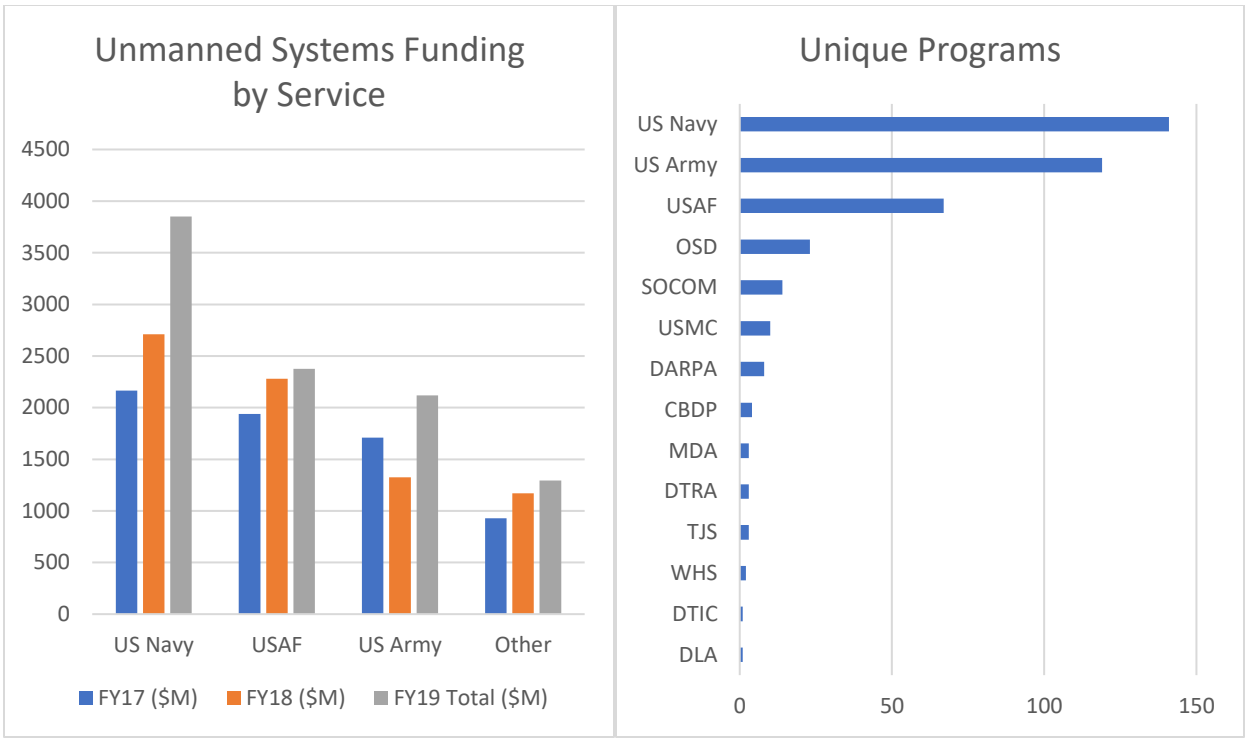


FIGURE 1: TOTAL UNMANNED SYSTEMS FUNDING BY AGENCY (LEFT), TOTAL UNMANNED SYSTEMS-RELATED PROGRAMS CAPTURED FOR EACH AGENCY (RIGHT)

Separating the President's Budget request by domain (figure 2), we see that air is receiving the largest funding support with the budget for unmanned aircraft reaching almost $7 billion in FY2019, followed by $1.5 billion for counter unmanned systems (C-UxS), $1.3 billion for unmanned maritime vehicles and $0.7 billion for ground robotics. From FY2018 to FY2019, the budget for C-UxS technologies almost doubles. Figure 2 also shows the number of unique projects and sub-projects that involve unmanned systems relative to the domains in which they are operating. Cross-domain operations of air and ground unmanned vehicles are supported by the largest number of projects. Over 60 percent of these efforts are funded by the U.S. Army. The U.S. Navy is also working to provide solutions for interoperability and teaming of unmanned vehicles across multiple domains as they support over half of the projects involving operations in all domains (air, ground, and maritime).

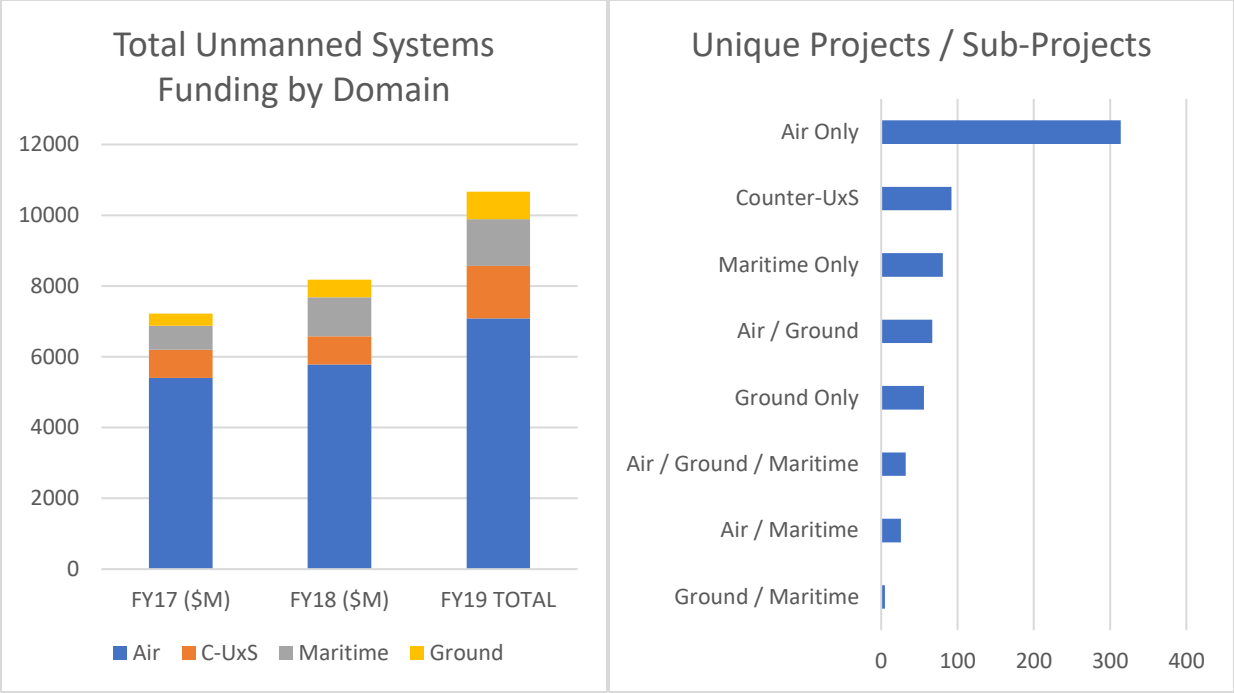


FIGURE 2: TOTAL UNMANNED SYSTEMS FUNDING BY DOMAIN – TOTALS INCLUDE PROJECTS THAT FUND MULTIPLE DOMAINS SO THESE VALUES ARE SLIGHTLY INFLATED (LEFT), TOTAL NUMBER OF PROJECTS BASED ON DOMAIN(S) OF OPERATION (RIGHT)

The last way the programs have been parsed in this initial overview is based on the technologies that enable the operation of unmanned systems. In Figure 3, seven core technologies have been identified. The largest investment can be seen in the integrated sensors and payloads followed by navigation and control systems. Please see the "Program Details" section of this report for more information on each of the initiatives supporting unmanned systems in the President's Budget.

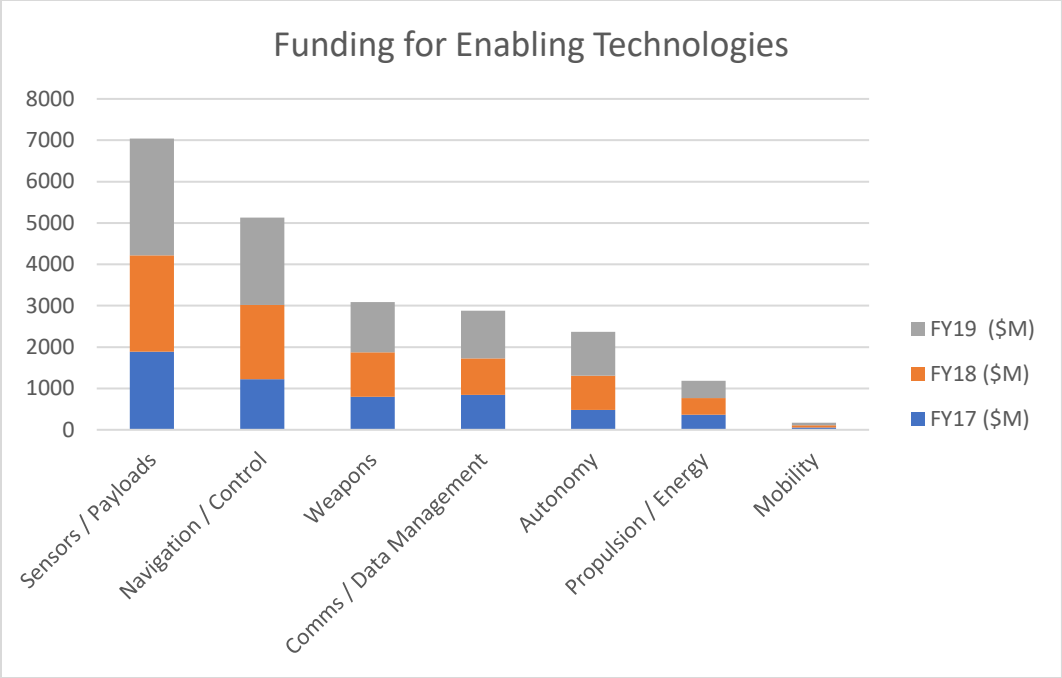


FIGURE 3: FUNDING FOR TECHNOLOGIES THAT ENABLE THE OPERATION OF UNMANNED SYSTEMS (THE TOTALS ARE SLIGHTLY INFLATED AS SOME PROGRAMS SUPPORT MULTIPLE ENABLING TECHNOLOGIES)

Overview (Procurement)

The requested DoD funding for unmanned systems procurement in FY2019 (Figure 4) totals approximately $4.7 billion (including OCO). This represents all unclassified programs from the U.S. DoD. Again, the three main services show increases in funding from FY2018 to FY2019 with the Army showing the largest growth followed closely by the Navy.

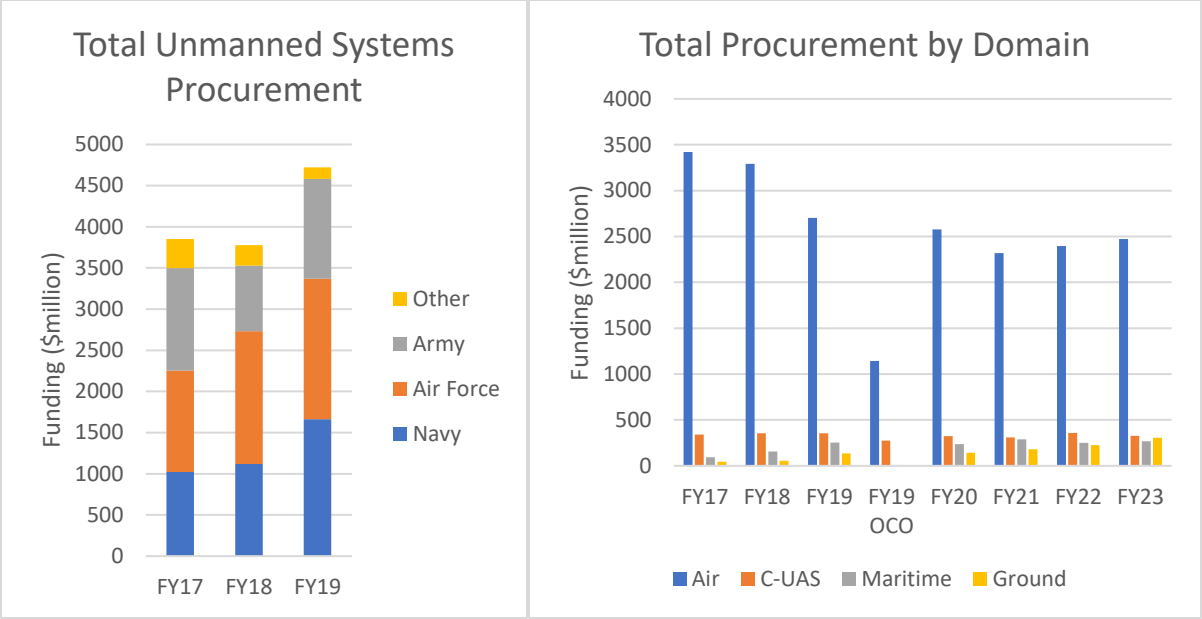


FIGURE 4: TOTAL UNMANNED SYSTEMS PROCUREMENT (LEFT), UNMANNED SYSTEMS PROCUREMENT BY DOMAIN (RIGHT)

Separating the budget by domain (Figure 4) we see that most of the funding request is for Unmanned Aerial Systems (UAS) and related equipment. Support for C-UxS technologies saw the next largest funding request from FY2017 to FY2023 followed by unmanned maritime systems and ground robotics. The graph may seem to suggest that procurement declines in FY2020 to FY2023 but this decrease is attributed to programs that haven't yet been initiated. Only the programs initiated as of FY2019 will appear in the yearly totals.

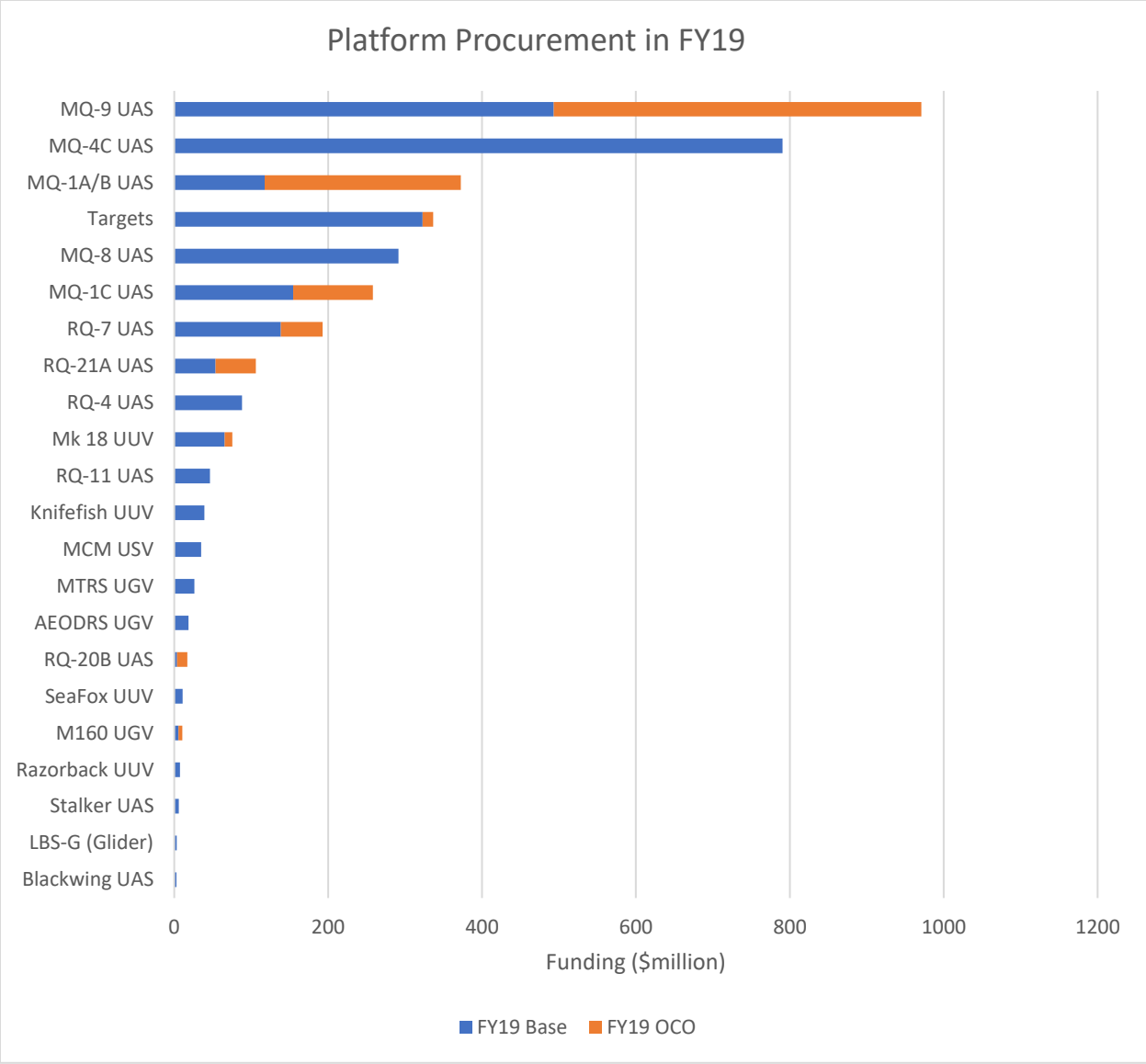


FIGURE 5: THE TOTALS REPRESENT ALL PROGRAMS ASSOCIATED WITH EACH VEHICLE INCLUDING PAYLOADS, SUBSYSTEMS, SUPPORT EQUIPMENT, ETC.

The requested platform procurement in FY2019 (Figure 5) is dominated by UAS, with the MQ-9 Reaper (USAF/SOCOM) topping the list at $970 million. 29 total MQ-9 aircraft are being requested in FY2019, 21 of which are for OCO with a unit cost of $14.8 million each. Other funding programs that are factored into the total include the communication infrastructure that supports operations, vehicle upgrades, spares and repairs, payloads (Gorgon Stare, bombs/munitions, etc.), and other production charges. The MQ-9 (Figure 6) is a large weaponized aircraft used by the U.S. Air Force and Special Operations Command and, as is evident by the substantial OCO request, it continues to play a critical role in the ongoing war on terrorism.

FIGURE 6: GENERAL ATOMICS MQ-9 REAPER UAV[2]

The MQ-4C Triton UAS (USN) (Figure 7) has the next highest funding request with a base FY2019 total of $790 million. Most of this is attributed to the three Low Rate Initial Production (LRIP) aircraft at $68 million each with a flyaway cost of $400 million for all three. Other hardware consists of systems for navigation, command, control, networking and communications as well as ground support equipment, spares and repairs, etc. The MQ-4C provides persistent ISR data in littoral and maritime environments for the U.S. Navy.

[2] http://www.ga-asi.com/predator-b

FIGURE 7: MQ-4C TRITON UAV[3]

The Mk 18 UUV (Unmanned Undersea Vehicle) (Figure 8) has the largest funding request for unmanned maritime vehicles with $75 million in FY2019. The Mk 18 family of systems (FOS) consists of the mod 1 (modified REMUS 100 UUV) and mod 2 (modified REMUS 600 UUV) and are used mainly for Mine Counter Measure (MCM) operations by the U.S. Navy. Over 95 percent of the total Mk 18 funding is for the mod 2.

FIGURE 8: REMUS 600 FOR DEFENSE APPLICATIONS[4]

With respect to Unmanned Ground Vehicles (UGVs), the Man Transportable Robotic System (MTRS) secured the largest funding request at $26 million. MTRS provides enhanced protection to the EOD soldier with the ability to render safe and dispose of explosive ordnance (EO) and improvised explosive devices (IEDs). Contractors for this system include QinetiQ with a

[3] http://www.northropgrumman.com/Capabilities/Triton/Pages/default.aspx
[4] https://www.hydroid.com/remus-600-defense-applications

FY2019 request of two Talon 5a (Figure 9) at $156,000 each and Endeavor Robotics with a FY2019 request of 43 MTRS Inc II at $120,000 each.

FIGURE 9: QINETIQ TALON V UGV[5]

Each of the three core services have requested funding to obtain systems that support C-UxS operations with a total estimated cost of $356 million across all programs. Looking at specific programs, U.S. Navy Physical Security Equipment has the largest C-UxS request at over $71 million in FY2019 followed by the U.S. Air Force Physical Security System at $60 million. Details for many of the C-UxS programs are not publicly available, and are only accessible to those with certain government clearances.

Overview (RDT&E)

In FY2019, the President's Budget has requested an estimated $4.9 billion to invest in unmanned systems RDT&E (including OCO; representing all unclassified programs in the DoD). This is a marked increase from FY2018 which has an estimated $3.7 billion to fund unmanned

[5] https://www.qinetiq-na.com/products/unmanned-systems/talon/talonv/

systems RDT&E. Looking at specific agencies (Figure 10), the Navy has the largest budget request in FY2019, followed by the Army, Air Force, OSD, DARPA, and other agencies (CBDP, DLA, DTIC, DTRA, MDA, SOCOM, TJS, WHS). The Army shows the highest growth with an increase of 72 percent from FY2018 to FY2019.

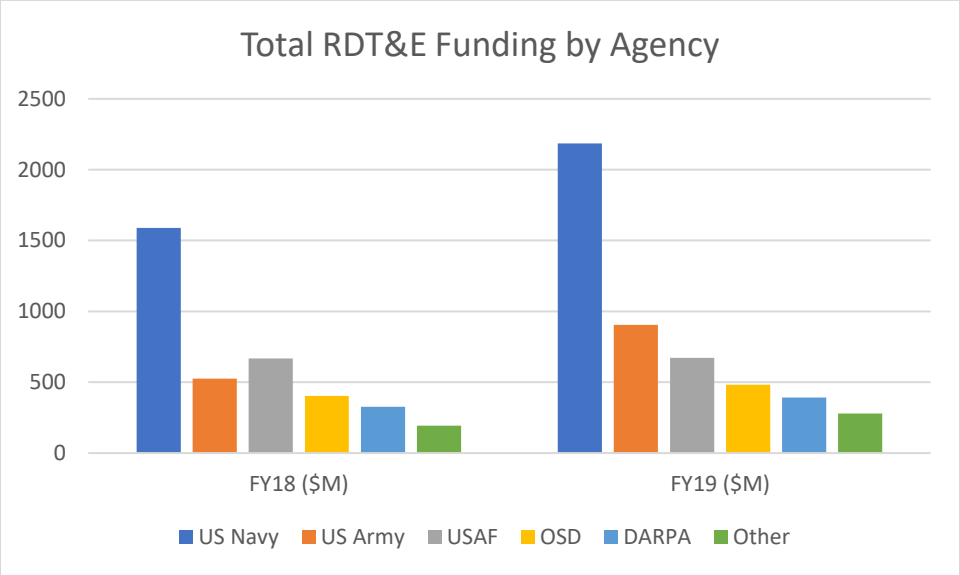


FIGURE 10: RDT&E FUNDING FOR UNMANNED SYSTEMS SEPARATED BY AGENCIES IN THE DOD

The funding for RDT&E has also been separated by domain of operation (Figure 11). Programs supporting the air domain alone represent over half of FY2019 funding for unmanned systems followed by the maritime domain and technologies to counter unmanned systems. Programs supporting both UAS and C-UxS saw the largest increase with almost triple the funding from FY2018 to FY2019. The ground domain is also poised for significant growth with a 75 percent rise year-to-year.

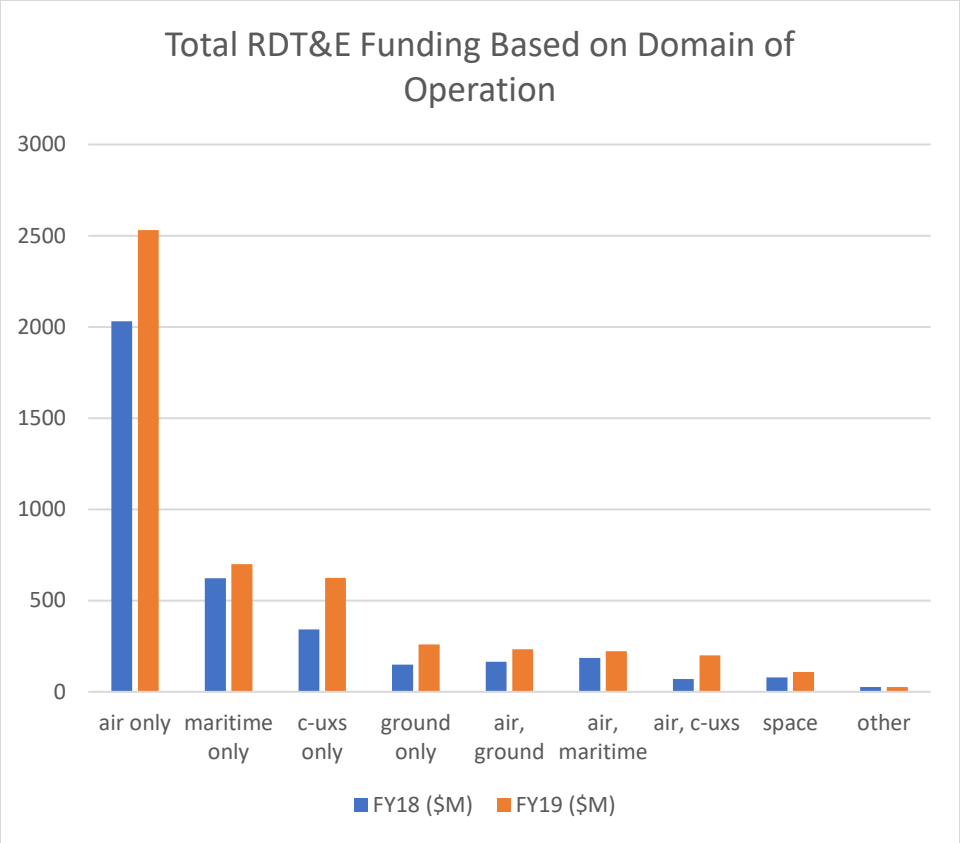


FIGURE 11: RDT&E FUNDING FOR UNMANNED SYSTEMS PROJECTS SEPARATED BY DOMAIN OF OPERATION

Looking at the technology areas that are being focused (Figure 12), the integrated sensors and payloads are the most crucial component of any unmanned vehicle and thus received the largest budget request. This is followed by platform development, which has the largest growth with an increase of approximately 68 percent from FY2018 to FY2019. The Figure also shows the growing importance of autonomy on the battlefield with over half of Navigation & Control projects involving or working to implement some level of autonomous operation.

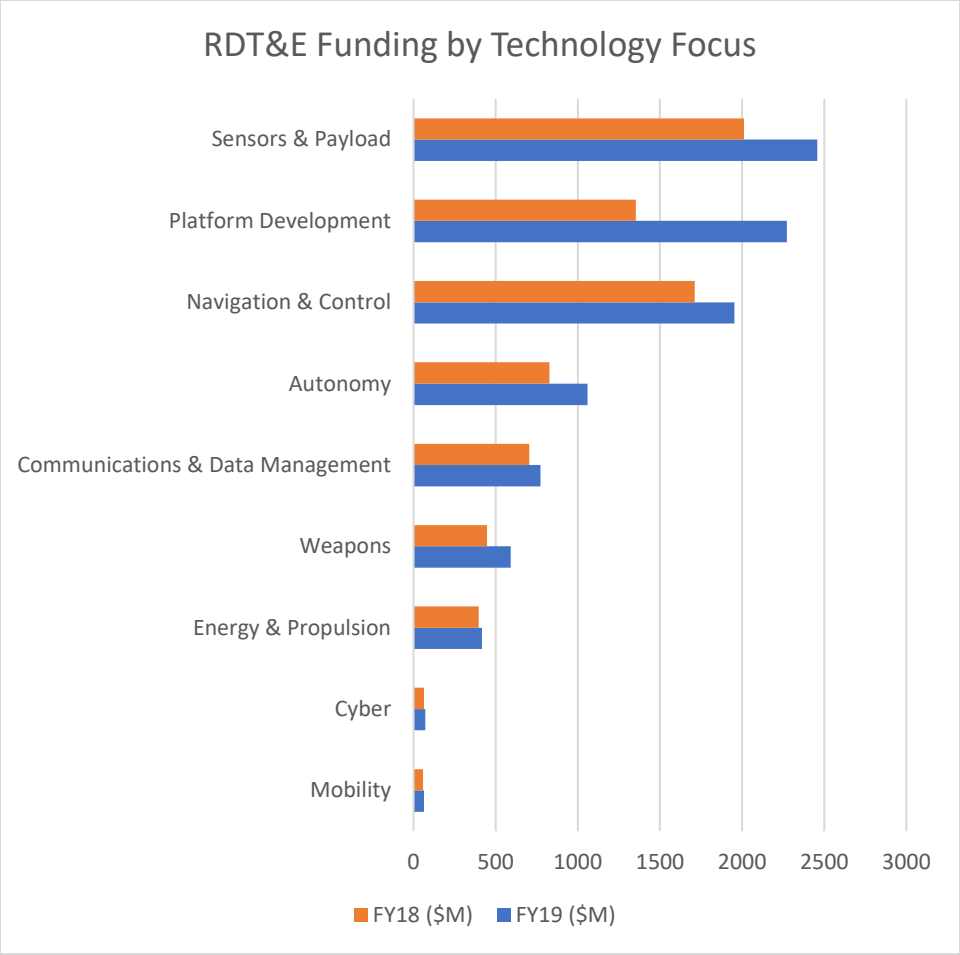


FIGURE 12: RDT&E FUNDING FOR UNMANNED SYSTEMS PROJECTS SEPARATED BY ENABLING TECHNOLOGIES (THE TOTALS ARE SLIGHTLY INFLATED AS SOME PROGRAMS SUPPORT MULTIPLE ENABLING TECHNOLOGIES)

In FY2019, the "(U) Unmanned Carrier Aviation (UCA) (MQ-25 Development)" leads all programs in funding with a request of $684 million (an increase of $460 million from FY2018). The MQ-25 will be designed to conduct aerial refueling and ISR missions for the Navy. Navy RDT&E will also support MQ-4C Triton UAS modernization efforts with upgrades including associated management, engineering and logistics activities as well as development of system payloads (approximately $220 million in FY2019).

The Air Force is requesting $196 million in FY2019 for RQ-4 Capability Enhancements with sub-projects such as MS-177 Sensor Integration, Ground Segment Modernization Program (GSMP), Capability Enhancements (such as ice protection solutions, cybersecurity, etc.), and others. The Air Force also has significant investments in programs including, but not limited to, Airborne Reconnaissance Systems (Dismount Detection RADAR), MQ-9 UAV (MQ-9 Upgrade), Aerospace Vehicle Technologies (Flight Controls and Pilot-Vehicle Interface), etc.

Interestingly, the Army program with the largest funding request in FY2019 is related to Counter-UAS (C-UAS) technologies. The program "Air Defense Command, Control and

Intelligence - Eng Dev (Counter Unmanned Aerial Systems (CUAS))" will develop, integrate, and test kinetic, or hard kill, defeat solutions into the Low-slow-small UAS Integrated Defeat System (LIDS) ($188 million in FY2019 - $69 million base, $119 million OCO). The "Robotics Development (Robotics Systems)" program has the next largest funding request with almost $93 million in FY2019. This program is focused on technologies that enable ground robot operations such as Tactical Wheeled Vehicle - Leader Follower (TWV-LF), Automated Convoy Operations (ACO), Dismounted Engineer Mobility System (DEMS), Route Clearance & Interrogation System (RCIS) Type II and Robotic Combat Vehicle - Robotic Wingman (RCV-RW).

Other than the three core military services, the OSD leads all other agencies for unmanned systems RDT&E funding in FY2019. The program "Advanced Innovative Technologies (Ghost Fleet)" ($188 million in FY2019) through the Strategic Capabilities Office (SCO) will develop and demonstrate fleet-integrated, operational prototype unmanned maritime vehicles to fill existing mission requirements for Combatant Commanders.

National Defense Authorization Act (NDAA) – Program Changes

The National Defense Authorization Act (NDAA)[6] is passed each year to specify the funding provided to the DoD. This legislation uses the President's Budget request as a baseline and then recommends funding changes as the congressional committees see fit. Both the House and Senate Armed Services Committees submitted versions of the NDAA. The final conference report[7] is a compromise of the House and Senate recommendations and was signed by President Trump on July 13, 2018.

The conference report from the U.S. House recommended changes to 15 programs related to unmanned systems. In the final NDAA signed by the President, six of these changes were accepted, five were accepted with alterations, and four were rejected. These programs are detailed in tables 1 and 2 below.

TABLE 1: PROGRAM CHANGES RECOMMENDED IN THE HOUSE NDAA THAT WERE ACCEPTED

Service	Title	Description	Program Change ($ million)
Air Force	RQ-4 Mods	One EQ-4 Battlefield Airborne Communications Node (BACN) aircraft which provides communications relay for the U.S. Air Force	+105
Army	MQ-1 UAV	MQ-1C Gray Eagle Service Life Extension Program	+60

[6] https://www.congress.gov/bill/115th-congress/house-bill/5515/text
[7] https://www.congress.gov/115/crpt/hrpt874/CRPT-115hrpt874.pdf

Navy	Undersea Warfare Applied Res	Academic partnerships for undersea unmanned warfare research and energy technology	+20
Air Force	Airborne Reconnaissance System	Gorgon Stare – a wide-area surveillance sensor system integrated on the MQ-9 Reaper UAV	+10
Navy	(U) Unmanned Carrier Aviation (UCA)	MQ-25 Development was decreased due to insufficient air vehicle budget	-116.9
Navy	Directed Energy and Electric Weapon System	Surface Navy Laser Weapon System (SNLWS) is an advanced 60kW+ class prototype Solid State Laser (SSL) weapon system to counter UAS-mounted sensors	-80.932
Air Force	MQ-9	Nine excess attrition aircraft were removed from FY2019 OCO for a decrease of $192.7 million and two aircraft were added to base funding for an increase of $42.8 million.	-74.04
Navy	MQ-4 TRITON	Unit and support cost growth	-23.95
Navy	Large Unmanned Undersea Vehicles	Excessive Snakehead LDUUV growth	-21.2
Navy	(U)Advanced Tactical Unmanned Aircraft System	Unjustified cost growth. This program supports the Marine Corps MUX Medium Altitude - Long Endurance (MALE) Group 5 UAV.	-14
Navy	Underwater EOD Programs	Insufficient transition strategy	-5.807

TABLE 2: PROGRAM CHANGES RECOMMENDED IN THE HOUSE NDAA THAT WERE REJECTED

Service	Title	Description	Program Change ($ million)
Air Force	Educational Partnership Agreements	For unmanned platforms	+5
Air Force	RQ-4 Post Production Charges	UNSPECIFIED	-37.3
Air Force	RQ-4 UAV	Unjustified request to fund infrastructure support	-9.8
Navy	(U)RQ-4 Modernization	UNSPECIFIED	-3

The conference report from the U.S. Senate version of the NDAA[8] was submitted on June 19, 2018. It recommended funding increases to 10 programs related to unmanned systems, which accounted for a total increase of $272 million. However, only half of these changes made it into the final version of the bill. Two programs saw decreases in funding: the LDUUV will receive $21.2 million less in FY2019 (this was also recommended by the U.S. House) and the Surface and shallow water mine countermeasure program will only be reduced by $2 million from the original request by the U.S. Navy after the Senate recommended a $26 million cut. These programs are detailed in tables 3 and 4 below.

TABLE 3: PROGRAM CHANGES RECOMMENDED IN THE SENATE NDAA THAT WERE ACCEPTED

Service	Title	Description	Program Change ($ million)
Air Force	MQ-9	Increase to accelerate Advanced Battle Management System (6 additional aircraft)	+120
Air Force	Demonstrator Laser Weapons System	Continued development of the demonstrator laser weapon system	+10
Defense-Wide	Operational energy capability improvement	Operational Energy Capability Improvement Fund (OECIF)	+5
Air Force	Aerospace propulsion and power technology	Technologies that lead to low-cost, high-performance turbofan engines	+9
Defense-Wide	Defense Logistics Agency generic logistics research and development technology demonstrations	Technology to advance supply chain capabilities	+1
Navy	Large unmanned undersea vehicles	Early to need based on prior year congressional funding reductions	-21.2
Navy	Surface and shallow water mine countermeasure	Barracuda Engineering Development Models ahead of PDR and CDR	-2

TABLE 4: PROGRAM CHANGES RECOMMENDED IN THE SENATE NDAA THAT WERE REJECTED

Service	Title	Description	Program Change ($ million)
Marine Corps	Medium-Altitude Long-Endurance Unmanned Aircraft System	Procurement of UAV	+100

[8] https://www.congress.gov/115/crpt/srpt262/CRPT-115srpt262.pdf

Air Force	Prototype Tanker	Prototyping a contested environment tanker (optionally unmanned)	**+10**
Navy	Innovative Naval prototypes—applied research	Directed energy, electronic warfare, and unmanned and autonomous systems	**+5**
Navy	Innovative Naval prototypes—advanced technology development	Directed energy, electronic warfare, and unmanned and autonomous systems	**+4.5**
Navy	Advanced combat systems technology	LOCUST, HCUS, and Innovative Naval Prototype Transition	**+2.5**

NDAA – Chairman and Committee Marks

The base bill language included in the NDAA consists of commentary on technology areas of interest. In this text, the committees and chairman provide recommendations or directives to address capability gaps and shortfalls that will contribute to the success of the DoD in executing its mission. Some of this text also provides reasoning for the changes that have been applied to the programs noted in the tables above. The technology areas that have been discussed in the NDAA are as follows:

- **Increased Programs (House Committee on Armed Services)**
  - **RQ-4 Global Hawk and EQ-4 battlefield airborne communications node aircraft:** The committee is concerned that, based on current mission support tasking of the EQ-4, the fleet could reach service-life limits more quickly than anticipated and thus create a capability gap. Therefore, the committee recommends the procurement of one additional EQ-4 aircraft and associated modifications.
  - **Academic partnerships for undersea unmanned warfare research:** The committee has expressed the importance of academic partnerships to advance maritime robotic technologies and has recommended an increase of $20 million for Undersea Warfare Applied Research.
  - **Academic partnerships for modeling, design, and analysis of unmanned air platforms:** The committee strongly supports the collaboration between the Air Force and academia to advance research and development of unmanned systems. Additionally, these partnerships will foster relationships with students and improve efforts by the Air Force to recruit a diverse and educated workforce. Therefore, the committee recommends an increase of $5 million for Educational Partnership Agreements for unmanned platforms.
  - **Wide-area motion imagery intelligence capability:** The committee notes the importance of wide-area motion imagery (WAMI) and beyond line-of sight (BLOS) capabilities for ISR. However, no funding was requested for these systems beyond FY2018, which will prevent necessary sensor system upgrades to satisfy validated

warfighter requirements. Therefore, the committee has recommended an increase of $10.8 million to address these upgrades.

- **Increased Programs (Senate Committee on Armed Services)**
  - **MQ-9:** The committee believes that more aircraft are required to prevent overtasking the MQ-9 fleet with the increased deployment of the Ground Moving Target Indicator (GMTI). Therefore, it is recommended that six additional aircraft be procured for a total of $120 million.
  - **USMC Medium-Altitude Long-Endurance Unmanned Aircraft System:** The committee is concerned that the currently deployed RQ-21A Blackjack UAS is lacking in certain performance capabilities. The committee also recognizes that the Marine Corps is also employing the MQ-9 Reaper UAS for operations in Afghanistan. Therefore, the committee recommends $100 million to fund the acquisition of a Group 5 Medium Altitude Long Endurance (MALE) UAS fleet.
  - **Demonstrator Laser Weapons System:** The committee believes a more robust testbed can be developed to further improve the efficacy of the electric Laser Weapon System to defeat adversarial UAS and cruise missiles. Therefore, an increase of $10 million is recommended to fund the continued development of this demonstrator.
  - **Prototype Tanker:** The committee is concerned by the growing threat to large high-value aircraft (especially tankers like the KC-135 and eventually the KC-46A) in contested environments and believes the option should be explored of operating these vehicles in an unmanned configuration. An increase of $10 million has been recommended to develop a prototype tanker.
  - **Operational energy capability improvement:** An increase of $10 million to the Operational Energy Capability Improvement Fund (OECIF) has been recommended by the committee to address urgent concerns including long endurance UAS.
  - **Aerospace propulsion and power technology:** Increased funding of $9 million has been recommended by the committee to advance low-cost, high-performance technologies for small turbines which can be integrated onto future aircraft, missiles, and remotely piloted aircraft.
  - **Innovative Naval prototypes—applied research:** The committee notes that cyber, directed energy, electromagnetic warfare, and autonomous systems are "leap ahead technologies in game-changing areas" and thus has recommended an increase of $5 million to fund these systems.
  - **Innovative Naval prototypes—advanced technology development:** A similar explanation was provided for this as the above "applied research" program. An increase of $4.5 million has been recommended to for directed energy, electronic warfare, and unmanned and autonomous systems.
  - **Advanced combat systems technology:** The committee has noted the importance of both the Low-Cost UAV Swarming Technology (LOCUST) program and the

Heterogeneous Collaborative Unmanned Systems (HCUS) demonstration and thus recommends an increase of $2.5 million to support these initiatives.

- **Defense Logistics Agency generic logistics research and development technology demonstrations:** The committee believes logistics on the battlefield are of critical importance and notes that development of innovative technologies such as autonomous vehicles, UAS, robots, etc. can significantly improve the efficiency of these operations, while also removing warfighters from danger. Accordingly, the committee has recommended an increase of $1 million to fund advancements in logistics defense-wide.

- **Decreased Programs (House Committee on Armed Services)**
  - **MQ-25 Unmanned Carrier Aviation program:** The committee believes the Navy has provided insufficient air vehicle justification regarding the Air Segment Primary Hardware Development and therefore has recommended a decrease of $116.9 million to procure one test article for the MQ-25 Unmanned Carrier Aviation program.
  - **Future sustainment of remotely piloted aircraft tactical intelligence and strike capabilities:** The committee is concerned that MQ-9A airframes reaching their service-life limit were categorized by the Air Force as "combat-loss attrition" to justify additional aircraft procurement using OCO resources, when past practice has been to categorize combat-loss attrition only as those aircraft that are destroyed or damaged beyond repair due to hostile engagement by adversaries or aircraft accidents. Therefore, the committee recommends a decrease of seven aircraft to minimize any waste of resources. The committee will also receive cost-benefit analysis from the Air Force to compare continued procurement of MQ-9A block 5 versus the MQ-9B which is still in prototype development.
  - **Marine Corps Group 5-class unmanned aircraft development:** The committee believes the Marine Corps has underestimated the necessary resources to train, operate, maintain and sustain the Group 5 UAS currently planned for development. The committee also believes other platforms across joint-service portfolios could potentially address the capability gaps identified in the original documentation from August 2016. Therefore, the committee recommends a decrease of $10.3 million to this program and has directed that two briefings be provided by February 5, 2019. These briefings will provide reasoning why other joint-service platforms would not address the Marine Corps capability requirements and detail an affordable acquisition and funding strategy.

- **Decreased Programs (Senate Committee on Armed Services)**
  - **Surface and shallow water mine countermeasures:** The committee has recommended a delay in funding for the Barracuda Engineering Development Models (EDMs) (which will be used by the Navy for mine neutralization) until a

Critical Design Review (CDR) drawing has been approved. The CDR is currently scheduled for FY2021 and, as such, the committee recommends a decrease of $26 million.

- **Large unmanned undersea vehicles:** The committee has recognized that $21.1 million of the $92.6 million to fund the LDUUV is "early-to-need" and therefore recommends this amount be decreased to $71.4 million in FY2019.

- **Counter-UAS Directives**
  - **Counter-Unmanned Aircraft System Authority for United States Facilities and Assets (House Committee on Armed Services)**: the DoD in conjunction with the Administrator and Federal Aviation Administration (FAA) is required to provide a semiannual briefing on how current C-UAS is being utilized and implemented. The briefing will address capability gaps and shortfalls for C-UAS technology as well as provide a list of all existing RDT&E locations within the DoD that are working with these types of systems.
  - **Counter small tactical unmanned air systems (House Committee on Armed Services):** The committee is concerned by the rapid proliferation of small UAS that can be deployed by state and non-state actors against U.S. military personnel. The committee perceives a capability gap in organic air defense for Army Maneuver Brigades. The committee directs the Secretary of the Defense to provide a briefing to the House Committee on Armed Services by December 15, 2018. The briefing will provide updates on programs capable of countering class I and II UAS.
  - **Counter-unmanned aerial system threat detection (House Committee on Armed Services):** The committee is concerned by the threat posed by UAS to forward operating bases and special operations forces personnel and believes scalable C-UAS technologies are necessary for effective detection and neutralization of threats. The committee directs the Secretary of Defense to provide a briefing to the House Committee on Armed Services by October 31, 2018, on the employment of C-UAS systems.
  - **Counter-Unmanned Aircraft Systems Technology (Senate Committee on Armed Services):** The committee is concerned by the rapid proliferation of UAS both domestically and in areas of international conflict that can be used with malign intent. Therefore, the committee believes it is of critical importance to develop a legal framework with respect to C-UAS domestically and notes the importance of collaboration across all government departments and agencies. The DoD should continue partnering with the Department of Transportation (DoT) and FAA to ensure the protection of U.S. and allied personnel, facilities, and interests from adversarial UAS.
  - **Maneuver Short Range Air Defense (MSHORAD) to counter Unmanned Aircraft Systems (Senate Committee on Armed Services):** The committee has requested a briefing from the Army regarding current solutions to counter low-flying, agile

small UAS and cruise missiles, as well as which requirements are similar between the MSHORAD and C-UAS mission areas.

- **Acoustic Threat Detection (Senate Committee on Armed Services):** The committee is concerned by the continued danger posed by UAS to forward operating bases and supports efforts to develop acoustic threat detection technologies for accurate geo-location of air and ground threats. Therefore, the committee directs a briefing be provided no later than 60 days after the enactment of the NDAA to discuss the current status of these solutions.
- **Report on capabilities and capacities of Armored Brigade Combat Teams (sec. 1045):** The committee directs the Army to submit a report on the capabilities of the Armored Brigades Combat Teams (ABCT). One area of interest noted by the committee is the current training conducted for C-UAS missions.

- **Program Directives (Briefings to the House Committee on Armed Services)**
  - **Unmanned aerial system units for Army National Guard:** The MQ-1C Gray Eagle UAS is not currently planned for fielding to the Army National Guard and the committee notes that the aircraft could be used for military support to civilian authorities in a wide range of missions. These missions include wildfire response, search and rescue, border security, counter-narcotics, and communications support during emergencies. The committee directs the Secretary of the Army to provide a briefing to the House Committee on Armed Services by March 1, 2019, on the potential utility, feasibility, and cost of establishing MQ-1C Gray Eagle units in the Army National Guard.
  - **MQ-4:** The committee supports the budgeted procurement of three MQ-4C UAS though concern was expressed regarding specifics on integration into the DoD's ISR Global Force Management Allocation Process (GFMAP) for airborne ISR aircraft. A briefing will be provided by October 15, 2018 to detail this integration process including the scheduling start date, the type of aircraft capability, and the capacity of intelligence discipline capability the MQ-4C will provide to the combatant commanders.
  - **Squad multipurpose equipment transport:** The committee supports a rapid start to fund SMET development and encourages the Army to determine ways to expedite acquisition of this capability. A briefing will be provided by November 30, 2018, that includes ways to expedite acquisition, evaluations from two brigade combat teams, an assessment of each variant's reliance on integrated subsystems (such as power, noise signature, attachments, etc.), and ensures key performance parameters.
  - **Briefing on Navy support for research into autonomous systems:** The committee recognizes the importance of research into autonomous systems and specifically notes the capability to operate unmanned air, ground and maritime autonomous systems simultaneously across domains. Therefore, the committee directs the

Director of ONR to brief the House Committee on Armed Services by November 1, 2018, on initiatives that enhance the ability of academia to conduct complex experiments with autonomous systems.

- **MISSILE DEFENSE PROGRAMS - Airborne Tracking and Targeting System:** The committee has directed the MDA to provide a brief by December 31, 2018 that details the addition of MQ-9 Reaper systems with advanced sensors to the ballistic missile defense system (both regional and homeland defense).
- **MQ-9 Enterprise Supporting Air Combat Command and Air Force Special Operations Command Activities:** The committee is concerned that a system to manage MQ-9 aircrews does not exist between Air Force Special Operations Command (AFSOC), Air Combat Command (ACC), and the Air Force Personnel Center. Therefore, the committee has directed a brief be provided by October 19, 2018 on how MQ-9 aircrews are assigned, managed, and developed among ACC and AFSOC.

- **Other Program Directives (House Committee on Armed Services)**
  - **National Guard Access to Department of Defense Owned Unmanned Aircraft Systems (**Item of Special Interest**):** The committee requires that a review be completed of DoD policy memorandum 15-002, “Guidance for the Domestic Use of Unmanned Aircraft Systems (UAS)" and then submit results to the congressional defense committees.
  - **Long-range naval carrier aviation:** The committee has noted the future requirement for enhanced carrier-based unmanned long-range strike capability beyond current plans and programs. The committee encourages the Navy to develop this technology in addition to current MQ-25A plans.
  - **Artificial intelligence and computer vision technologies in Navy unmanned systems:** The committee recognizes the importance of artificial intelligence, machine learning, and computer vision in exploitation and analysis for the Navy. The committee also notes the increasing amount of sensor data produced by unmanned undersea and surface vehicles. Therefore, the committee recommends integrating efforts with OSD’s Project Maven which is developing similar data exploitation systems for unmanned aircraft. For more details on this program see Table 43 in the Program Details section below.
  - **Aerospace composite structures manufacturing:** The committee strongly supports efforts to reduce production cost and enable future Air Force unmanned systems requirements to be achieved at an affordable cost. No change to funding has been recommended.

- **Other Program Directives (Senate Committee on Armed Services)**
  - **DARPA Gremlins Air-Recoverable Unmanned Aerial Vehicle System:** The DARPA Gremlins project seeks to develop a low-cost, reusable UAS that can be air-

launched and air-recovered to counter anti-access area denial (A2/AD) threats. The committee recommends that the Air Force monitor the status of this project and collaborate with DARPA on a strategy to transition this technology into Air Force programs.

- **Light emitting diodes for aviation applications:** The committee notes current development of LEDs by the Services and DLA and recommends that requirements be established for current aviation developments and acquisitions such as UAS.
- **Next Generation Combat Vehicle (sec. 233):** The committee directs the Army to submit a report on the Next Generation Combat Vehicle (NGCV). One of the key capabilities that has been noted as a requirement is the ability for the NGCV to control unmanned vehicles (also referred to as manned-unmanned teaming).
- **Comptroller General report on monitoring ongoing challenges in remotely piloted aircraft community:** The committee has expressed its continued commitment to pilots and operators in the remotely piloted aircraft (RPA) community. Therefore, the committee directs a report be provided by the Air Force regarding current efforts that improve retention and quality of life for these individuals and their families.

- **Section 220—Modification of CVN-73 to Support Fielding of MQ-25 Unmanned Aerial Vehicle (House Committee on Armed Services):** This section would require the Navy to fund the modification of CVN-73 during its refueling and overhaul period in support of future MQ-25 unmanned carrier aircraft operations.

- **Section 1045—Limitation on Availability of Funds for Unmanned Surface Vehicles (House Committee on Armed Services):** This section would limit the availability of funds in FY2019 for the OSD Ghost Fleet Overlord Unmanned Surface Vehicle program. The committee requires that the project accelerates future Navy USV development; the Commander of the Naval Sea Systems Command be designated as the contracting officer for such project; and ensures that the project is not duplicative of the Navy Sea Hunter USV program.

- **Littoral Combat Ship mission modules (Senate Committee on Armed Services):** Funds have been transferred from three programs and re-aligned under the LCS Mission Modules program: $7.6 million from PE 64127N (surface mine countermeasures), $10.1 million from PE 64126N (littoral airborne mine countermeasures), and $16.7 million from PE 64028N (small and medium unmanned undersea vehicles).

Program Details

The goal of this report is to capture all programs in the 2019 President's Budget that support unmanned systems and associated technologies. In this section, programs that have

contributed to the totals in this report will be detailed (these graphs do not reflect the changes in the final NDAA signed by President Trump).

Each budget document in the DoD was scanned for relevant programs and, when funding was recorded, a weighted value was assigned based on the degree of relevance. As an example, reference the first figure provided below. Program 0605414N – (U) Unmanned Carrier Aviation (UCA) (MQ-25 Development) – is entirely related to unmanned systems and thus 100 percent of the funding is included in the FY2017 to FY2023 totals. However, for Program 2867 – JPALS procurement (which supports technology for ship-based landing of manned and future unmanned systems) – only a small percentage of the total funding has been included as the MQ-25 is not currently in operation with the Navy. In some cases, only a portion of a program is related to unmanned systems and only the relevant project or even sub-project has been captured. For sub-projects, the funding in the budget documents is only provided for FY2017-FY2019. These sub-projects have been marked with an asterisk (*) at the end of their title when included in graphs of funding for the full FY2017-FY2023 range.

Programs in this section have been grouped based on the technology being focused. Programs that fund multiple technologies have been grouped based on the area that seems to be the strongest focus. No programs have been duplicated in the below figures.

MQ-25 Stingray UAS (and other programs that specifically note the MQ-25)

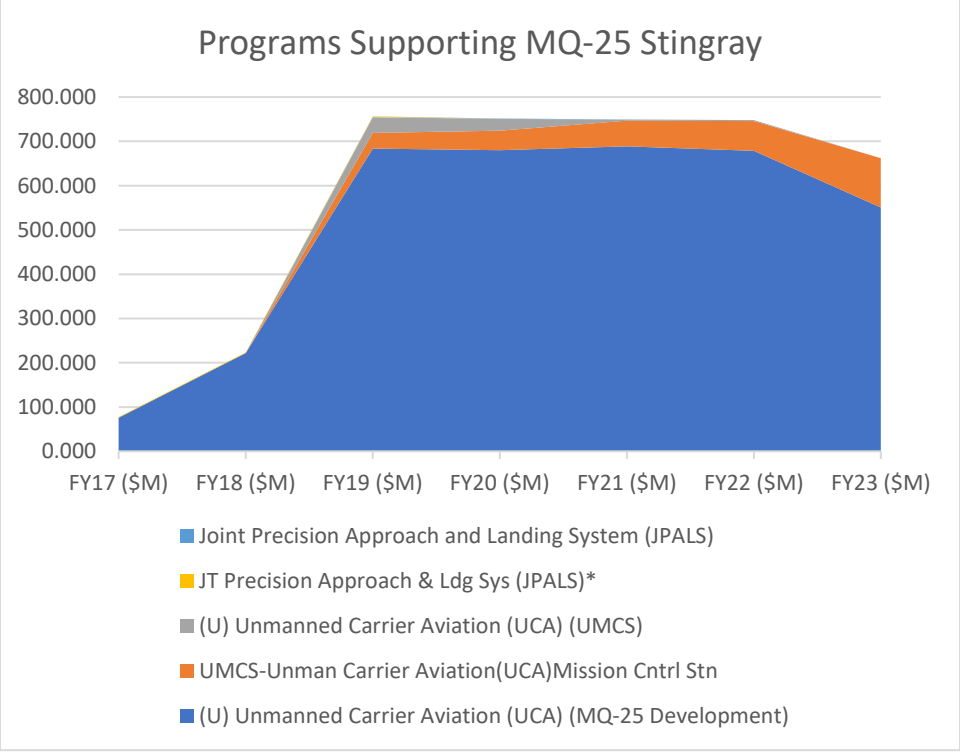


FIGURE 13: PROGRAMS SUPPORTING MQ-25 STINGRAY UAS

TABLE 5: LISTING OF PROGRAMS SUPPORTING MQ-25 STINGRAY UAS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0605414N	RDT&E	(U) Unmanned Carrier Aviation (UCA) (MQ-25 Development)	MQ-25 will be designed to conduct aerial refueling and ISR missions
US Navy	4269	Procurement	UMCS-Unman Carrier Aviation(UCA) Mission Cntrl Stn	MQ-25 vehicle and mission control
US Navy	0605414N	RDT&E	(U) Unmanned Carrier Aviation (UCA) (UMCS)	Unmanned Carrier Aviation (UCA) Mission Control System (UMCS) (MD-5 control station for MQ-25 and C4I/CVN infrastructure for mission control / ARC-210 Radio Control System for command and control / changes to JPALS software for launch and recovery)
US Navy	0603860N	RDT&E	JT Precision Approach & Ldg Sys (JPALS)*	Development of precision approach and auto-land capabilities on aircraft carriers. These efforts support the F-35B/C, MQ-25A, and future air platforms. In FY19: Provide MQ-25 support to including JPALS algorithm integration support to Aircraft OEM, validation and verification activities supporting the aircraft software development, supporting development of the Patuxent River MQ-25 Systems Integration Lab, and preparation for future testing.
US Navy	2867	Procurement	Joint Precision Approach and Landing System (JPALS)	Technology for ship-based landings for manned aircraft and future unmanned systems

MQ-4C Triton UAS (and other programs that specifically note the MQ-4C)

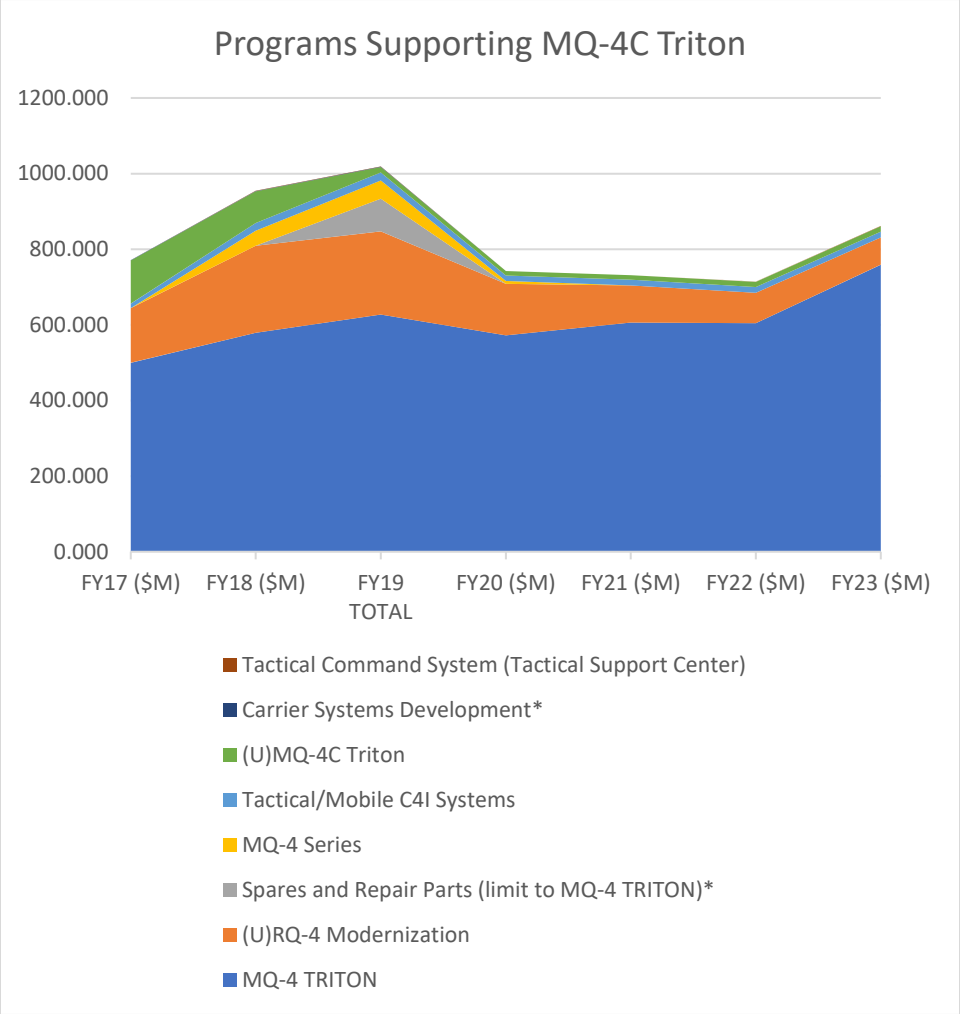


FIGURE 14: PROGRAMS SUPPORTING MQ-4C TRITON UAS

TABLE 6: LISTING OF PROGRAMS SUPPORTING MQ-4C TRITON UAS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0442	Procurement	MQ-4 TRITON	MQ-4C Triton UAS (3 in FY19 @ $67,729,330 ea)
US Navy	0305421N	RDT&E	(U)RQ-4 Modernization	MQ-4C Triton modernization efforts: upgrades including associated management, engineering and logistics activities; development of system payloads. FY19: Sense and Avoid radar development, AMP development and integration of development assets for capability upgrades including electro-optical/infra-red, SIGINT High Band and SIGINT Low Band systems
US Navy	0605	Procurement	Spares and Repair Parts (MQ-4 TRITON)*	Spares and repairs for MQ-4C Triton
US Navy	0596	Procurement	MQ-4 Series	MQ-4C Triton UAS

US Navy	2906	Procurement	Tactical/Mobile C4I Systems	Supports MQ-4C Triton UAS and P-8A manned aircraft (command, control, networking, communications systems)
US Navy	0305220N	RDT&E	(U)MQ-4C Triton	The MQ-4C Triton acquisition approach supports the Navy's Maritime Intelligence, Surveillance, Reconnaissance, and Targeting (MISR&T) Transition Plan by providing a stable and effective baseline early operational capability in FY18 to facilitate Fleet introduction and learning while continuing System Development and Demonstration engineering and integrated test on Signals Intelligence (SIGINT) and other upgrades to deliver a Multi-INT configuration at Initial Operational Capability (IOC). Phased capability upgrades will continue post IOC to enable the MQ-4C Triton to keep pace with rapidly evolving technologies and threats, and address correction of deficiencies and obsolescence issues to ensure the Navy maintains persistent Intelligence, Surveillance and Reconnaissance dominance through the system's lifecycle. Performance Metrics: Successfully achieve Integrated Test, Operational Evaluation and Early Operational Capability.
US Navy	0603512N	RDT&E	Carrier Systems Development*	AN/SQQ-34 Aircraft Carrier Tactical Support Center integrates data from a range of aircraft and other sensors for ASW and SUW (support for MQ-4C Triton)
US Navy	0604231N	RDT&E	Tactical Command System (Tactical Support Center)	TacMobile is a long-running, multi-year acquisition program which provides Command, Control, Communications, Computers, and Intelligence (C4I) for Navy's Maritime Patrol and Reconnaissance Force (MPRF). FY19 supports a tech refresh to maintain interoperability with P-8A Poseidon and the MQ-4C Triton (Global broadcast System (GBS), Super High Frequency (SHF) and Tactical Data Links (TADIL).

MQ-9 Reaper UAS (and other programs that specifically note the MQ-9)

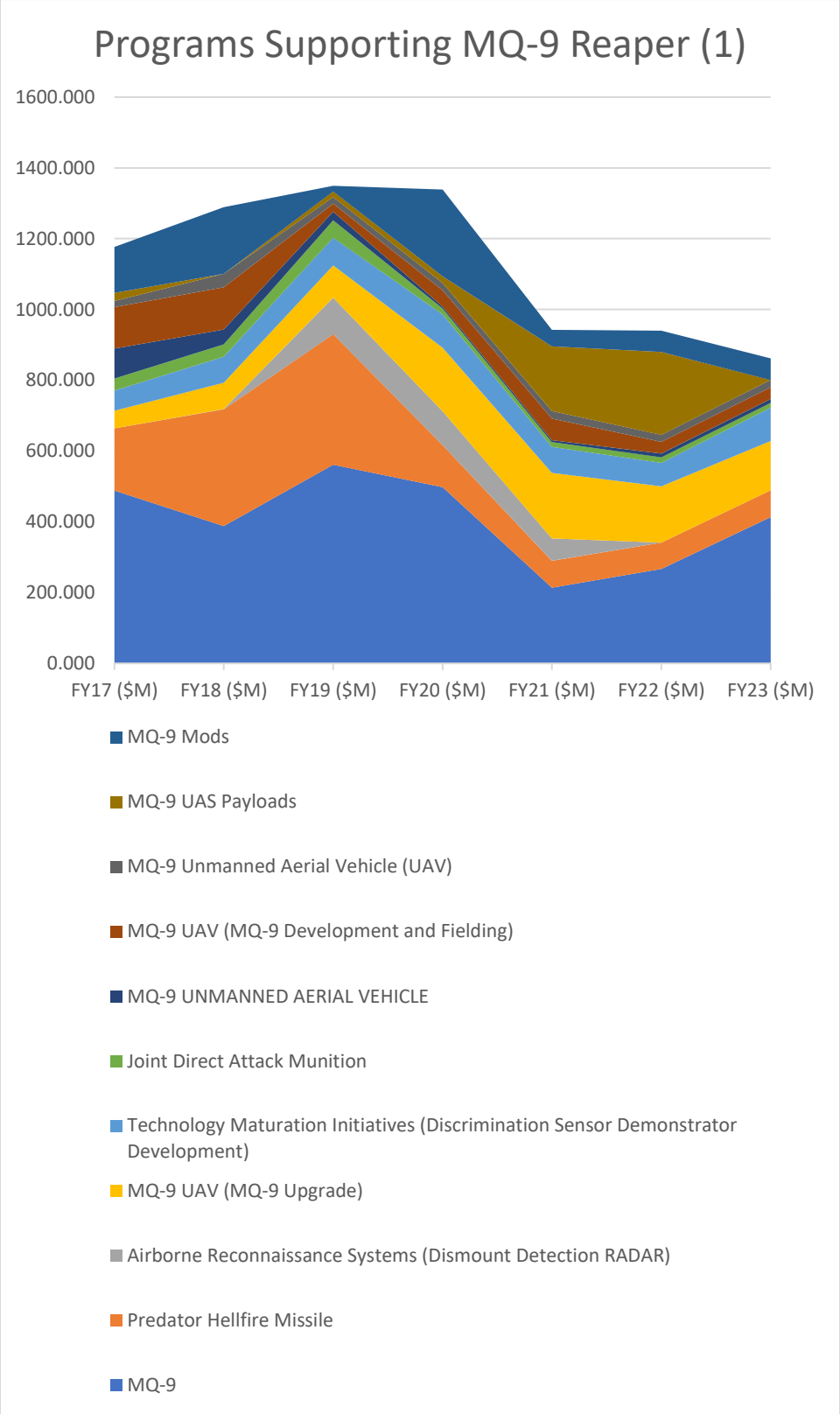


FIGURE 15: PROGRAMS SUPPORTING MQ-9 REAPER UAS

TABLE 7: LISTING OF PROGRAMS SUPPORTING MQ-9 REAPER UAS

Organization	PE Number	Funding Type	Title	Notes
USAF	PRDTB1	Procurement	MQ-9	MQ-9 Reaper UAV (8 in FY19 base, 21 in FY19 OCO @ $14,808,000 per system)
USAF	PRDTA2	Procurement	Predator Hellfire Missile	Hellfire missiles used by the MQ-9 Reaper and MQ-1 Predator
USAF	0305206F	RDT&E	Airborne Reconnaissance Systems (Dismount Detection RADAR)	Detection Radar (DR): Design, develop, integrate, test, field, and sustain a persistent Moving Target Indicator (MTI) capability in theater for employment on airborne platforms and various technical studies/analysis to support future advanced radar development. This sensor will be employed on airborne platforms, such as the MQ-9 Reaper.
USAF	0205219F	RDT&E	MQ-9 UAV (MQ-9 Upgrade)	MQ-9 Upgrade ($66.595M FY18, $78.371M FY19): FY 2018 Plans: Will continue Tech Maturation effort (TME) developing upgrade capabilities in conjunction with the CCL to include, but not limited to: • Auto takeoff and landing (ATLC) capabilities with agile ground operations (i.e. XC2 and PDGT) • Technology/reliability upgrades such as AoA vane, radios, batteries and operating systems • Improvements to weapons capabilities (i.e. auto-lockout, JAGM, LSDB/UAI) • Updated GCS components for usability, security, and performance (i.e. monitors, controllers) • MTS and SAR improvements for targeting, exploitation, and supportability (i.e. video SAR, improved diagnostics) • Expand theater capabilities (i.e. anti-ice/de-ice) • Studies and analysis, simulations, demonstrations, system corrections, training, and testing • Open Architecture Mission Control Module (OA MCM) FY 2019 Base Plans: Will continue Tech Maturation effort (TME) developing upgrade capabilities in conjunction with the CCL to include, but not limited to: • Unified Tactical Situational Awareness • Automated Dependent Surveillance - Broadcast (ADS-B) Dismount Radar (DR) to design, development, integration, and testing of Moving Target Indicator (MDI) capability on medium altitude air vehicles for improved dismount and moving target detection, identification, tracking, and classification. MQ-9 Upgrade - Operator Simulator ($2.5M FY18, $6.928M FY19): FY 2018 Plans: Implementation of updates which will keep the operator simulator current with the aircraft and GCS, including, but not limited to: • Sensors • Databases • Weapons upgrades • software FY 2019 Base Plans: Continuing to implement updates which will keep the operator simulator current with the aircraft and GCS. MQ-9 Upgrade - Communications ($2.318M FY18, $0.176M FY19): MQ-9 Upgrade communications capabilities development will continue.
MDA	0604115C	RDT&E	Technology Maturation Initiatives (Discrimination Sensor Demonstrator Development)	Discrimination Sensor Demonstrator Development: This project includes advanced sensor integration into a high altitude airborne platform, a MDA Configured MQ-9 aircraft, and testing in operationally relevant environments. The MDA Configured MQ-9 aircraft equipped with an advanced sensor provides the MDA a viable quick reaction capability to augment BMDS radar. In FY18, Complete build and begin integration of a flight qualified laser system onto a MQ-9 aircraft. In FY19, Complete integration of flight qualified advanced sensor

				system components onto a MQ-9 aircraft; Conduct first flight test of the advanced sensor system on a MQ-9 aircraft.
USAF	353620	Procurement	Joint Direct Attack Munition	Munition that is currently used on manned aircraft - integration with MQ-9 Reaper in progress
SOCOM	1108MQ9	Procurement	MQ-9 UNMANNED AERIAL VEHICLE	MQ-9 Reaper UAV
USAF	0205219F	RDT&E	MQ-9 UAV (MQ-9 Development and Fielding)	MQ-9 System Development and Demonstration (SDD) (~4M FY18): in FY18 Will continue general research, engineering change orders and associated studies, this may include, but not limited to KU-BAND PPDL Line Of Sight Modification Characterization Testing, SATCOM and Predator Primary Data Link (PPDL), both Line Of Sight (LOS) and Beyond Line of Sight (BLOS), and upgrade and/or improvements. Ground Control Station (GCS) Development ($13.526M FY18, $9.311M FY19, Funding reduced in FY19 due to higher USAF priorities). MQ-9 MTS-B Electro-Optic/Infrared (EO/IR) Sensor ($3.365M FY18). Operator Simulator (~4M in FY18/FY19): Will continue to implement updates which will keep the Operator Simulator current with the aircraft and GCS, including, but not limited to: Sensors; Databases; Weapons upgrades; Resolution of DMS issues. Title: Release 1 and Release 2 ($80.186M FY18, $5.605M FY19): Continue developing and integrating the software and data to update the MQ-9 Block 5 UAS capabilities (Tech maturation efforts will continue at a reduced level as efforts under the MQ-9 Upgrade program (project 675249) ramp up). Communications ($0.073M new start in FY19): Begin to develop and enhance MQ-9 communications capabilities, to include but not limited to, solutions of various diminishing manufacturing sources (DMS) issues.
SOCOM	1105219BB	RDT&E	MQ-9 Unmanned Aerial Vehicle (UAV)	FY 2019 Plans: Develops, tests, and integrates SOF-peculiar emerging technology mission kits, mission payloads, weapons and modifications on MQ-9 UAVs, GCSs, and training systems. FY 2018 to FY 2019 Increase/Decrease Statement: Decrease of $19.304 million due to the MQ-9 program receiving FY 2018 funding to develop Automatic Takeoff & Landing and Global Positioning System Hardening technologies.
USAF	PRDTB3	Procurement	MQ-9 UAS Payloads	Payloads for MQ-9 Reaper
USAF	PRDTB2	Procurement	MQ-9 Mods	Upgrades to MQ-9 Reaper

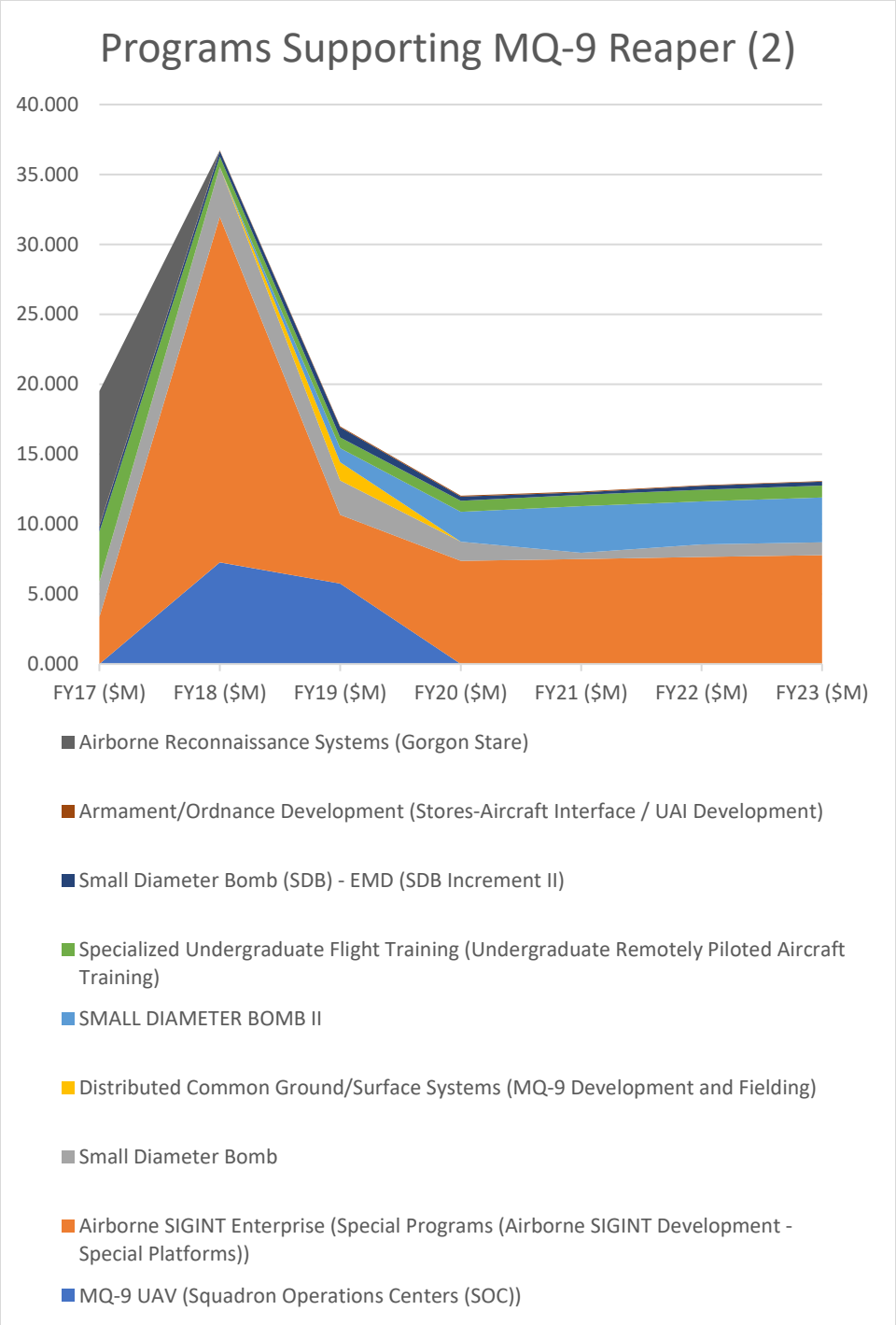


FIGURE 16: PROGRAMS SUPPORTING MQ-9 REAPER UAS

TABLE 8: LISTING OF PROGRAMS SUPPORTING MQ-9 REAPER UAS

Organization	PE Number	Funding Type	Title	Notes
USAF	0205219F	RDT&E	MQ-9 UAV (Squadron Operations Centers (SOC))	Squadron Operations Center (SOC): provides the communications, network, aircraft control and sensor

				distribution circuits to effectively execute Remote Split Operations (RSO) missions. In FY19, Complete design review, development, and delivery of Systems Integration Lab (SIL) to integrate capabilities into RPA SOC; Integration of emerging technologies into the SOC baseline
USAF	0304260F	RDT&E	Airborne SIGINT Enterprise (Special Programs (Airborne SIGINT Development - Special Platforms))	SIGINT Development: Develop, update, and test SIGINT capabilities for QRC and normalized special programs SIGINT projects. In FY19, Will continue to modernize SIGINT systems used by the MQ-1B/9A RPA. The funding decreases of FY19 reflects decreasing quick reaction capability upgrade requirements, consistent with pre-FY18 levels.
USAF	SDB000	Procurement	Small Diameter Bomb	Bomb that is used by manned aircraft with objective aircraft including the MQ-9 Reaper UAV
USAF	0305208F	RDT&E	Distributed Common Ground/Surface Systems (MQ-9 Development and Fielding)	**Error - should be new start PE 0305829F,"Video Data Link" (Major funding for MQ-9 Development and Fielding can be found in PB12). Video Data Link (VDL) Family of Systems (FoS) provides situational awareness (SA) to the operator on the ground using real time Full Motion Video (FMV) from secure line of sight links to airborne ISR, NTISR, PR and SF platforms.
USAF	SDB002	Procurement	SMALL DIAMETER BOMB II	Bomb that is used by manned aircraft with objective aircraft including the MQ-9 Reaper UAV
USAF	0604233F	RDT&E	Specialized Undergraduate Flight Training (Undergraduate Remotely Piloted Aircraft Training)	Predator Reaper Integrated Mission Environment (PRIME) support: in FY19, Continue to extend and enhance interoperability between PRIME and Modern Air Combat Environment (MACE) software incorporated in Phase 7 for instructor operations and entity generation. Add additional instrumentation functionality. Add multiple emergency missions. Add additional entity functionality. Phase 8 planning that was originally planned to occur has been pushed out awaiting completion of Phase 7.
USAF	0604329F	RDT&E	Small Diameter Bomb (SDB) - EMD (SDB Increment II)	Bomb that is used by manned aircraft with objective aircraft including the MQ-9 Reaper UAV
USAF	0604602F	RDT&E	Armament/Ordnance Development (Stores-Aircraft Interface / UAI Development)	Universal Armament Interface (UAI). UAI is an Air Force initiative to develop standardized software interfaces in aircraft weapons and Mission Planning. UAI standardizes software interfaces to support integration of weapons independent of aircraft Operational Flight Programs (OFP) cycles. UAI is currently implemented on a range of manned aircraft with additional aircraft having plans to implement UAI (such as MQ-9 and Army/Navy UAVs)
USAF	0305206F	RDT&E	Airborne Reconnaissance Systems (Gorgon Stare)	Wide-Area Motion Imagery: FY 2017 Accomplishments: Initiated integration of Processing, Exploitation, and Dissemination (PED) algorithms for analysts; Continued fielding of limited BLOS capability. FY 2018 Plans: First Article fielding of a limited BLOS capability and furthering integration of PED algorithms for analysts.

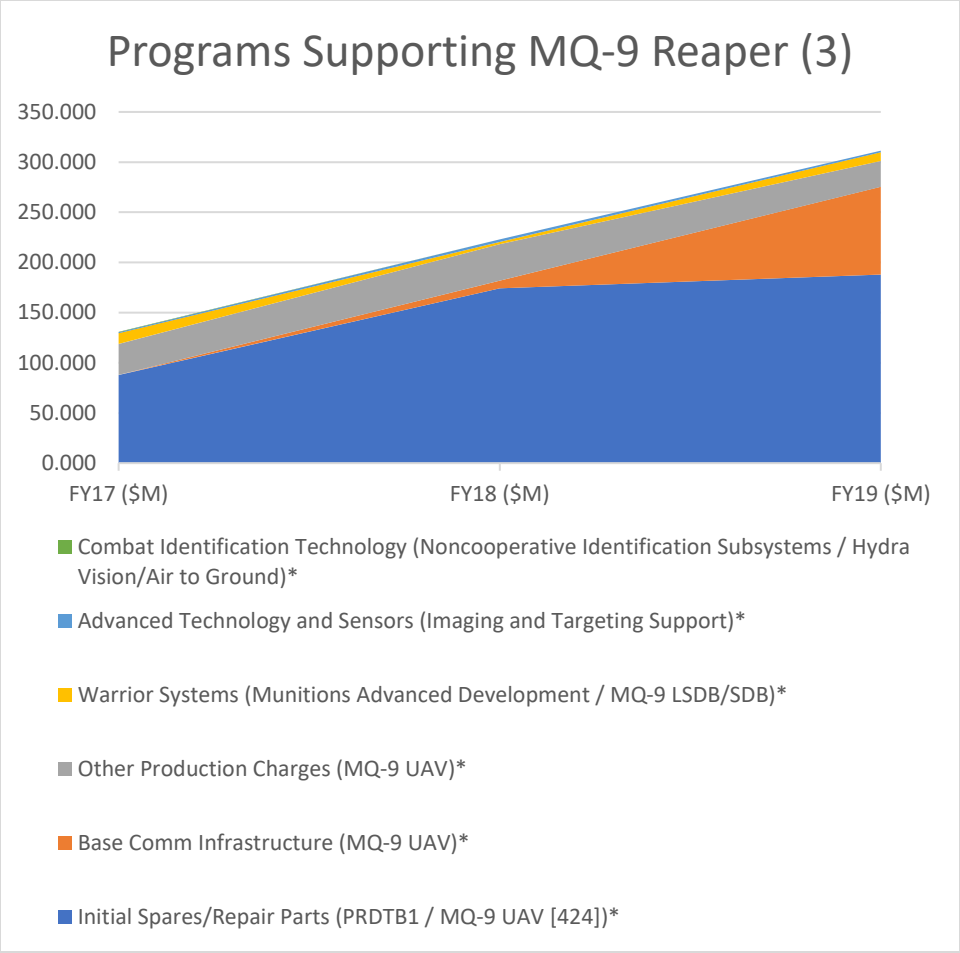


FIGURE 17: PROGRAMS SUPPORTING MQ-9 REAPER UAS

TABLE 9: LISTING OF PROGRAMS SUPPORTING MQ-9 REAPER UAS

Organization	PE Number	Funding Type	Title	Notes
USAF	000999	Procurement	Initial Spares/Repair Parts (PRDTB1 / MQ-9 UAV [424])*	Spares and repairs for MQ-9 Reaper
USAF	837300	Procurement	Base Comm Infrastructure (MQ-9 UAV)*	Communication infrastructure for MQ-9 Reaper UAV (FY19 for Remote Split Operations)
USAF	000075	Procurement	Other Production Charges (MQ-9 UAV)*	Other production charges related to MQ-9 Reaper UAV
SOCOM	1160431BB	RDT&E	Warrior Systems (Munitions Advanced Development / MQ-9 LSDB/SDB)*	MQ-9 Laser Small Diameter Bomb (LSDB) / Small Diameter Bomb (SDB) II: Weapon Mount Hardware/Software Development; Universal Armament Interface Software Development (FY17/FY18). Integration & Test (FY19). Integration & Test Overseas Contingency Operations (OCO) (FY19 OCO).

USAF	0604257F	RDT&E	Advanced Technology and Sensors (Imaging and Targeting Support)*	Imaging & Targeting Support (I&TS): Efforts include Full Spectrum HIS MQ-9 Pod; CERBERUS (Full Spectrum HSI in AgilePod (MQ-9)) (FY18/FY19) FY 2019 funding decreased due to a return to normal funding as well as the transfer of DRACO and SOSA to Program 0305206, Project 674818.
USAF	0603742F	RDT&E	Combat Identification Technology (Noncooperative Identification Subsystems / Hydra Vision/Air to Ground)*	Hydra Vision/Air to Ground (AGHV): a family of balanced (robust) amalgamation of sensor data from multiple sources to provide warfighters with higher confidence CID results on surface or air targets.; in FY18 Complete actions associated with AGHV Operational Demo with MQ-9 Reaper

RQ-4 Global Hawk UAS (and other programs that specifically note the RQ-4)

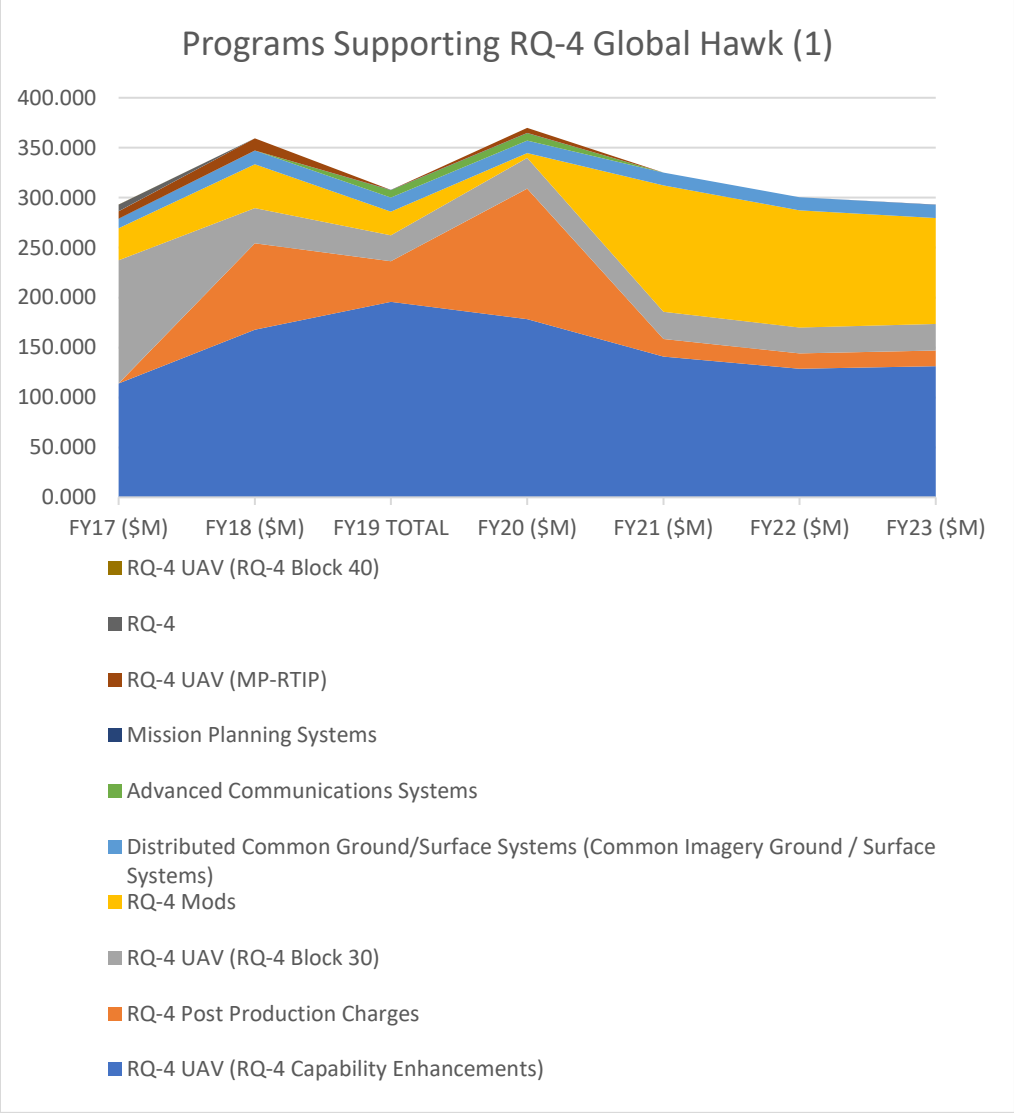


FIGURE 18: PROGRAMS SUPPORTING RQ-4 GLOBAL HAWK UAS

TABLE 10: LISTING OF PROGRAMS SUPPORTING RQ-4 GLOBAL HAWK UAS

Organization	PE Number	Funding Type	Title	Notes
USAF	0305220F	RDT&E	RQ-4 UAV (RQ-4 Capability Enhancements)	RQ-4 Capability Enhancements ($90.135M FY18, $13.546M FY19): in FY19, Will conduct risk reduction and analysis of ice protection solutions, continued system interoperability and upgrades, cybersecurity and information assurance and reliability & maintainability, and associated testing; Will conduct Communication System Modernization Program (CSMP) pre-contract activities and establish as a formal program; Will Continue government test and non-prime engineering and technical support and OGC. Integrated Functional Capability 9 (IFC 9) ($55.345M FY19): IFCs are periodic hardware and software capability, releases similar to an Operational Flight Program (OFP). IFC 9 provides (Optical Bar Camera (OBC), Nose Wheel Steering enhancement, in flight Waypoint Modification as well as numerous software enhancement and deficiency resolutions, and Other Government Costs (OGC) (Funding in FY19 increased because it was previously included in the RQ-4 Capability Enhancements Accomplishment/Planned Program). RQ-4 Ground Segment Modernization Program (GSMP) ($66.61 FY18, $37.55M FY19): GSMP resolves fleet grounding DMS and obsolescence issues associated with ground segment equipment and provides critical warfighter capabilities such as building-based multi-aircraft control. It will also enhance interoperability data dissemination as well as provide training capability. RQ-4 MS-177 Sensor Integration ($11M FY18, $39.732M FY19): in FY19, Will continue the integration, and testing of MS-177 on Block 30, including additional spectral bands; Will conduct MS-177 OT and attain Initial Operational Capability (IOC); Will continue development of MS-177A (10-Band) and integration; Will begin DT of MS-177A. RQ-4 Infrastructure ($49.566M FY19): RQ-4 Infrastructure includes system engineering, program management, test and evaluation, and fielding support for all RQ-4 projects as well as periodic Operational Flight Program (OFP) updates and releases, development testing, and Other Government Costs (OGC). This funding was previously included in the RQ-4 Capability Enhancements Accomplishment/Planned Program.
USAF	RQ4DIS	Procurement	RQ-4 Post Production Charges	RQ-4 Global Hawk sensors and costs relating to shut down of production line
USAF	0305220F	RDT&E	RQ-4 UAV (RQ-4 Block 30)	RQ-4 Block 30 Development and Demonstration ($24.98M FY18, $10.795M FY19): Continue upgrades to ASIP SIGINT and EISS sensors (FY18/FY19); Continue airspace integration activities including IFF Mode 5/ADS-B, comm interoperability and upgrades, cybersecurity and information assurance and reliability & maintainability, and associated testing (FY18/FY19); Will conduct Battlefield Airborne Communication Node enhanced weather capability testing (FY19). RQ-4 MS-177 Sensor Integration ($36.182M FY17 only): Integration of MS-177 multispectral sensor into Block 30. RQ-4 Infrastructure ($14.733M FY19): includes systems engineering, program management, test and evaluation, and fielding support for all RQ-4 projects as well as periodic Operational Flight Program updates and releases, studies, development testing, and Other

				Government Costs (OGC). This funding was previously included in the RQ-4 Block 30 Development and Demonstration and Block 30 Government Test and Non-Prime Support Accomplishments/Planned Programs. Block 30 Government Test and Non-Prime Support (~20M FY17, ~10M FY18, $0.422M FY19)
USAF	HAWK00	Procurement	RQ-4 Mods	Continuous mods to RQ-4 Global Hawk (major upgrades include ice protection system, IP-based communication system & ASIP Inc II encryptor system which expands COMINT/ELINT frequency range FY21-23)
USAF	0305208F	RDT&E	Distributed Common Ground/Surface Systems (Common Imagery Ground / Surface Systems)	GEOINT Transformation ($3.5 FY19 OCO): The GEOINT Transformation effort rapidly integrates new capabilities and migrates GEOINT-specific applications and capabilities into the open architecture framework. Furthermore, GEOINT Transformation provides continuous and incremental improvement to the capability for planning and direction, collection, processing and exploitation, analysis and production, and dissemination (PCPAD) of advanced imagery intelligence. GEOINT Transformation builds upon GB4.1 to integrate new sensors, provide enhanced processing techniques, and provide imagery analysts the advanced capability to exploit, analyze, produce, and disseminate imagery. The GEOINT Baseline 4.1 (GB4.1) effort completes the Bulk Release process and provides a common baseline across the weapon system. It also integrates Airborne Cuing and Exploitation System, Hyper Spectral ACES-HY (MQ-1) and Global Hawk (GH) Block 40 capability into AF DCGS. SIGINT Transformation ($9.442 FY18, $11.386M FY19): The Signal Intelligence (SIGINT) Transformation effort rapidly integrates new capabilities, leverages mission partner methods and tools, improves data exchange, and migrates the SIGINT-specific applications/capabilities into the open architecture framework. The SIGINT Segment provides command and control (C2) of ISR sensors, data processing, and data distribution to the customers in near real time from connected sensors at both core and remote sites. Sensor Integration ($6.58M FY19): in FY19, Begin integration of RQ-4 Global Hawk Block 40 sensor modification processing, exploitation, and dissemination capabilities into OA DCGS. Multi-INT Transformation ($0.884M FY18, $5.413M FY19): in FY19, Will begin efforts to replace existing legacy communications within the weapon system with the Enterprise Communications Capability (ECC) project and to integrate Real-time analytics into the intel analysts' suite of exploitation tools. Network Infrastructure Transformation ($17.175M FY18, $1.175M FY19): The Network Infrastructure Transformation effort modernizes the AF DCGS infrastructure to improve data ingest, transfer, and storage capabilities while migrating the network toward a cloud architecture. A primary task is to replace the Asynchronous Transfer Mode (ATM) capability with a non-ATM based Transport Architecture. In FY18/FY19, Continue modernizing the AF DCGS infrastructure to improve data ingest, transfer, and storage capabilities while migrating the network toward an open architecture; Continue integration and deployment activities for the AF DCGS Transport Architecture. In FY19, Weapon System Trainer effort will incrementally add to the DWST intelligence discipline enterprise level and world-wide positional and team/crew virtual training capabilities. Funding

				decreased due to completion of the RDT&E phase of the Network Enterprise Transformation effort.
USAF	0207423F	RDT&E	Advanced Communications Systems	Protected Tactical Waveform (PTW) is a waveform designed to mitigate the effects of advanced jamming in Anti-Access/Area Denial environments. In FY19 Continue PTW modem development and aperture development on suitable platforms like (but not limited to) RQ-4 Global Hawk and EQ-4B/E-11A Battlefield Airborne Communications Node (BACN).
USAF	833170	Procurement	Mission Planning Systems	Mission planning software and hardware for a range of aircraft including the RQ-4 Global Hawk UAV
USAF	0305220F	RDT&E	RQ-4 UAV (MP-RTIP)	Multi-Platform Radar Tech Insertion Program (MP-RTIP) ($11.935M FY18): in FY18, Will complete transition of core capability development; Will begin development to integrate Radar Software Development (RSD) 1.5 software build into the RQ-4 Block 40 Program. (SDD contract close-out begins 1QFY20 ending 4QFY20).
USAF	HAEUAV	Procurement	RQ-4	RQ-4 Global Hawk UAV (procurement completed in 2017)
USAF	0305220F	RDT&E	RQ-4 UAV (RQ-4 Block 40)	In FY 2019, RQ-4 Block 40 efforts were transferred to RQ-4 Capability Enhancements in order to allow greater visibility into Global Hawk modernization efforts.

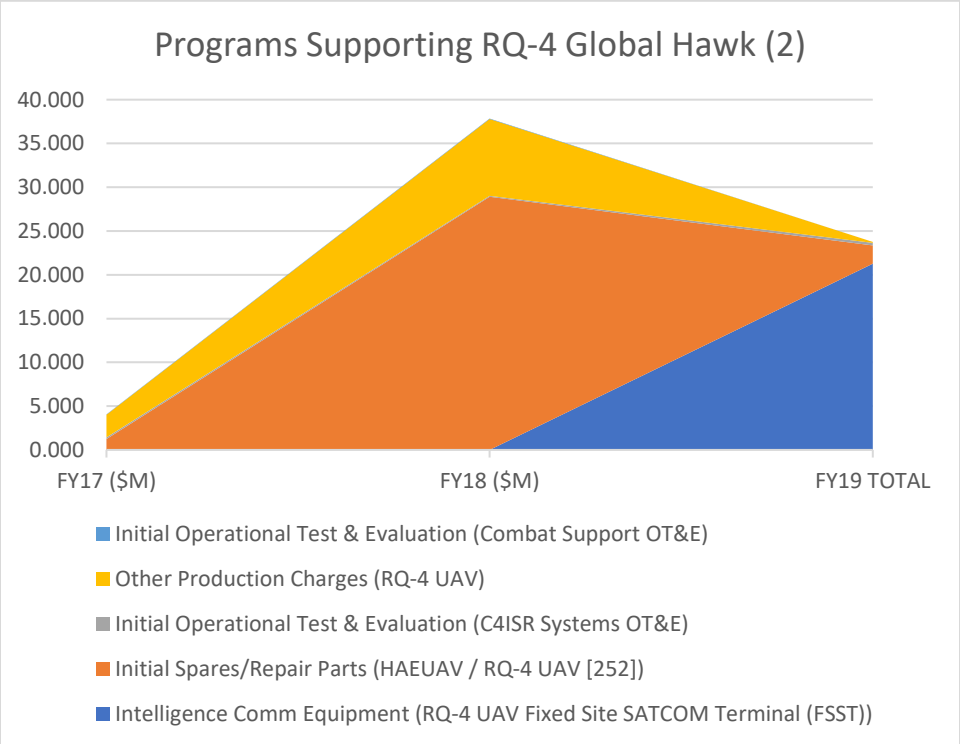


FIGURE 19: PROGRAMS SUPPORTING RQ-4 GLOBAL HAWK UAS

TABLE 11: LISTING OF PROGRAMS SUPPORTING RQ-4 GLOBAL HAWK UAS

Organization	PE Number	Funding Type	Title	Notes

USAF	832070	Procurement	Intelligence Comm Equipment (RQ-4 UAV Fixed Site SATCOM Terminal (FSST))	SATCOM terminal for RQ-4 Global Hawk UAV
USAF	000999	Procurement	Initial Spares/Repair Parts (HAEUAV / RQ-4 UAV [252])	Spares and repairs for RQ-4 Global Hawk
USAF	0605712F	RDT&E	Initial Operational Test & Evaluation (C4ISR Systems OT&E)	C4ISR Systems OT&E: RQ-4 Global Hawk Block 30/Airborne Signals Intelligence Payload (ASIP) (Plan for FOT&E in FY18, Conduct FOT&E in FY19)
USAF	000075	Procurement	Other Production Charges (RQ-4 UAV)	Other production charges related to RQ-4 UAV
USAF	0605712F	RDT&E	Initial Operational Test & Evaluation (Combat Support OT&E)	Combat Support OT&E: Joint Mission Planning System RQ-4 Mission Planning Element (JMPS RQ-4 MPE) (Conduct IOT&E in FY18)

RQ-7 Shadow UAS (and other programs that specifically note the RQ-7)

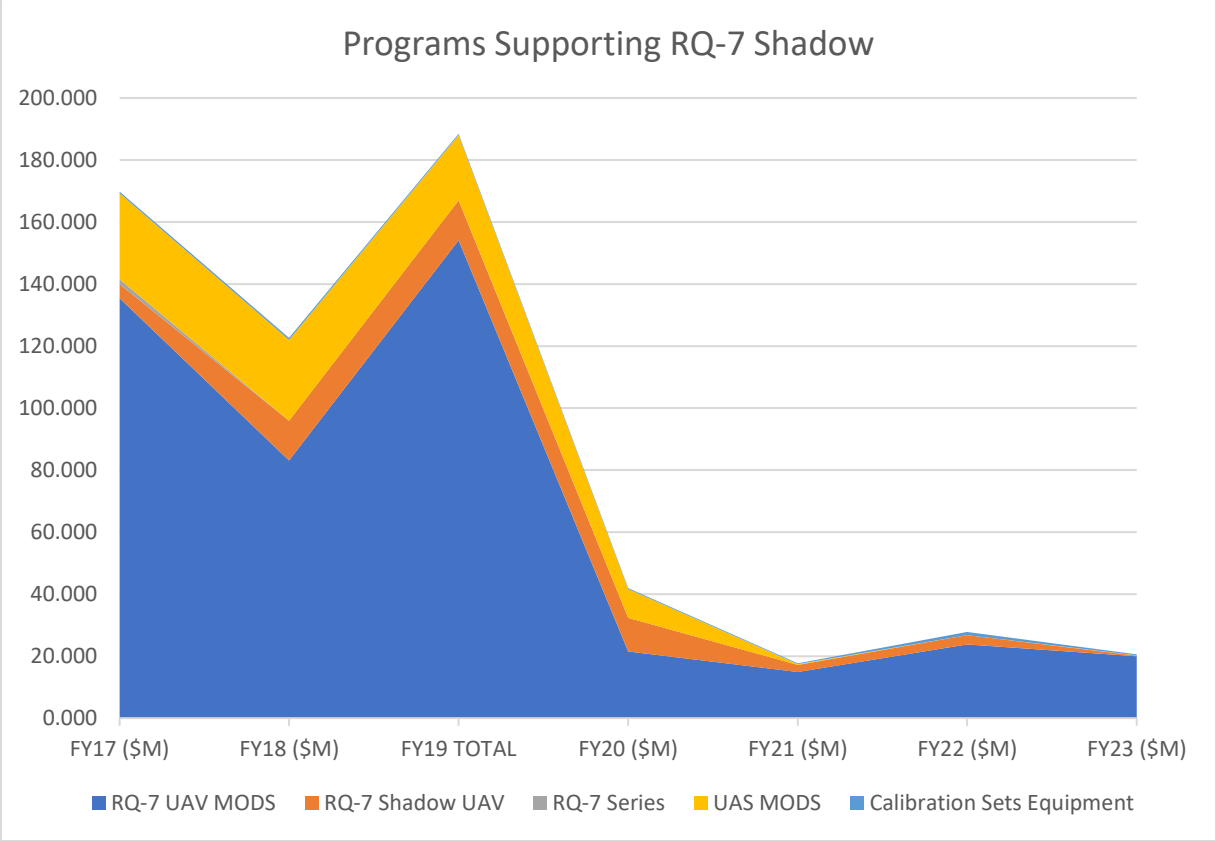


FIGURE 20: PROGRAMS SUPPORTING RQ-7 SHADOW UAS

TABLE 12: LISTING OF PROGRAMS SUPPORTING RQ-7 SHADOW UAS

Organization	PE Number	Funding Type	Title	Notes

US Army	9555A00018	Procurement	RQ-7 UAV MODS	Upgrades to Shadow UAS
US Army	0305233A	RDT&E	RQ-7 Shadow UAV	Fiscal Year (FY) 2019 RQ-7B UAS Base funding of $12.863 million will be utilized in the following: 1) $10.696M will be used to continue modifications for the RQ-7B UAS, 2) $2.167M provides interoperability and enhancements for the One System Remote Video Terminal (OSRVT). The $10.696M for modifications of the RQ-7B UAS will conduct an operational test on the Shadow v2 Block III upgrade, complete testing of the air vehicle modifications to allow operations in a Global Positioning System (GPS) denied environment and Air Vehicle and Ground Equipment software development for interoperability and MUM-T. The operational test for the Block III upgrade is required to assess the safety, suitability and effectiveness of the Block III upgrade prior to fielding. The GPS denied development is a phased, multi-year effort. Phase I (FY16) provided a trade study to determine the best hardware and software alternatives. Phase II (FY16) initiated the design and development through preliminary design review. Phase III (FY17) completed design and development through critical design review and conducted engineering flight testing. Phase IV (FY18 & FY19) will complete development, qualification, and developmental testing. RDTE also provides interoperability modifications that support MUM-T with the AH-64 Apache Helicopter, and Systems Engineering and Test and Evaluation to support the capability improvements.
US Navy	0589	Procurement	RQ-7 Series	RQ-7B Shadow UAS
US Army	9556A01002	Procurement	UAS MODS	Remote video terminal for Shadow UAS
US Army	0100N10000	Procurement	Calibration Sets Equipment	Calibration equipment used to maintain operation readiness of advanced technology weapons and systems including the shadow UAV

MQ-1 Predator / Gray Eagle UAS (and other programs that specifically note the MQ-1)

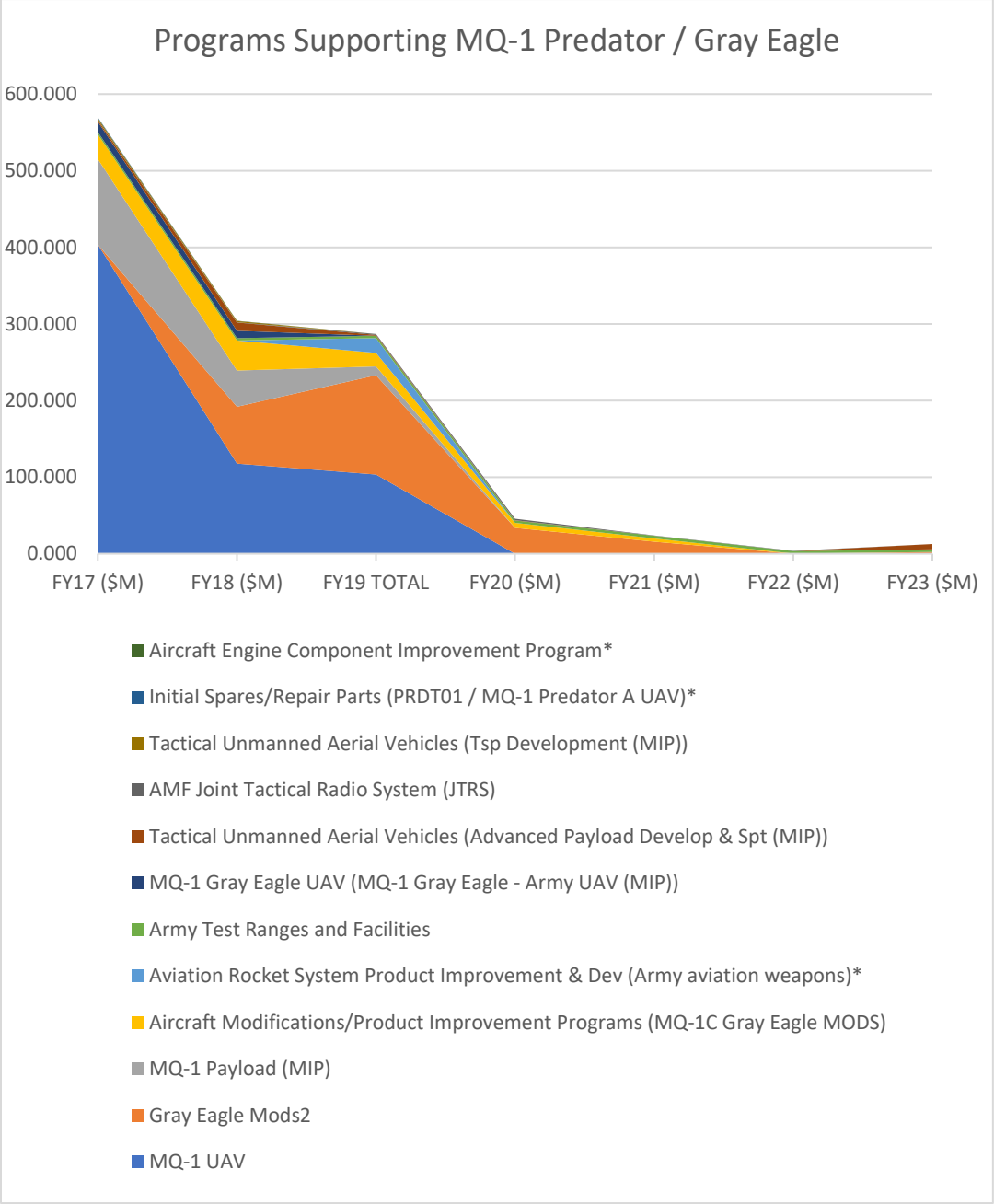


FIGURE 21: PROGRAMS SUPPORTING MQ-1 UAS

TABLE 13: LISTING OF PROGRAMS SUPPORTING MQ-1 UAS

Organization	PE Number	Funding Type	Title	Notes
US Army	9670A00005	Procurement	MQ-1 UAV	Procurement of Gray Eagle UAV

US Army	0756AA6601	Procurement	Gray Eagle Mods2	Payload procurement and modernization of SATCOM data link on Gray Eagle
US Army	0023A01001	Procurement	MQ-1 Payload (MIP)	Payload for Gray Eagle UAS
US Army	0203744A	RDT&E	Aircraft Modifications/Product Improvement Programs (MQ-1C Gray Eagle MODS)	MQ-1C modifications: GPS Denied ($4.313M FY18, $6.447M FY19): FY19 funding continues development of an electronic warfare capability that provides the system the ability to continue operations during periods of GPS outage as well as the ability to identify GPS jammer position location. Universal Ground Control Station (UGCS) Improvement ($9.235 FY18 only); Alternate Munition Integration ($9.18M fy18 only); Ground Base Sense and Avoid (GBSAA) Block II ($8.33M FY18, $6.699M FY19): Funding supports the development and Integration for Block II to provide GBSAA display moved to Ground Control Station (GCS). Maneuver Recommendation to Aircraft Operator (AO). (FY19 - Program is entering system test phase); Survivability ($8.3M FY18, $4.56M FY19): Funding for Electronic Attack (EA) survivability requirements for the MQ-1C Gray Eagle will be used to develop prototype solutions against known threat vulnerabilities. The Joint System Integration Lab (JSIL) will be funded to research and provide a Datalink Vulnerabilities Improvement Assessment. The prime contractor will be funded to provide survivability solutions for both software and hardware features. (Program anticipated to be completed in FY19)
US Army	0607142A	RDT&E	Aviation Rocket System Product Improvement & Dev (Army aviation weapons)*	Begin Lightweight Precision Munition (LPM) technology maturity and risk reduction efforts with industry to include fabrication of munition/launch system prototypes, evaluate mature existing systems to meet validated ONS 16-21556, integration and test efforts on the MQ-1C Gray Eagle. (this is a new start in FY19)
US Army	0605601A	RDT&E	Army Test Ranges and Facilities	Testing provided for UAV/UGVs - specifically noted in FY18/19 is the Gray Eagle Extended Range
US Army	0305219A	RDT&E	MQ-1 Gray Eagle UAV (MQ-1 Gray Eagle - Army UAV (MIP))	The Fiscal Year (FY) 2018 MQ-1 Gray Eagle funding of $9.574 million will support Test and Evaluation efforts associated with the MQ-1C Gray Eagle Extended Range Engineering Change Proposal (ECP). The test effort will evaluate overall system level performance to ensure it meets developmental and operational requirements. The types of effort required include Environmental Testing, Electromagnetic Environmental Effects (E3) testing, transport/mobility testing, logistics demonstration, and Follow-On Operational Test and Evaluation (FOTE II).
US Army	0305204A	RDT&E	Tactical Unmanned Aerial Vehicles (Advanced Payload Develop & Spt (MIP))	Fiscal Year (FY) 2019 base dollars in the amount of $1.252 million is for STARLite Sensor CE Development (in FY18 Complete test and integration of SPE (v.501) Software improvements onto Gray Eagle) and enhanced CSP to reduce cognitive burden on the Warfighter (Develop Tactical Awareness Improvements for increased operator situational awareness and program office management support).
US Army	0605380A	RDT&E	AMF Joint Tactical Radio System (JTRS)	Small Airborne Networking Radio (SANR) will provide increased data throughput to Army Aviation platforms via advanced networking capabilities supporting Mid-Tier and Lower Tier tactical networks, and maintain Single Channel Ground and Airborne Radio System (SINCGARS) capability. SANR is planned

				for implementation on the Gray Eagle Unmanned Aircraft System (MQ-1C) among other manned aircraft.
US Army	0305204A	RDT&E	Tactical Unmanned Aerial Vehicles (Tsp Development (MIP))	Fiscal Year (FY) 2019 FDI/G8 has ceased EE PEG Investment (FY19-FY23) for TSP POR in support of acquisition strategy of QRCs towards a Family of Systems to meet the critical SIGINT capability need with the desired Signals of Interest on the UAS Grey Eagle Platform and the MQ-1C (ER).
USAF	000999	Procurement	Initial Spares/Repair Parts (PRDT01 / MQ-1 Predator A UAV)*	Spares and repairs for MQ-1A Predator
US Army	0203752A	RDT&E	Aircraft Engine Component Improvement Program*	UAV Gray Eagle Engine Investigation at U.S. Army Research Laboratory (ARL) Vehicle Technology Directorate (VTD) at Aberdeen Proving Ground, MD. Will continue to research improvements to address service related deficiencies to improve safety and reduce O&S Costs.

MQ-8 Fire Scout UAS (and other programs that specifically note the MQ-8)

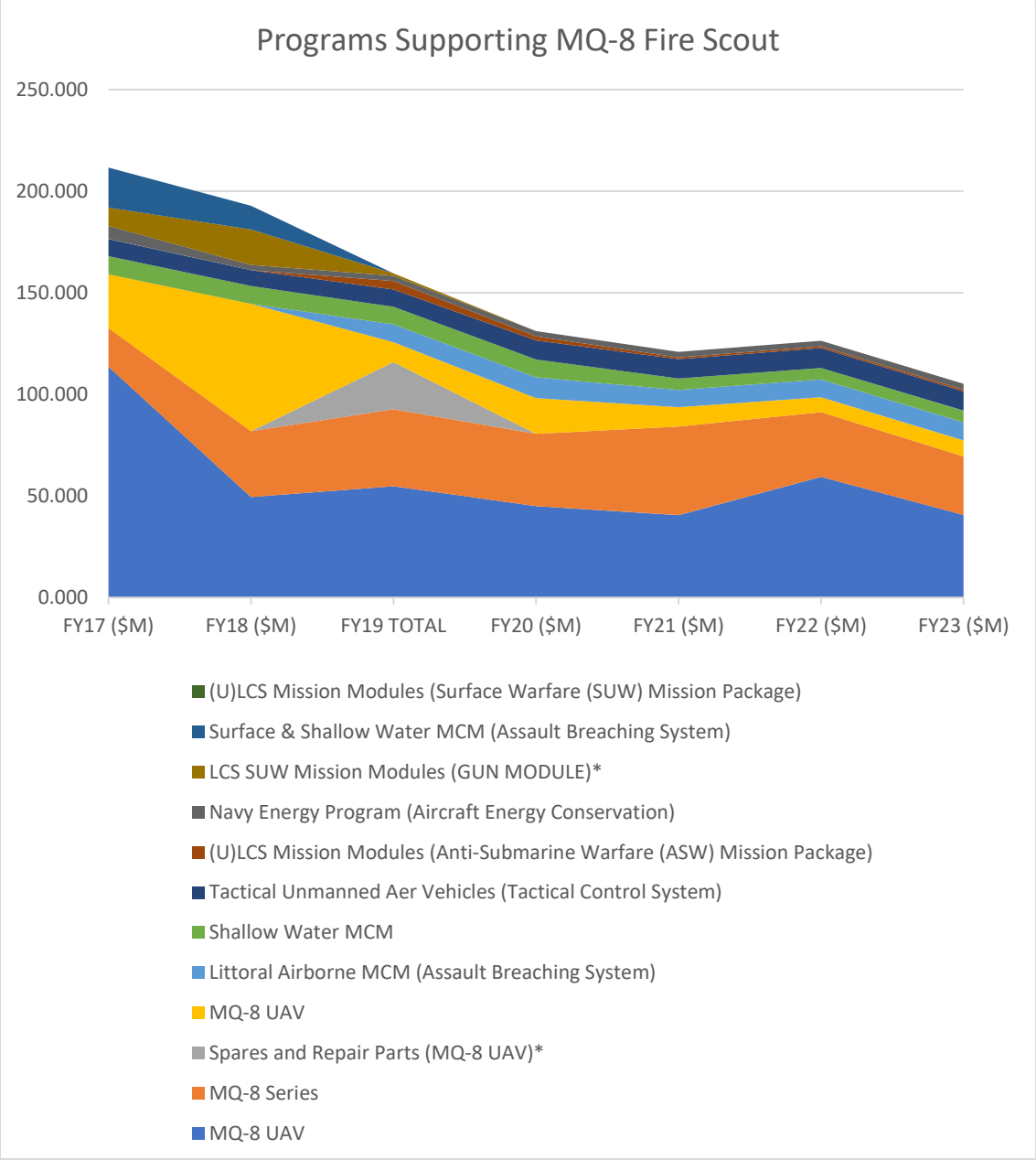


FIGURE 22: PROGRAMS SUPPORTING MQ-8 UAS

TABLE 14: LISTING OF PROGRAMS SUPPORTING MQ-8 UAS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0443	Procurement	MQ-8 UAV	MQ-8 Fire Scout UAS
US Navy	0588	Procurement	MQ-8 Series	MQ-8 Fire Scout UAS

US Navy	0605	Procurement	Spares and Repair Parts (MQ-8 UAV)*	Spares and repairs for MQ-8C Fire Scout
US Navy	0305231N	RDT&E	MQ-8 UAV	FY19 funding decrease reflects the deferral of significant MQ-8C weapons development efforts to the end of the FYDP. Remaining FYDP funding supports completion of Radar development, MQ-8C and Radar test requirements, and continued weapons studies. Radar and weapons funding supports requirements outlined in the MQ-8C Capabilities Production Document (CPD). Test funding supports DT and OT events to meet IOC, and deployment dates. Future payload efforts will be considered when developing current efforts. Initial Operational Capability of an MQ-8B-based system was achieved in 2QFY14 while IOC of an MQ-8C-based system onboard Littoral Combat Ship is anticipated in 4QFY18. The maritime Radar has been competitively selected. The integration effort will require sole source contracts to the current prime Original Equipment Manufacturers for the Tactical Control System and the MQ-8 Fire Scout air vehicle.
US Navy	0604126N	RDT&E	Littoral Airborne MCM (Assault Breaching System)	Coastal Battlefield Reconnaissance and Analysis (COBRA) which provides Airborne MCM through a multispectral sensor (daytime), 3D LIDAR (nighttime, beach/surf zone); successfully integrated on MQ-8B and achieved IOC in FY17
US Navy	2624	Procurement	Shallow Water MCM	MQ-8B VTUAV integrated with COBRA for MCM and obstacle detection in shallow waters
US Navy	0305204N	RDT&E	Tactical Unmanned Aer Vehicles (Tactical Control System)	Tactical control system for MQ-8 Fire Scout: The FY19 funding increase supports final development of the MCS integration with the MQ-8C radar program.
US Navy	0603596N	RDT&E	(U)LCS Mission Modules (Anti-Submarine Warfare (ASW) Mission Package)	Aviation Module that offers airborne threat localization and engagement capability through a MQ-8B Fire Scout VTUAV and an MH-60R with MK54 torpedoes (one of three modules)
US Navy	0603724N	RDT&E	Navy Energy Program (Aircraft Energy Conservation)	Continue evaluation of engine technology to improve efficiency of the MQ-8C and F-18
US Navy	1603	Procurement	LCS SUW Mission Modules (GUN MODULE)*	Gun mission module (GMM) that can be mounted on MQ-8B Fire Scout UAV and MH-60R manned helicopter
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Assault Breaching System)	Coastal Battlefield Reconnaissance and Analysis (COBRA) which provides Airborne MCM through a multispectral sensor (daytime), 3D LIDAR (nighttime, beach/surf zone); successfully integrated on MQ-8B and achieved IOC in FY17
US Navy	0603596N	RDT&E	(U)LCS Mission Modules (Surface Warfare (SUW) Mission Package)	Aviation Module using MQ-8B Fire Scout VTUAV for the detection, identification, and classification of surface contacts and to engage long range threats (one of 4 modules noted but all funding in FY19 is for the Surface-to-Surface Missile Module (SSMM))

Small UAS (and other programs that specifically note sUAS)

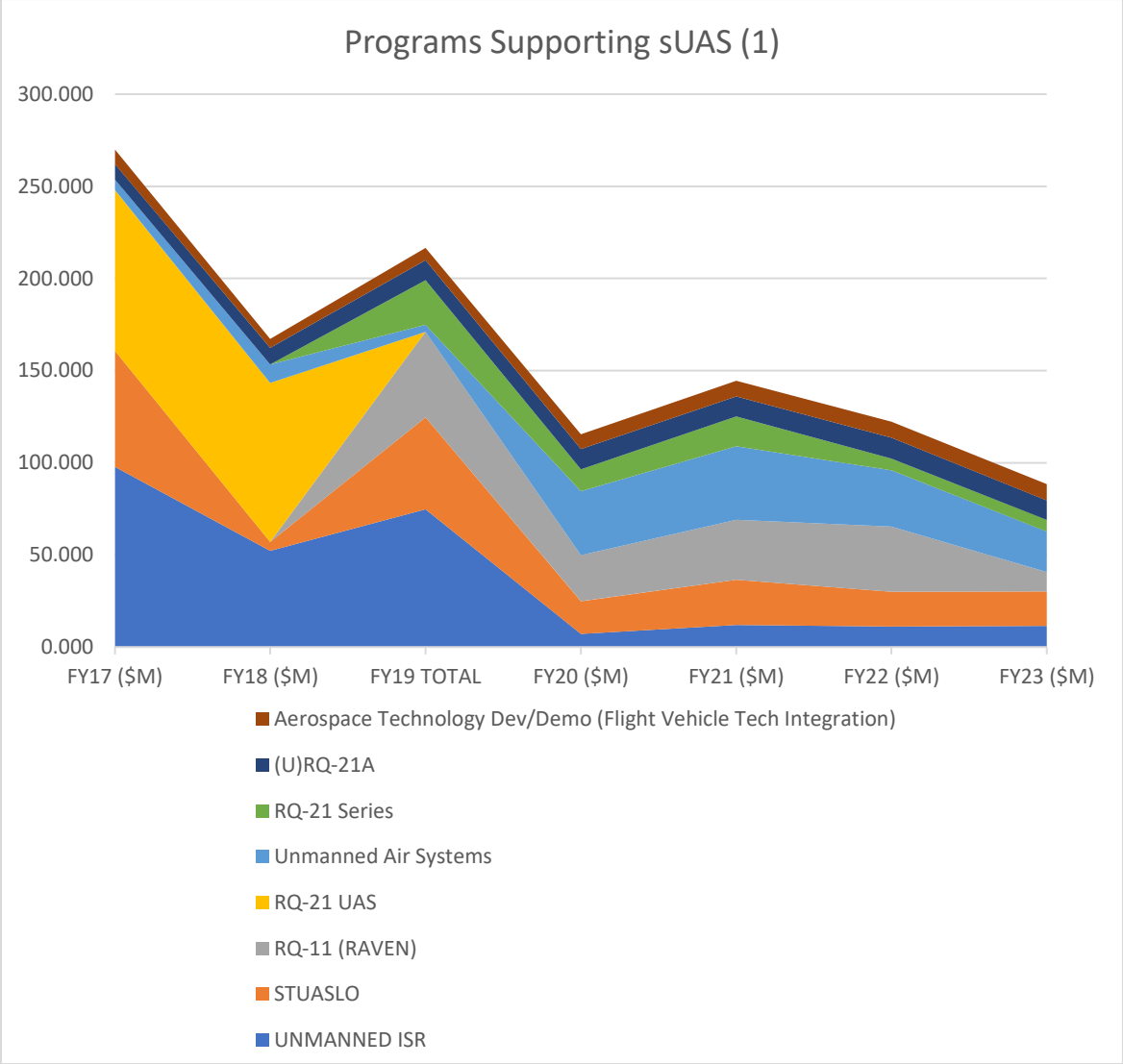


FIGURE 23: PROGRAMS SUPPORTING SUAS

TABLE 15: LISTING OF PROGRAMS SUPPORTING SUAS

Organization	PE Number	Funding Type	Title	Notes
SOCOM	0201UMNISR	Procurement	UNMANNED ISR	UAS and related sensors for ISR (2 Scan Eagle in FY17 @ $687,000 ea, 4 Puma in FY18 @ $450,000 ea, 4 Stalker in FY19 @ $1,471,000 ea, others)
US Navy	0444	Procurement	STUASLO	RQ-21 Blackjack UAS (transition of PE4737, 3 systems in FY17 @ $11,269,000 ea, 22 USN attrition air vehicles in FY19 @ $1,500,000 ea)
US Army	9675A00010	Procurement	RQ-11 (RAVEN)	RQ-11 Raven UAV
USMC	4737	Procurement	RQ-21 UAS	RQ-21 Blackjack UAS (Funding transitions to another program in FY19, 4 systems in FY18 @ $86,241,000 total)

USMC	4757	Procurement	Unmanned Air Systems	SUAS for ISR (5 Wasp in FY17 @ $246,239 ea, 26 Puma in FY18 @ $254,316 ea, Raven, Long Endurance SUAS (to be equipped with hybrid electric/fuel cell for 8+ hrs of endurance)
US Navy	0598	Procurement	RQ-21 Series	RQ-21 Blackjack UAS (FY19 new start) with funding for improvements to recovery system and EO/IR camera turret with laser designator
US Navy	0305239M	RDT&E	(U)RQ-21A	RQ-21A Test & Evaluation: Initiate follow-on test and evaluation for Propulsion Module Unit; Initiate follow-on test and evaluation for SAR/GMTI payload; Initiate follow-on test and evaluation for Laser Designator; Initiate follow-on cyber security test and evaluation.
USAF	0603211F	RDT&E	Aerospace Technology Dev/Demo (Flight Vehicle Tech Integration)	Aerospace Vehicle Technology Integration: in FY19, Initiate the flight demonstration of a low cost unmanned aerospace systems (UAS) capable of interoperations with different UAS assets; Advanced Aerospace Structure Technologies: in FY18, Complete an electronic warfare and passive radar flight demonstration of an integrated antenna into load-bearing structures for small remotely piloted aircraft.

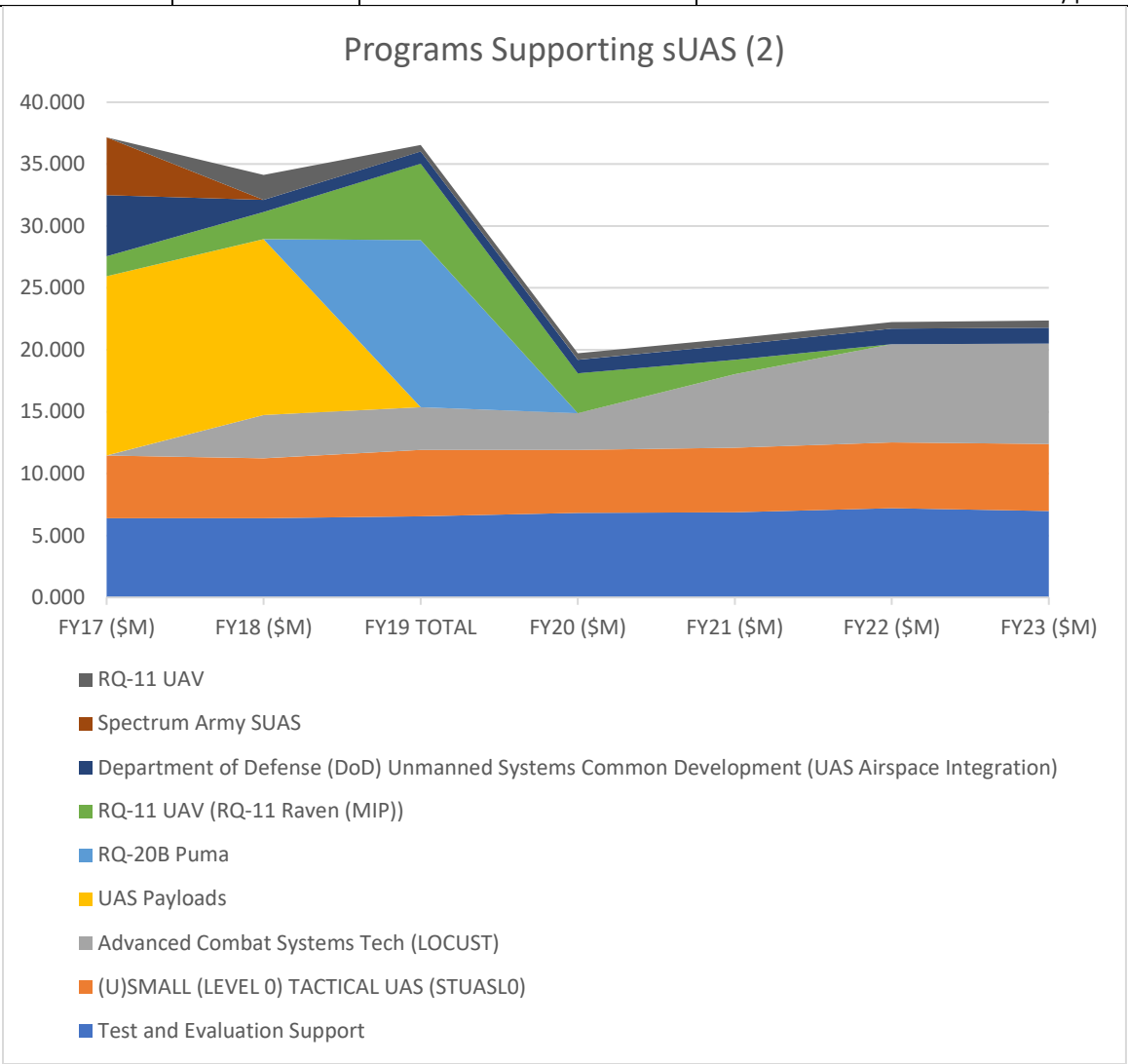


FIGURE 24: PROGRAMS SUPPORTING SUAS

TABLE 16: LISTING OF PROGRAMS SUPPORTING SUAS

Organization	PE Number	Funding Type	Title	Notes
USAF	0605807F	RDT&E	Test and Evaluation Support	412 Test Wing (TW), located at Edwards AFB, CA (one of three Air Force Test Center (AFTC) test wings) (support includes unmanned miniature vehicles)
US Navy	0305234N	RDT&E	(U)SMALL (LEVEL 0) TACTICAL UAS (STUASL0)	RQ-21A Blackjack: software engineering and development for block software updates; improvements to the fuel tank, maximum gross takeoff weight, launch and recovery systems, parts durability and manufacturability, avionics module, and other components.
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (LOCUST)	Demo and integrate inexpensive sUAS for swarming; Phase 1: air from MV-22/ground launched counter-IED and comms jamming; Phase 2: UUV-launched swarm for counter-Integrated Air Defense Systems (IADS)
USMC	4787	Procurement	UAS Payloads	Payloads for Group I and Group III UAS (funding transitioned in FY19)
USAF	Q020BR	Procurement	RQ-20B Puma	RQ-20B Puma UAV (60 in FY19 OCO @ $225,000 per system)
US Army	0305232A	RDT&E	RQ-11 UAV (RQ-11 Raven (MIP))	FoSUAS is transitioning to a Capabilities Production Document (CPD) that will utilize existing RQ-11 and RQ-20 in a system of systems fielding concept, with a Short Range Micro (SRM) option under consideration. (FY19 Increase continues Program Management Support for Short Range Micro solution investigation of candidates)
OSD	0604400D8Z	RDT&E	Department of Defense (DoD) Unmanned Systems Common Development (UAS Airspace Integration)	Unmanned Aircraft System Airspace Integration Initiatives (~1M FY18/FY19): Main activities: GBSAA Development and Integration, Unmanned Traffic Management, UAS Integration NAS support. In FY19, Develop future Policy and architectures that support the operation of DoD, Commercial, and Private Group 1-5 UAS systems in the national Airspace safely by developing an Unmanned Traffic Management (UTM) system. Investigate and draft Cyber security concept of operations for Manned and Unmanned Aircraft Systems operating in the National Airspace with a focus on Groups 1-2 UAS. Evaluate and validate identified best-candidate solutions for low size, weight, power and cost technology supporting military sUAS operations in national, international and foreign national airspace. Develop quantitative safety assessment approaches that support unique UAS operations to support emerging DoD needs and inform future rulemaking. Make formal recommendations for separation minima that enable low-altitude military UAS to remain well clear of other aircraft. Continue to engage the FAA to advance DoD UAS airspace integration. Investigate and draft Cyber security concept of operations for Manned and Unmanned Aircraft Systems operating in the National Airspace. Congressional Add: Airspace Integration ($4M FY17). FY 2017 Accomplishments: Investigated and developed the technology requirements, policies and architectures required to integrate DoD Unmanned systems safely into the national Airspace.
US Army	9990A19900	Procurement	Spectrum Army SUAS	Manned/Unmanned Teaming Extended Capability (MUMT-X)

US Navy	0305232M	RDT&E	RQ-11 UAV	Successful operational test of Mobile Ad hoc Networks communication relay (MANET), SIGINT and Laser Marker payloads. Successful operational test of Single Operator Man-Portable Ground Control System (SOMGCS). Fielding of the SOMGCS, MANET, SIGINT and Laser Marker payloads in accordance with planned schedule. Fielding of remaining RQ-20 PUMA systems in accordance with planned schedule. Demonstrated improvements in Digital Interoperability.

Targets – Mainly Aerial Targets (and other programs that specifically note targets)

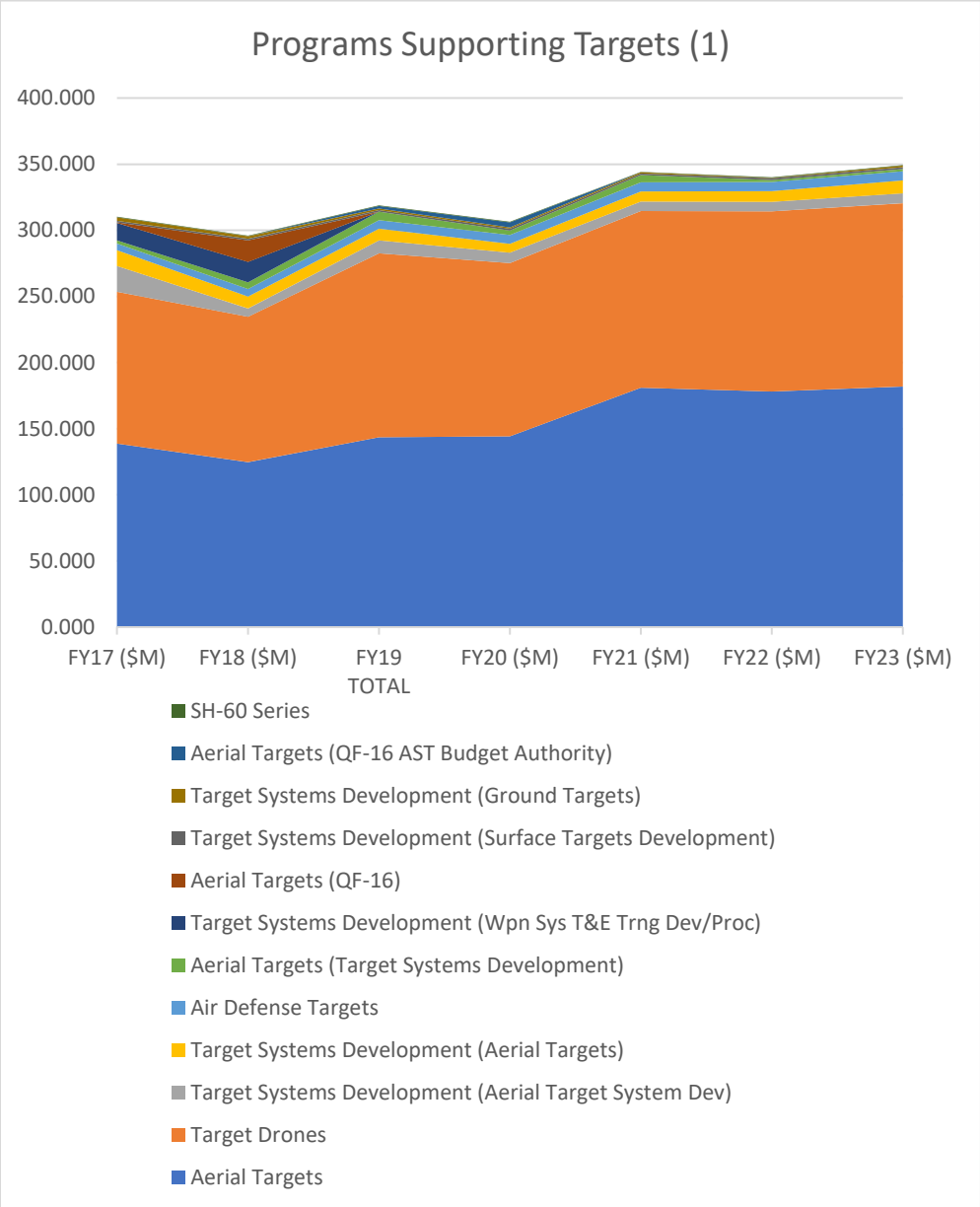


FIGURE 25: PROGRAMS SUPPORTING TARGETS (AIR/GROUND)

TABLE 17: LISTING OF PROGRAMS SUPPORTING TARGETS

Organization	PE Number	Funding Type	Title	Notes
US Navy	2280	Procurement	Aerial Targets	Aerial targets for T&E and fleet training events
USAF	10TRGT	Procurement	Target Drones	Target drones (19 QF-16 in FY19 @ $1,902,000 ea; 29 AFSAT Composite Engineering BQM-167 @ $1,017,000 ea)
US Navy	0604258N	RDT&E	Target Systems Development (Aerial Target System Dev)	GQM-163A Supersonic Sea Skimming Targets; BQM-177A subsonic target (replacement to BQM-74E with alternatives including BQM-74G); Target Control Systems (TCS) involves the improved command and control systems capable of controlling multiple targets simultaneously while delivering adequate fidelity of Test and Evaluation (T&E) telemetry data
US Army	0604258A	RDT&E	Target Systems Development (Aerial Targets)	High Speed Aerial Target (HSAT) ($5.361M FY18, $7.196M FY19): MQM-107 to provide a realistic aerial target capable of simulating the performance of enemy aircraft. FY19 Funds EMD phase for replacement of mission-essential HSAT system that will be cost effective and meet capabilities currently supported by the MQM-107. Will continue life cycle management for the aging HSAT MQM-107. Targets will continue to support T&E programs such as Patriot, Stinger, IAMD, Sentinel Radar, CMDS and classified programs for Army and Tri-Service customers. (FY19 Increased developmental effort for replacement of MQM-107 target) Unmanned Aerial System - Target (UAS-T) ($0.361M FY18, 0.253M FY19): Technical updates and life cycle management activities for the UAS-T to provide Threat representative support for test and experimentation missions. FY19 includes: Technical and life cycle management for the UAS-T to operate and maintain a generic, tactical class unmanned aircraft system target to support a variety of test requirements by providing a generic threat representative aerial target to support test and experimentation missions. Projects to be supported include the Space and Missile Defense Command and the JIAMDO live fire testing. This activity will continue to require technical support for investigation, demonstration, and integration of a more economical target, to include technical oversight of the targets' acquisition and ground support equipment. Army Ground Aerial Target Control System (AGATCS) ($2.893M FY18, $1.673M FY19): EMD phase activities for the AGATCS in support of a modern current technology target control system for control of both aerial and ground targets. FY19 includes: AGATCS engineering and manufacturing to provide remote control of aerial (both fixed and rotary wing), ground (heavy, medium, and light vehicles), and seaborne targets with a single control system in support of live fire testing necessary for lethality evaluation and sensor package testing for evaluation of suitability and effectiveness. Aerial Virtual Targets ($0.791M FY18, 0.426M FY19): Will continue engineering and manufacturing for Aerial Virtual Targets for evolving Army and Department of Defense (DoD) simulation standards and evolving implementation techniques; focuses on simulation target models of airplanes, helicopters, missiles, unmanned aerial vehicles, and aerial targets in commonly used formats to support visualization, infrared analysis, and radar analysis

				simulations. (FY19) Towed Targets/Ancillary devices (not relevant to UxVs - $0.557M FY18, $0.272M FY19)
US Army	1242C93000	Procurement	Air Defense Targets	Target drone procurement
USAF	0305116F	RDT&E	Aerial Targets (Target Systems Development)	BQM-167A Development ($1.34M FY18, $2.036M FY19): in FY19, Continue BQM-167A improvement efforts to include enhanced payload capability (Funds increased to continue threat realism enhancements associated with future Title 10 Live Fire Test & Evaluation (LFT&E) requirements). Target Control System ($2.389 FY18, $1.392 FY19): Provide system modernization enhancements to Target Control System Gulf Range Drone Control System, (GRDCS) for command and control and tracking of Aerial Targets. In FY19, Continue system modernization enhancements to include but not limited to GRDCS software updates to support implementing QF-16 and AFSAT enhancements and future TCS capability assessment. Digital Radio Frequency Memory (DRFM) ($1.3M FY18, $2.97M FY19): in FY19, Continue efforts to upgrade existing and develop new EA pod hardware and software used on QF-16 and subscales to emulate evolving adversary EA tactics and techniques (Funds increased to continue threat realism enhancements associated with future Title 10 LFT&E requirements).
US Navy	0604258N	RDT&E	Target Systems Development (Wpn Sys T&E Trng Dev/Proc)	QF-16 Full-Scale Aerial Target (FSAT) incremental funding to complete the procurement of the five (5) Lot five (5) QF-16 FSAT test assets to be delivered 3rd Quarter FY21. Procure three (3) QF-16 FSAT test assets. Conduct regeneration of engines and airframes and drone conversion of QF-16 FSAT aircraft retrieved from Davis Monthan AFB storage. A FSAT Gulf Range Drone Control Station (GRDCS) demonstration planned to be held March 2018 at NAS Pt. Mugu. FY 2019 funds were reprogrammed to the Weapons Procurement, Navy (WPN) appropriation (BLI 2280).
USAF	0305116F	RDT&E	Aerial Targets (QF-16)	QF-16 Development Program: Provide enhancements to emulate emerging threat in support of weapons testing. In FY18, Continue threat realism improvements to improve countermeasures and their control. Conduct studies and analysis on QF-16 Radar Cross Section (RCS). (see project 675336 for future funding)
US Navy	0604258N	RDT&E	Target Systems Development (Surface Targets Development)	Develop sea-based targets and associated technologies for testing of weapons systems. FY18: high fidelity control and feedback for target emitters and cameras; precise remote control steering systems; target swarm formation control; advanced radar and infrared signature enhancement; FY19: over-the-horizon command and control including satellite links
US Army	0604258A	RDT&E	Target Systems Development (Ground Targets)	Mobile Ground Target Operations (MGTO) ($2.216M FY18, $1.257M FY19): The MGTO will provide support and oversight for actual threat foreign ground vehicles and mobile ground target surrogate vehicles for use as threat targets by the T&E community for destructive and non-destructive scenarios. Efforts will support users such as, but not limited to ATEC, Apache 64E, GMLRS, Brigade Modernization Command, JAGM, Gray Eagle, and FFV.
USAF	0305116F	RDT&E	Aerial Targets (QF-16 AST Budget Authority)	QF-16 Development Program: Provide enhancements to emulate emerging threat in support of weapons testing. In FY19, Continue threat realism improvements to improve countermeasures and their control. Conduct studies and

				analysis on QF-16 Radar Cross Section. This effort is not a new start. FY18 efforts identified in BPAC 675366. Funds increased to continue threat realism enhancements associated with future Title 10 LFT&E requirements.
US Navy	0530	Procurement	SH-60 Series	Target drone recovery via manned helicopter

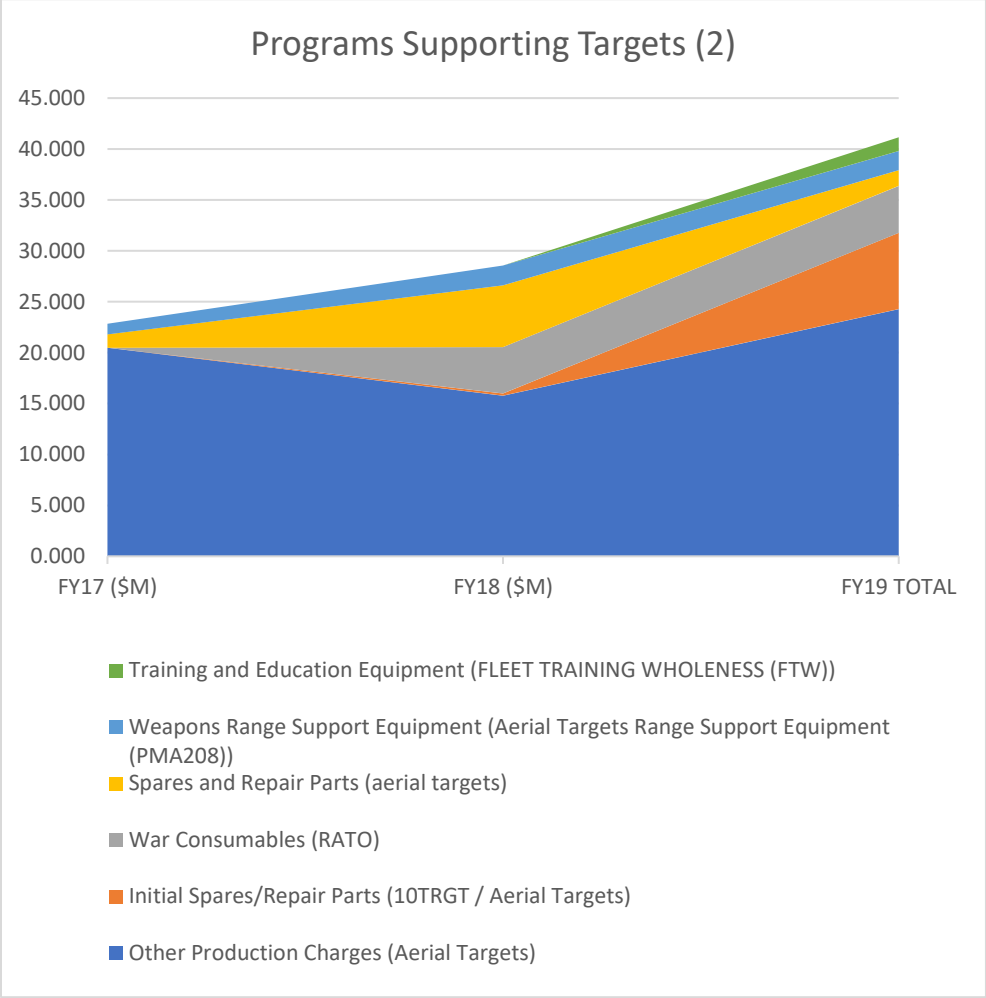


FIGURE 26: PROGRAMS SUPPORTING AERIAL TARGETS

TABLE 18: LISTING OF PROGRAMS SUPPORTING AERIAL TARGETS

Organization	PE Number	Funding Type	Title	Notes
USAF	000075	Procurement	Other Production Charges (Aerial Targets)	Other production charges related to Aerial Targets
USAF	000999	Procurement	Initial Spares/Repair Parts (10TRGT / Aerial Targets)	Spares and repairs for aerial targets (large OCO funding in FY19)
USAF	000074	Procurement	War Consumables (RATO)	Rocket used for launching the AFSAT BQM-167 target drone

US Navy	6120	Procurement	Spares and Repair Parts (aerial targets)	Spares and repairs for aerial targets
US Navy	4204	Procurement	Weapons Range Support Equipment (Aerial Targets Range Support Equipment (PMA208))	Moving land targets from Kairos
US Navy	8101	Procurement	Training and Education Equipment (FLEET TRAINING WHOLENESS (FTW))	Upgrades to subsonic aerial targets (Digital Radio Frequency Memory (DRFM))

Maritime Platforms (and other programs that specifically note maritime platforms)

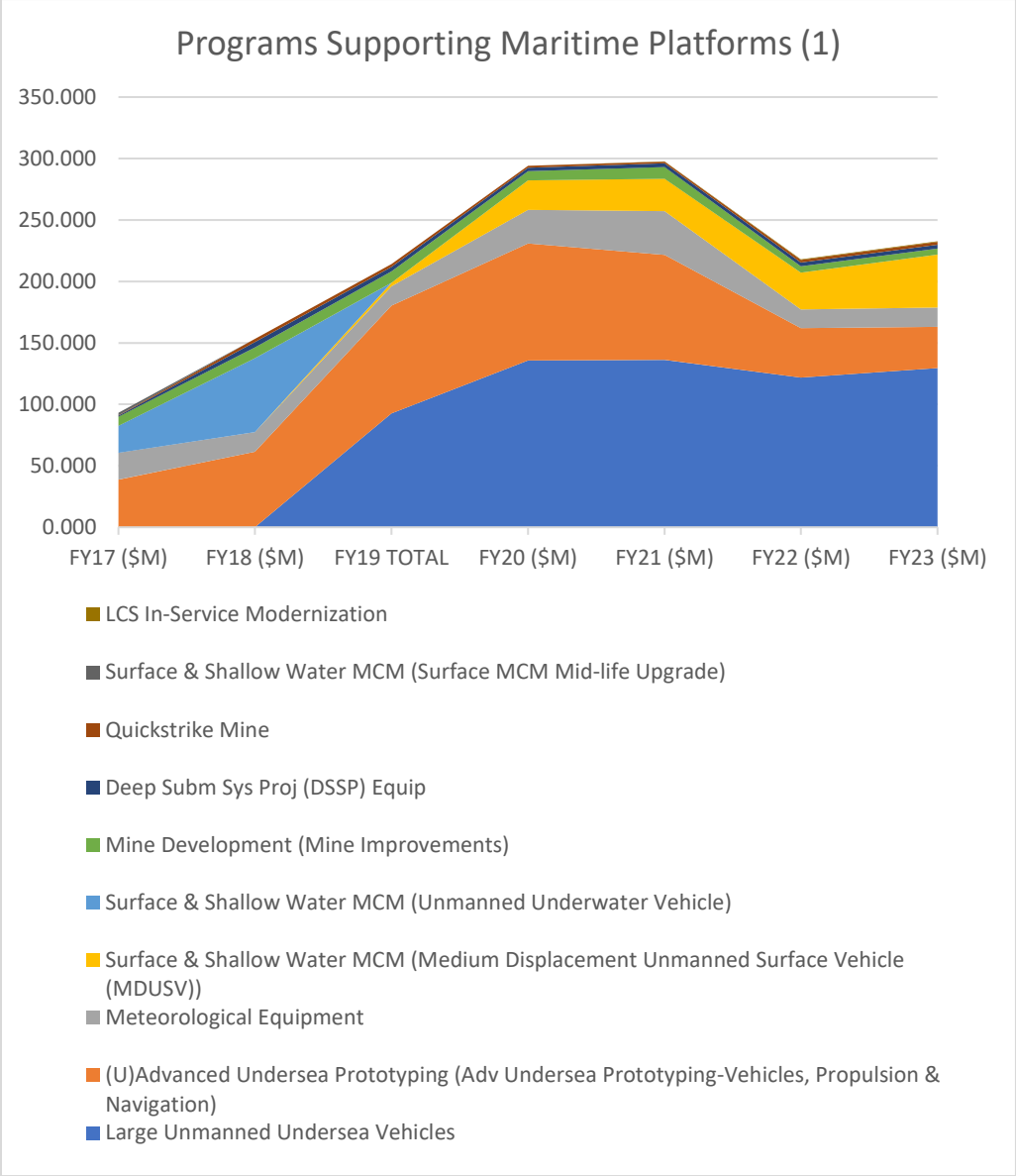


FIGURE 27: PROGRAMS SUPPORTING MARITIME PLATFORMS

TABLE 19: LISTING OF PROGRAMS SUPPORTING MARITIME PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0604031N	RDT&E	Large Unmanned Undersea Vehicles	Complete detailed design for Phase I LDUUV and complete Critical Design Review (CDR) in 1QFY19; Procure remaining materials and parts and commence fabrication of two (2) Phase I LDUUVs. FY 2018 to FY 2019 Increase/Decrease Statement: FY 2018 funding in Program Element (PE) 0603502N. FY 2019 increase in funding supports detailed design efforts.
US Navy	0604536N	RDT&E	(U)Advanced Undersea Prototyping (Adv	ORCA XLUUV is being developed via a full and open competition to two industry teams to design systems (with down select to one team to fabricate). Complete design efforts

			Undersea Prototyping-Vehicles, Propulsion & Navigation)	and conduct Critical Design Reviews (CDR) early in FY19 for both industry teams. Conduct down select to one industry partner (possibly keep both) and award contract for fabrication of up to five (5) XLUUVs. Begin XLUUV vehicle fabrication, including procurement of remaining materials (long lead materials previously procured in FY18) and initial assembly and integration of the first vehicles. Continue to lease Commercial Off the Shelf (COTS) UUVs to develop Tactics, Techniques and Procedures (TTPs). FY 2019 increase in funding supports commencing XLUUV system fabrication.
US Navy	4226	Procurement	Meteorological Equipment	Teledyne Brown Engineering Gliders (16 in FY19 @ $199,524 ea) and Hydroid Razorback AUVs (2 in FY19 @ $2,140,000) for collection of meteorological data
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Medium Displacement Unmanned Surface Vehicle (MDUSV))	New start for Medium Displacement Unmanned Surface Vehicle (MDUSV) in FY19 with expected missions including EW, ASW, strike, others.
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Unmanned Underwater Vehicle)	LDUUV program will design, build, and test risk-reducing UUVs in two phases followed by competitive award of a production contract. Performance Metrics: LDUUV - Completed Preliminary Design Review (PDR) 4Q FY17; LDUUV - Complete Critical Design Review (CDR) 1Q FY19
US Navy	0604601N	RDT&E	Mine Development (Mine Improvements)	Development of Clandestine Delivered Mine (CDM) for delivery by the XLUUV
US Navy	0955	Procurement	Deep Subm Sys Proj (DSSP) Equip	ROV for submarine rescue
US Navy	3231	Procurement	Quickstrike Mine	Mine delivery via XLUUV (over $2.5 mil in FY19 for CDM)
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Surface MCM Mid-life Upgrade)	Unmanned Influence Sweep System (UISS); Multi-Function USV with a minehunting sensor; AN/SLQ-60 Mine Neutralization System (MNS) Seafox; AN/SLQ-48 Mine Neutralization System (realigned to PE 0604127N)
US Navy	1604	Procurement	LCS In-Service Modernization	LCS modernization including USV integration

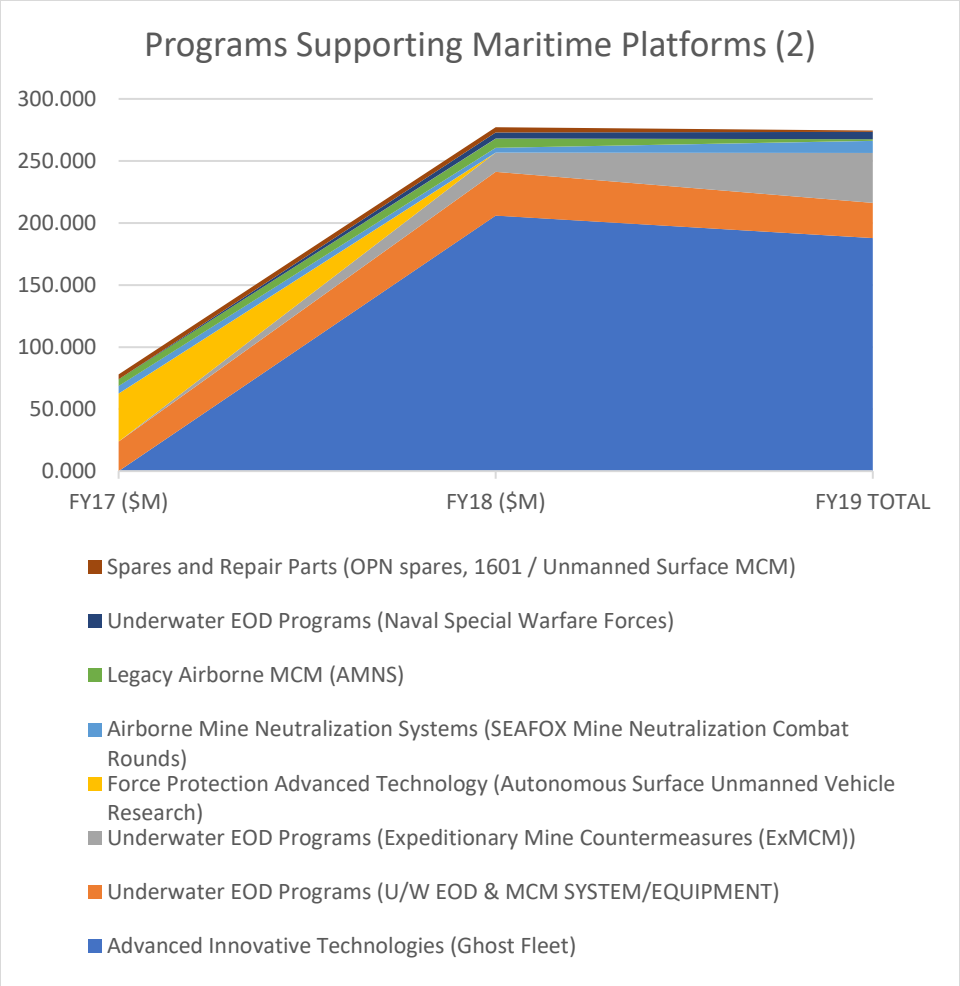


FIGURE 28: PROGRAMS SUPPORTING MARITIME PLATFORMS

TABLE 20: LISTING OF PROGRAMS SUPPORTING MARITIME PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
OSD	0604250D8Z	RDT&E	Advanced Innovative Technologies (Ghost Fleet)	Strategic Capabilities Office (SCO) will develop and demonstrate fleet integrated, operational prototype unmanned maritime vehicles to fill existing mission requirements for Combatant Commanders. The prototypes will include the platforms, autonomy, Command, Control and Communications (C3) and payload integration. In FY19: Complete surrogate in-water testing; Complete platform in-water test event; Continue integration and fabrication of final platforms; Complete component level testing and payload integration designs; Complete autonomy system delivery. Decrease in funding is due to long lead material purchases, early state surrogate analysis and in-water testing and autonomy developments taking place in prior year.
US Navy	0977	Procurement	Underwater EOD Programs (U/W EOD &	UUVs and ROVs for EOD/MCM (MK18 MOD 1, MK18 MOD 2, MK 19 FOV)

			MCM SYSTEM/EQUIPMENT)	
US Navy	0977	Procurement	Underwater EOD Programs (Expeditionary Mine Countermeasures (ExMCM))	MK18 UUV used for MCM
US Navy	0603123N	RDT&E	Force Protection Advanced Technology (Autonomous Surface Unmanned Vehicle Research)	FY17 support of MDUSV including design and fabrication of a second SEA HUNTER MDUSV (formerly ACTUV)
US Navy	4225	Procurement	Airborne Mine Neutralization Systems (SEAFOX Mine Neutralization Combat Rounds)	Seafox mine neutralization system (84 systems @ $98,210 ea, 70 battery replacements @ $8,500 ea)
US Navy	4248	Procurement	Legacy Airborne MCM (AMNS)	Expendable SeaFox ROV deployed from MH-60S manned helicopter
US Navy	0977	Procurement	Underwater EOD Programs (Naval Special Warfare Forces)	MK18 UUV used for MCM
US Navy	9020	Procurement	Spares and Repair Parts (OPN spares, 1601 / Unmanned Surface MCM)	Spares for MCM equipment deployed from LCS including Textron USV, Knifefish UUV, MQ-8 VTUAV + COBRA

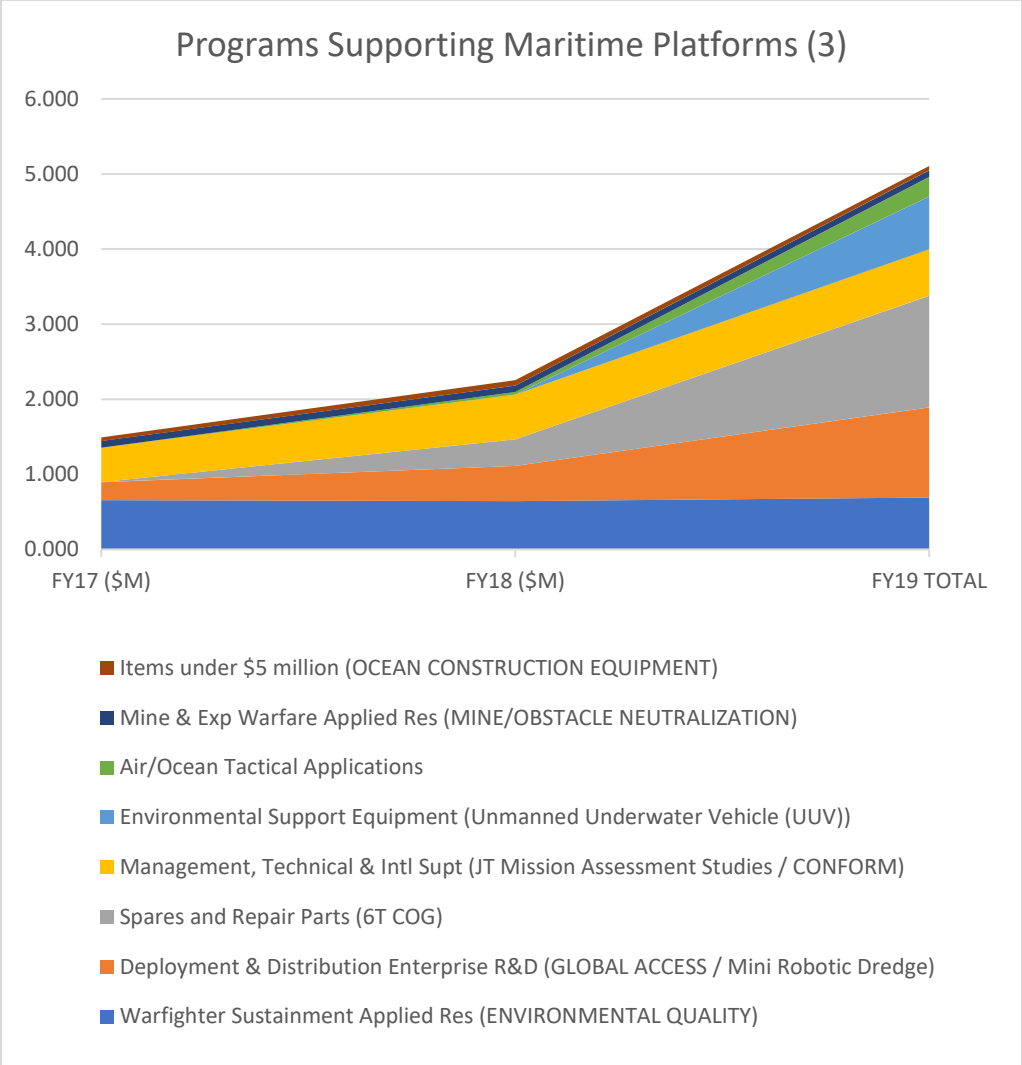


FIGURE 29: PROGRAMS SUPPORTING MARITIME PLATFORMS

TABLE 21: LISTING OF PROGRAMS SUPPORTING MARITIME PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0602236N	RDT&E	Warfighter Sustainment Applied Res (ENVIRONMENTAL QUALITY)	Field evaluation of prototype robotic Hull BUG (FY18)
USAF	0604776F	RDT&E	Deployment & Distribution Enterprise R&D (GLOBAL ACCESS / Mini Robotic Dredge)	Mini Robotic Dredge: in FY18, TRL 5/6: Ability to clear a shipping lane/berthing area to allow for pier side unloading operations. In FY19, TRL 5-6: Evaluate various cutter heads to determine those suitable for the various types of sediments
US Navy	6120	Procurement	Spares and Repair Parts (6T COG)	Spares and repairs for mines sweeping equipment

US Navy	0605853N	RDT&E	Management, Technical & Intl Supt (JT Mission Assessment Studies / CONFORM)	Continue to conduct ship, boat, and unmanned marine vehicle concept studies in preparation for Capabilities Based Assessments (CBAs) and Analysis of Alternatives (AoAs). Studies will be performed in a continuous manner to support future recapitalization of Surface Combatants, Amphibious Ships, Carriers, Auxiliary Ships and other emerging program requirements.
US Navy	8126	Procurement	Environmental Support Equipment (Unmanned Underwater Vehicle (UUV))	UUV for bathymetry and imagery operations
US Navy	0603207N	RDT&E	Air/Ocean Tactical Applications	Continue: Provide automated mission-relevant water sampling plans with joint optimization of varied observing systems: gliders, profiling floats, shipboard, satellite, buoy, air-deployed, etc. (completed in FY19)
US Navy	0602782N	RDT&E	Mine & Exp Warfare Applied Res (MINE/OBSTACLE NEUTRALIZATION)	Autonomous neutralization of surface and submerged drifting mines
US Navy	6060	Procurement	Items under $5 million (OCEAN CONSTRUCTION EQUIPMENT)	Ocean construction equipment including an underwater drone

Programs Supporting MCM

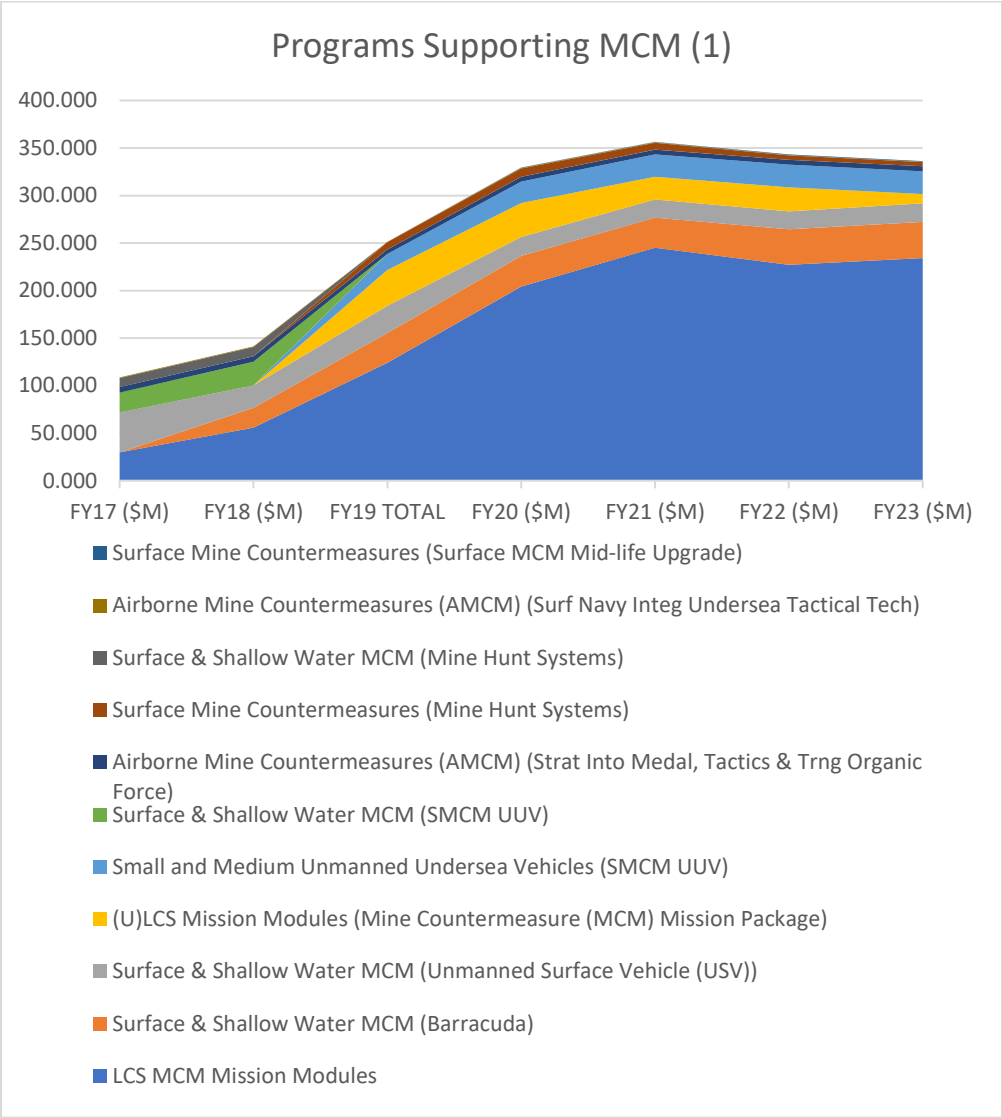


FIGURE 30: PROGRAMS SUPPORTING MCM

TABLE 22: LISTING OF PROGRAMS SUPPORTING MCM

Organization	PE Number	Funding Type	Title	Notes
US Navy	1601	Procurement	LCS MCM Mission Modules	MCM equipment deployed from LCS including 2 Textron USV in FY19 @ $17,480,000 ea, 2 Knifefish UUV in FY19 @ 13,002,000 ea, MQ-8 VTUAV + COBRA
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Barracuda)	Development of Barracuda - a weaponized unmanned mine neutralization capability deployed from the MCM USV and stored onboard LCS.
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Unmanned Surface Vehicle (USV))	Main funding in FY19 for MCM USV (integration with AQS-20C minehunting sonar / AQS-24B minehunting sonar) - $15.039M / $4.1M for other related program management, engineering and technical support efforts

US Navy	0603596N	RDT&E	(U)LCS Mission Modules (Mine Countermeasure (MCM) Mission Package)	Remote Minehunting (RMH) Module: MCM USV + AN/AQS-20 Minehunting Sonar - integration of sonar and conduct initial at-sea tests in FY19, integrate MCM USV on Independence variant; Airborne Mine Neutralization (AMN) Module: studies to integrate Barracuda on MCM USV (Freedom variant); COBRA + MQ-8B Fire Scout VTUAV: integrate and at-sea test on Freedom variant; Unmanned Influence Sweeping System (UISS) (MCM USV + Unmanned Surface Sweep System): conduct at-sea development test on Independence variant; Knifefish UUV for buried minehunting: pier-side Launch & Recovery demos / integration on Independence variant; FY 2018 to FY 2019 Increase/Decrease Statement: Significant increase in at-sea testing of MCM MP on LCS Independence variant resulting from contractor delivery of MCM USV, Knifefish and UISS systems.
US Navy	0604028N	RDT&E	Small and Medium Unmanned Undersea Vehicles (SMCM UUV)	Knifefish UUV / SMCM UUV equipped with advanced Low Frequency Broadband (LFBB) sonar that provides volume, bottom, and buried mine detection capability: Development (onboard processing and reacquisition/ID, processing container, Launch & Recovery, etc.); Support (engineering support and support of LRIP systems / RFP for FRP); T&E (operational testing from LCS or others); Procurement of the SMCM UUV with LFBB will occur after Milestone C. E. Performance Metrics: Successful Milestone C in 3Q FY 2018 and FRP decision in FY 2019. Previous funding in PE 0603502N.
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (SMCM UUV)	Accelerate future capability and support steady growth of UUV fleet - Knifefish SMCM UUV; efforts (onboard processing, re-acquisition, dual-side sonar, and increased endurance). The Knifefish program was initiated in FY11 to develop Surface Mine Countermeasure Unmanned Undersea Vehicles (SMCM UUV) equipped with advanced Low Frequency Broadband (LFBB) sonar that provides volume, bottom, and buried mine detection capability. Procurement of the SMCM UUV with LFBB will occur after Milestone C. Successful Milestone C in 3Q FY 2018 and FRP Decision in FY 2019.
US Navy	0604373N	RDT&E	Airborne Mine Countermeasures (AMCM) (Strat Into Medal, Tactics & Trng Organic Force)	Integrate training for MCM systems including: AN/AQS-24B/C, COBRA, Knifefish, MCM USV, and ExMCM UUV sensors to address LCS capability gaps.
US Navy	0604127N	RDT&E	Surface Mine Countermeasures (Mine Hunt Systems)	Development of AN/AQS-20 mine hunting sonar towed by a MCM US; previous funding in PE 0603502N
US Navy	0603502N	RDT&E	Surface & Shallow Water MCM (Mine Hunt Systems)	Development of AN/AQS-20 mine hunting sonar towed by a MCM USV
US Navy	0604373N	RDT&E	Airborne Mine Countermeasures (AMCM) (Surf Navy Integ Undersea Tactical Tech)	Develop sensor training modules for AMNS, COBRA and AN/AQS-20A (deployed from MCM USV); support training for the Remote Environmental Measuring Units (REMUS) sonar systems
US Navy	0604127N	RDT&E	Surface Mine Countermeasures (Surface MCM Mid-life Upgrade)	Unmanned Influence Sweep System (UISS); Multi-Function USV with a minehunting sensor; AN/SLQ-60 Mine Neutralization System (MNS) Seafox; AN/SLQ-48 Mine Neutralization System; previous funding in PE 0603502N

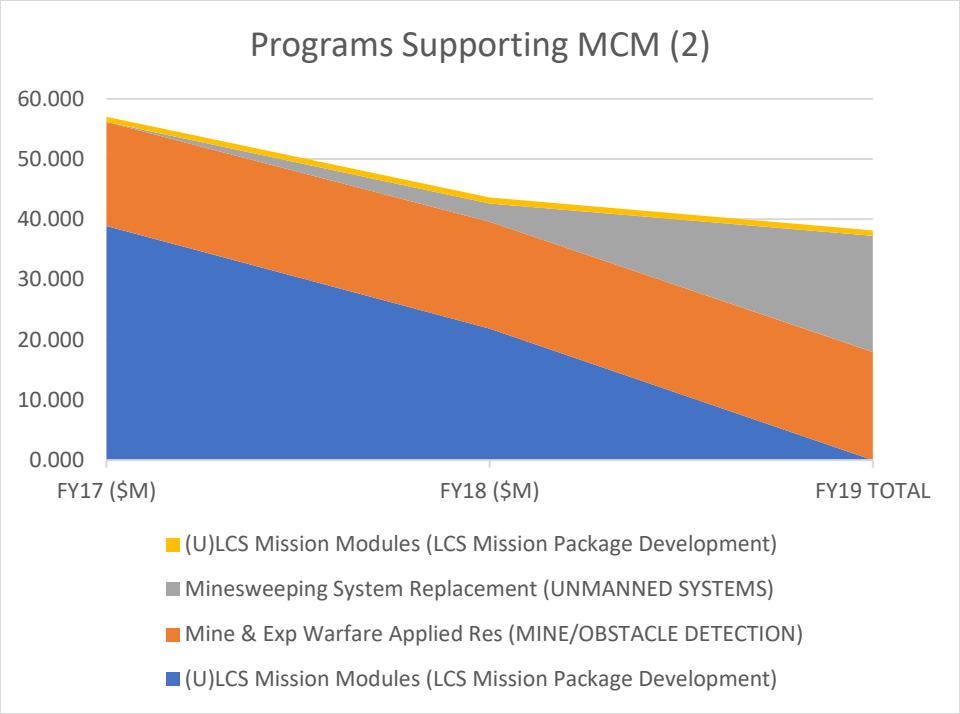


FIGURE 31: PROGRAMS SUPPORTING MCM

TABLE 23: LISTING OF PROGRAMS SUPPORTING MCM

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603596N	RDT&E	(U)LCS Mission Modules (LCS Mission Package Development)	See Mine Countermeasure (MCM) Mission Package (funds transitioned in FY19)
US Navy	0602782N	RDT&E	Mine & Exp Warfare Applied Res (MINE/OBSTACLE DETECTION)	MCM mission modules for LCS; AUV technologies (acoustic communications, navigation techniques, improved energy densities, hydrodynamics, and vehicle control technologies); sensor integration on AUVs (SAS, magnetic gradiometer sensing, EO technology for surface / near-surface mines, buried mine hunting technologies); thermal engine for UUV; develop miniaturized MCM sensor concepts for substantially smaller unmanned systems operating with increased autonomy; develop biomimetic propulsion mechanisms for future UUVs
US Navy	2622	Procurement	Minesweeping System Replacement (UNMANNED SYSTEMS)	General Dynamics Knifefish UUV (1 in FY19 @ $13,135,000) and UISS training equipment for MCM
US Navy	0603596N	RDT&E	(U)LCS Mission Modules (LCS Mission Package Development)	Multi Vehicle Communications System (MVCS): crypto and the replacement CDS on Unmanned Influence Sweep System (UISS) and Knifefish Unmanned Undersea Vehicle (completed in FY19); Continue development on the Extended Line of Site (ELOS) solution Unmanned Aerial Relay (UMAR) Rapid Innovation Fund effort; Perform an analysis to determine the amount of bandwidth required for remote mine hunting at various operating distances; Common Mission Package Trainer (CMPT): Begin update to integrate MCM Unmanned Sweep

				Module and Remote Minehunting Module capabilities into CMPT

Programs Supporting Other Maritime Sensors & Payloads

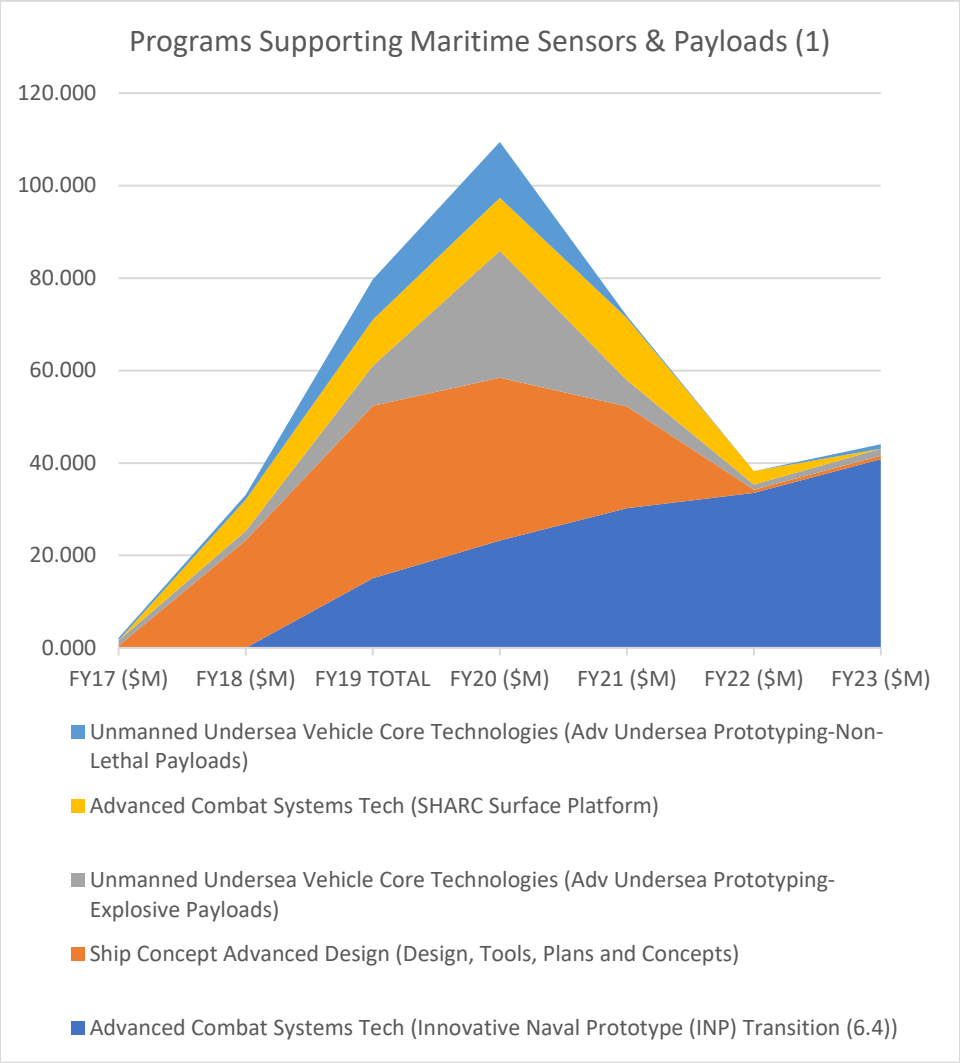


FIGURE 32: PROGRAMS SUPPORTING MARITIME SENSORS AND PAYLOADS

TABLE 24: LISTING OF PROGRAMS SUPPORTING MARITIME SENSORS AND PAYLOADS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (Innovative Naval Prototype (INP) Transition (6.4))	Development of 3 packages for integration onto MDUSV (ASW sensors, ASW Kinetic Effects, advanced aerial lift package); Note: all FY19 projects involve unmanned and autonomous systems with scheduled activity through FY21 but requested funding in FY22+ could be for other projects such as Directed Energy / Electric Weapons, Electromagnetic Maneuver Warfare, Cyber Warfare, and Undersea Warfare.

US Navy	0603561N	RDT&E	Ship Concept Advanced Design (Design, Tools, Plans and Concepts)	Develop USV and mission payloads, sensors and handling systems; define technical requirements for modular unmanned systems (payloads, common control systems, launch & recovery systems); develop technical requirements and standards for unmanned systems and autonomous operations / host ship technical requirements and interface standards
US Navy	0604029N	RDT&E	Unmanned Undersea Vehicle Core Technologies (Adv Undersea Prototyping-Explosive Payloads)	Continue development of ORCA XLUUV Undersea weapons payload systems; previously funded in PE 0604536N (funds from other program included)
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (SHARC Surface Platform)	Development and integration of ISR and targeting sensors / wideband data links onto SHARC Platforms (Wave Gliders)
US Navy	0604029N	RDT&E	Unmanned Undersea Vehicle Core Technologies (Adv Undersea Prototyping-Non-Lethal Payloads)	Investigate the possibilities of employing non-lethal payloads initially from the ORCA XLUUV to support ISR and strike missions (jamming, EO/IR dazzling, microwave, aerial assets, and other methods); previous funding in PE 0604536N (funds from other program included)

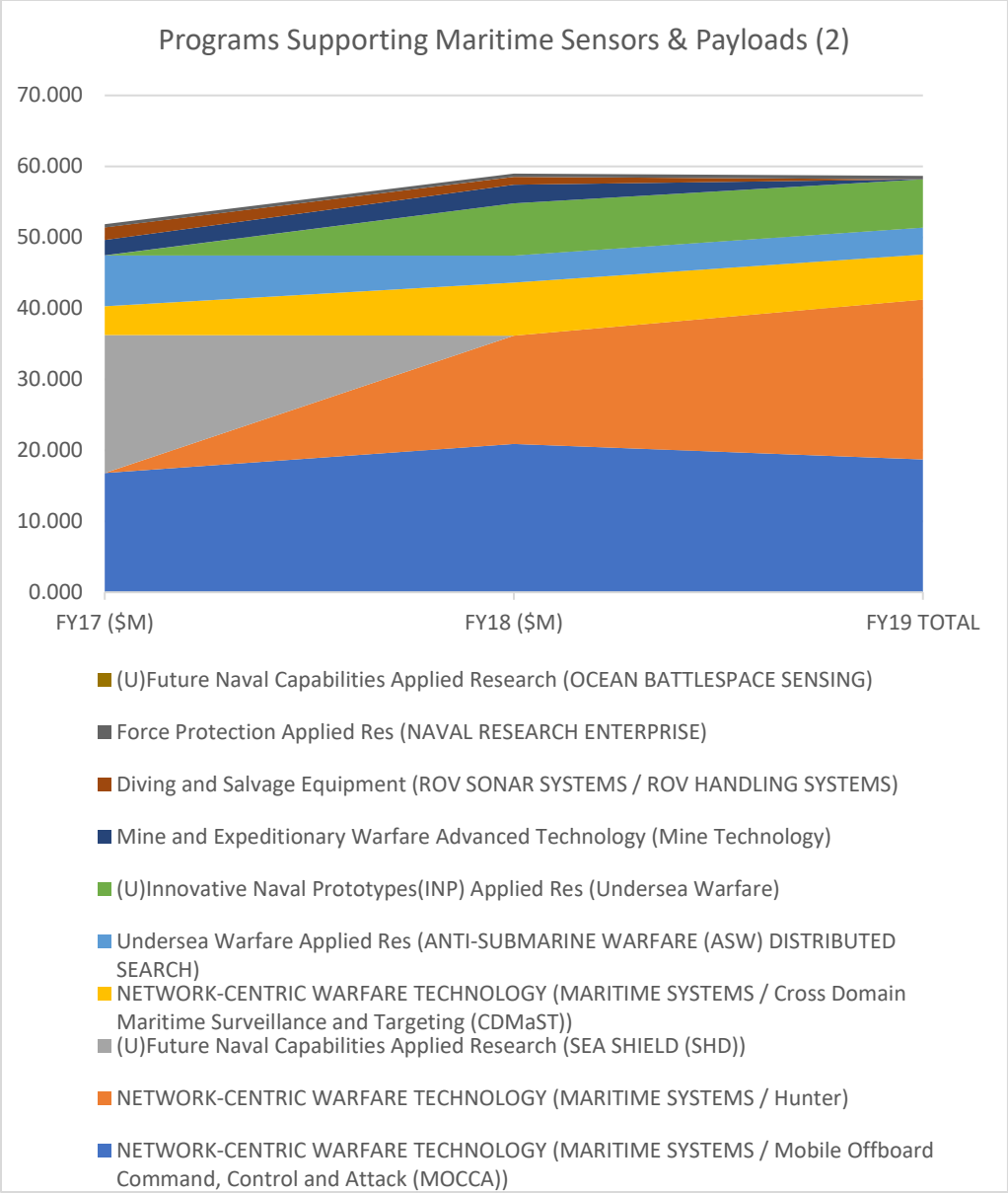


FIGURE 33: PROGRAMS SUPPORTING MARITIME SENSORS AND PAYLOADS

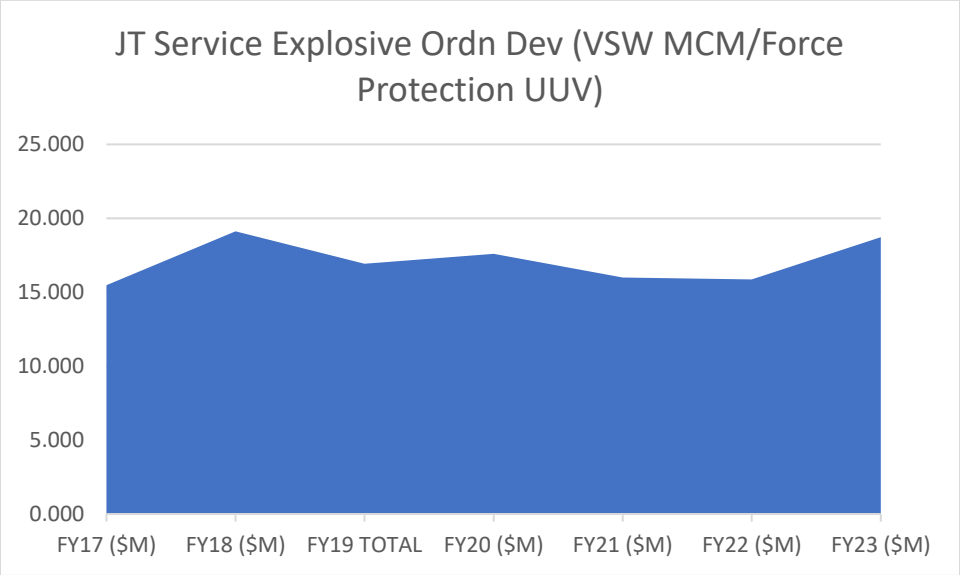
TABLE 25: LISTING OF PROGRAMS SUPPORTING MARITIME SENSORS AND PAYLOADS

Organization	PE Number	Funding Type	Title	Notes
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Mobile Offboard Command, Control and Attack (MOCCA))	Mobile Offboard Command, Control and Attack (MOCCA) program seeks to counter the fourth generation submarine signature quieting technology that has significantly degraded passive anti-submarine warfare (ASW) sonar detection range and targeting performance. The MOCCA program will nullify submarine signature reduction trends with active sonar projectors deployed from a mobile unmanned undersea vehicle (UUV) and cooperatively processed with onboard submarine acoustic receive sonar systems. The off-board UUV sonar projector will operate, under positive control, at a

				significant distance from the cooperative submarine using communication links. FY 2019 Plans: - Perform systems integration of active sonar and communication payload systems aboard test MOCCA UUV platforms. - Perform at-sea functional performance testing of MOCCA active sonar and communications systems. - Conduct integration of MOCCA sonar and communications Roll-on/Roll-off processors on-board a test submarine. - Conduct at-sea MOCCA system demonstration and performance analysis.
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Hunter)	Hunter program seeks to develop novel concepts for Extra Large Unmanned Undersea Vehicles (XLUUVs) to deliver complex payloads. FY 2018 Plans: - Develop preliminary advanced payload controller interface. - Develop system requirements for the Hunter payload delivery carriage and host vehicle integration. - Complete preliminary system design of the Hunter payload delivery carriage. - Initiate information assurance analysis of payload delivery carriage. FY 2019 Plans: - Complete design of Hunter payload delivery carriage. - Fabricate Hunter payload delivery carriage. - Perform stand-alone in-water test of Hunter payload delivery carriage. - Apply information assurance measures to Hunter payload delivery carriage. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 increase reflects the initiation of fabrication and testing of the system and initial integration with the XLUUV vehicle.
US Navy	0602750N	RDT&E	(U)Future Naval Capabilities Applied Research (SEA SHIELD (SHD))	Autonomous USV for mine warfare (FY17): situational awareness and hazard avoidance; magnetic influence sweep payload; automated refueling and data transfer to host refueling ship in up to SS3
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Cross Domain Maritime Surveillance and Targeting (CDMaST))	Cross Domain Maritime Surveillance and Targeting (CDMaST) program seeks to identify and implement architectures consisting of novel combinations of manned and unmanned systems to execute long-range kill chains and develop a robust "kill web" against submarines and ships over large contested maritime areas. In FY18, Develop autonomous surface platform architecture for distributed sensing and effects.
US Navy	0602747N	RDT&E	Undersea Warfare Applied Res (ANTI-SUBMARINE WARFARE (ASW) DISTRIBUTED SEARCH)	Complete effort to develop and demonstrate real time onboard processing for a UUV to detect, classify, and track submarines using active sonar; detect and classify the ultra-quiet, low-Doppler submarine threat in complex environments using multiple autonomous AUVs; enable detection and classification of adversarial UUVs
US Navy	0602792N	RDT&E	(U)Innovative Naval Prototypes(INP) Applied Res (Undersea Warfare)	Unmanned environmental observing system in support of persistent monitoring of environmental conditions; decrease due to completion of USV project
US Navy	0603782N	RDT&E	Mine and Expeditionary Warfare Advanced Technology (Mine Technology)	Undersea weapons including remote control, advanced sensing and compatibility with unmanned delivery options
US Navy	1130	Procurement	Diving and Salvage Equipment (ROV SONAR SYSTEMS / ROV HANDLING SYSTEMS)	ROV sonar (FY17) and handling systems (FY18)

US Navy	0602123N	RDT&E	Force Protection Applied Res (NAVAL RESEARCH ENTERPRISE)	Active Sonar-based Cooperative UUV Interception
US Navy	0602750N	RDT&E	(U)Future Naval Capabilities Applied Research (OCEAN BATTLESPACE SENSING)	The technologies being pursued under this activity include, but are not limited to, investments that: improve the detection and neutralization of mines in both the ocean and littoral environment; exploit advancements in maritime sensing, ocean engineering, marine systems, and undersea signal processing, and improve our understanding of the environment and the limits of predictability by maturing technologies in fields ranging from the littoral geosciences to high latitude dynamics.

Programs Supporting Maritime Autonomy



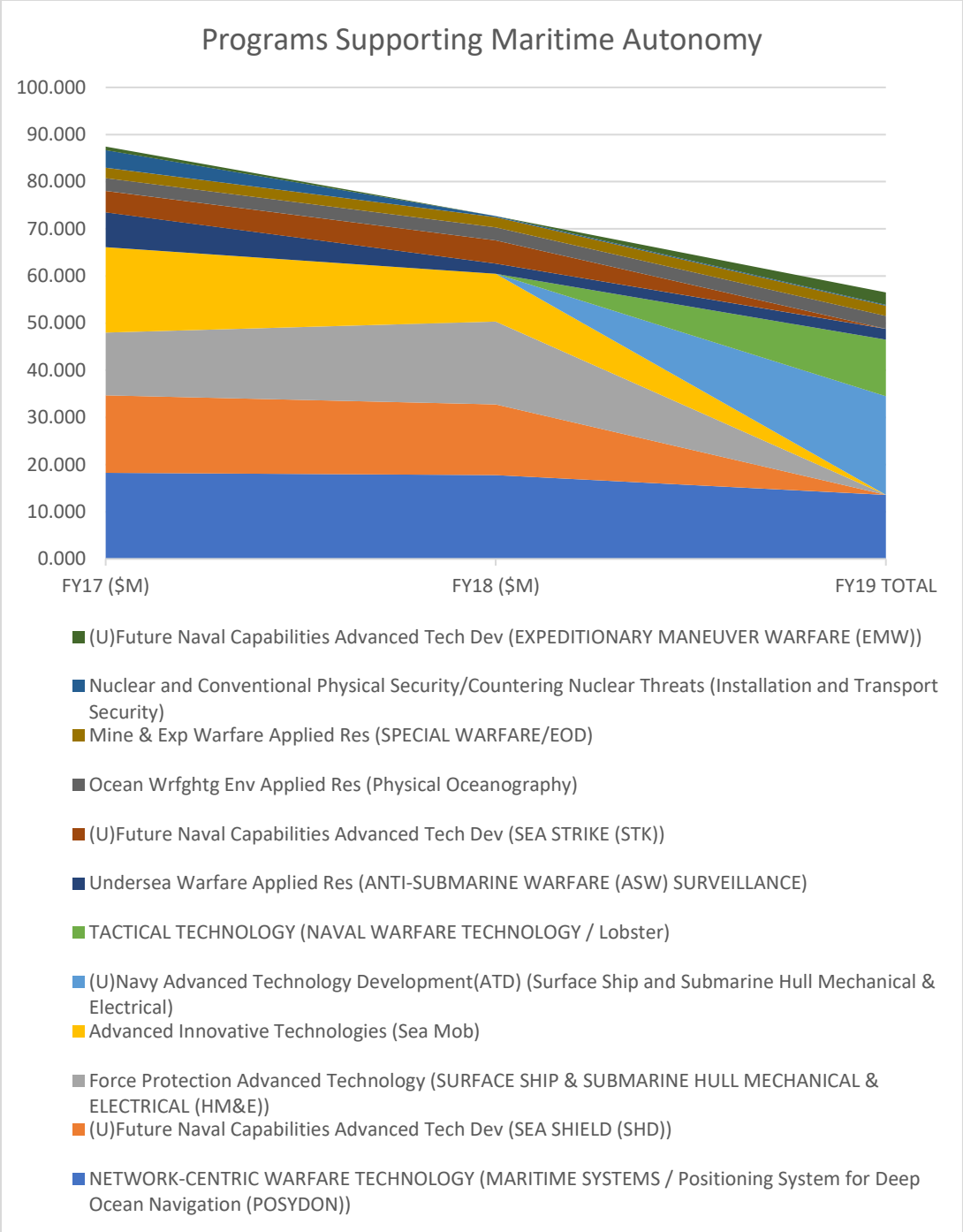


FIGURE 34: PROGRAMS SUPPORTING MARITIME AUTONOMY

TABLE 26: LISTING OF PROGRAMS SUPPORTING MARITIME AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603654N	RDT&E	JT Service Explosive Ordn Dev (VSW MCM/Force Protection UUV)	FY19 efforts will focus on continued development and testing of MK 18 Mod 2 Increment II and modified-off-the-shelf (MOTS) ROV projects. In FY18: Automated Target Recognition

				(ATR), advanced autonomy architecture and enhanced electro-optic sensor performance, improving MCM performance and reducing the tactical timeline through fielding a Reaquire, Identify and Mark capability (mk18 mod 2); MK 18 Mod 1 is undergoing a configuration change that will provide a higher area coverage rate, inclusion of vehicle autonomy, and Automated Target Recognition. Additional efforts will execute the open competition process necessary to acquire and verify an EOD Response ROV capability focusing on user effectiveness and operational suitability. inventory of 48 MK 18 Mod 2 vehicles and 75 MK 18 Mod 1 vehicles.
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Positioning System for Deep Ocean Navigation (POSYDON))	Positioning System for Deep Ocean Navigation (POSYDON) program will provide continuous, Global Positioning System (GPS)-level positioning accuracy to submarines and autonomous undersea vehicles (AUVs) in ocean basins over extended periods of time. FY 2019 Plans: - Design and test a prototype POSYDON system. - Demonstrate POSYDON system performance and utility for relevant AUV platforms. - Quantify the ability of the POSYDON system to support Navy AUV platform operations. - Document results of at-sea testing for all program phases to support future Navy deep-water development.
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (SEA SHIELD (SHD))	Conduct testing and preparations for at-sea demonstrations of XLUUV (FY14-04): autonomous threat detection and localization, remote command and control, tactical positioning and fire control; automation for UXV-based MCM (FY15-03): automated data analysis for target recognition and fusion algorithms; autonomous USV for mine warfare (FY17-02): situational awareness and hazard avoidance system, magnetic influence sweep payload for improved clearance rates and reduced risk from detonation, automated refueling and data transfer.
US Navy	0603123N	RDT&E	Force Protection Advanced Technology (SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E))	Autonomous navigation for USVs from host ship; evaluate emerging energy technologies; demonstrate at-sea three modular payloads to show operational benefit of autonomous MDUSV; FY 2018 to FY 2019 Increase/Decrease Statement: The funding decrease from FY 2018 to FY 2019 reflects the realignment of the funding for Surface Ship & Submarine Hull Mechanical & Electric (HME) to PE 0603671N Navy Advanced Technology Development.
OSD	0604250D8Z	RDT&E	Advanced Innovative Technologies (Sea Mob)	SCO is developing a group of Unmanned Surface Vehicles (USVs) capable of cooperative swarming behaviors. In FY18, Complete maturity of Sea Mob autonomy kit for multiple craft; Conduct in-water exercises against relevant targets for specified missions; Finalize Sea Mob Technical Data Packages for transition.
US Navy	0603671N	RDT&E	(U)Navy Advanced Technology Development(ATD) (Surface Ship and Submarine Hull Mechanical & Electrical)	Development of autonomous navigation for Unmanned Sea Surface Vehicles from host ship; evaluate emerging energy technologies; FY 2018 to FY 2019 Increase/Decrease Statement: The funding increase from FY18 to FY19 reflects the realignment of funding for Surface Ship & Submarine Hull Mechanical & Electrical (HM&E) from PE 0603123N Force Protection Advanced Technology. Additionally, funds are increased in FY 2019 for engineering and prototype development cost associated with the scheduled demonstration of the Vertical Launch System (VLS) Reload at Sea effort.

DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (NAVAL WARFARE TECHNOLOGY / Lobster)	Lobster: The undersea domain has significant importance to national security and military operations. Fiber optic cables, military seabed infrastructure, mines, submarines, unmanned vehicles and oil and gas infrastructure are all within this potentially contested environment. Yet it is a challenging domain in which to operate due to extreme water pressures, restricted communications, ever changing bottom environments, marine fouling and corrosion. The Lobster program seeks to improve U.S. operations in this domain by enabling underwater robotic systems significantly ahead of the state of the art. These robotic systems would be able to execute inspection, characterization, repair, manipulation, recharging, data exfiltration, re-tasking and other high value services without the need for continuous human control and high risk surface ship launch and recovery. Key Lobster technical challenges include scene recognition through visual and acoustic modalities, autonomous behaviors, environmental robustness, vehicle endurance, universality for all unmanned underwater systems, energy storage and interaction with the maritime domain. The anticipated transition is to the Navy. FY 2019 Plans: - Conduct exploratory trade studies to establish feasibility of technical approaches. - Initiate studies on integration within unmanned underwater vehicle system architecture. - Conduct a logistics study to determine vehicle support approaches. The FY 2019 increase reflects program initiation. In FY17, two programs concluded funding: Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV) / Upward Falling Payloads (UFP).
US Navy	0602747N	RDT&E	Undersea Warfare Applied Res (ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE)	Detect and classify the ultra-quiet, low-Doppler submarine threat in complex environments using multiple autonomous AUVs
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (SEA STRIKE (STK))	Autonomy suite for Modular Undersea Heavyweight Vehicle (MUHV) (mission planning, waypoint navigation, vehicle health); MUHV sensors, navigation and guidance (multiband and hybrid sonar, inertial navigation, fiber optic systems) (FY15-03)
US Navy	0602435N	RDT&E	Ocean Wrfghtg Env Applied Res (Physical Oceanography)	Advanced autonomy for operations of gliders and UUVs in extreme environments; gliders work in coordinated teams for a high resolution local forecast model enabling more accurate ocean predictions around Sea Base and Sea Strike areas
US Navy	0602782N	RDT&E	Mine & Exp Warfare Applied Res (SPECIAL WARFARE/EOD)	Applied research in sonar for autonomous EOD; mission support for AUVs (communication, navigation); dual manipulator robots for complex underwater EOD missions
OSD	0603161D8Z	RDT&E	Nuclear and Conventional Physical Security/Countering Nuclear Threats (Installation and Transport Security)	Installation and Transport Security: Robust installation and transport security are vital to preventing a weapon of mass destruction attack or the unauthorized access to key assets such as nuclear weapons and special nuclear material. This capability area will focus on programs and equipment intended to improve the physical security profile of fixed sites and facilities, as well as critical items while in-transit. In FY19, Integrate Man-portable Tactical Autonomous System Unmanned Surface Vehicle controls into the Near-shore Unified Tactical Response capability.
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced	Autonomous USV for mine warfare; off-board refueling and data transfer for USVs; automated data analysis for MCM

			Tech Dev (EXPEDITIONARY MANEUVER WARFARE (EMW))	

Maritime Programs Funding Both Autonomy and Energy/Propulsion

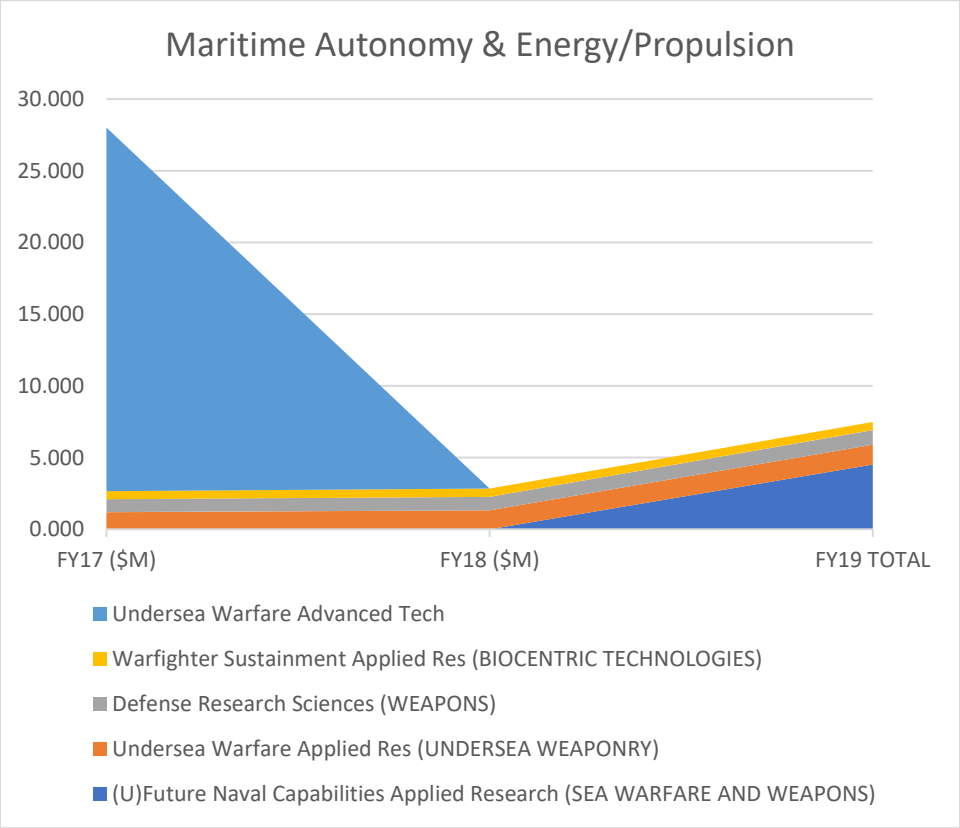


FIGURE 35: MARITIME PROGRAMS SUPPORTING EFFORTS FOR BOTH AUTONOMY AND ENERGY/PROPULSION

TABLE 27: LISTING OF MARITIME PROGRAMS SUPPORTING BOTH AUTONOMY AND ENERGY/PROPULSION

Organization	PE Number	Funding Type	Title	Notes
US Navy	0602750N	RDT&E	(U)Future Naval Capabilities Applied Research (SEA WARFARE AND WEAPONS)	Developments for USVs (hydrodynamics, survivability, electrical and thermal systems, platform structures and autonomy); developments for autonomous vehicles (new battery, fuel cell, liquid and solid fuels, and motors)
US Navy	0602747N	RDT&E	Undersea Warfare Applied Res (UNDERSEA WEAPONRY)	Autonomy & unmanned systems; propulsion systems for undersea platforms
US Navy	0601153N	RDT&E	Defense Research Sciences (WEAPONS)	Enhance performance of existing power/energy sources; autonomous control of surface and subsurface vehicles
US Navy	0602236N	RDT&E	Warfighter Sustainment Applied Res (BIOCENTRIC TECHNOLOGIES)	Sea-floor sediment energy harvesting for sustainable and autonomous powering of underwater sensor networks and AUV's; integration of programmable cellular controllers with

				robotic devices; integrate biomimetic sonar with bioinspired AUV's to achieve closed loop control; advanced biomimetic sensing and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems; brain-based intelligent systems to support high level interaction between warfighters and autonomous systems
US Navy	0603747N	RDT&E	Undersea Warfare Advanced Tech	LDUUV development (energy, autonomy, endurance) - program shifted to PE0603801N (limited funding for ASW mission package - $1.49M in FY19)

Programs Supporting Ground Platforms

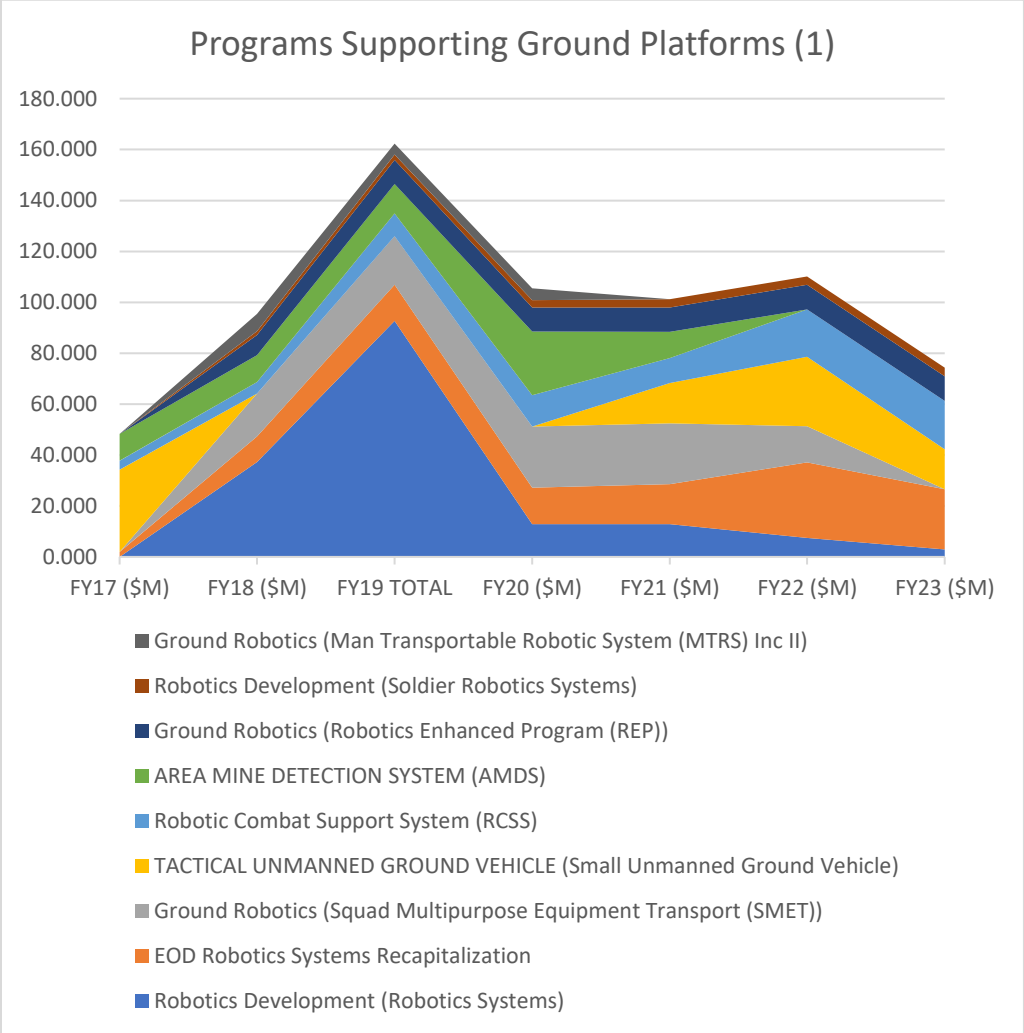


FIGURE 36: PROGRAMS SUPPORTING GROUND ROBOTICS

TABLE 28: LISTING OF PROGRAMS SUPPORTING GROUND PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Army	0604017A	RDT&E	Robotics Development (Robotics Systems)	Tactical Wheeled Vehicle - Leader Follower (TWV-LF) - RD for PdM Applique & Large Unmanned Ground Systems (ALUGS)

				and RCIS Type II ($6.264M FY18, $7.002MFY19): FY19 funding will support the capability development of incremental technology insertions for Program of Records (PoR), technology transitions, testing, and milestone document preparation. Modeling and Simulation (M&S) development and initial prototype testing will refine the system performance to meet required Tactical Wheeled Vehicle-Leader Follower (TWV-LF) system capabilities. Development of a TWV-LF Software Integration Lab (SIL), in addition to M&S efforts, will stress the TWV-LF systems and ultimately reduce Program of Record testing requirements, technical risks and costs through validated simulations. Supports capability development of RCIS Type II, Dismounted Engineer Mobility System (DEMS), and other emerging programs. Tactical Wheeled Vehicle - Leader Follower - Tank Automotive Research Development & Engineering Center (TARDEC) Tech Demo ($30M FY18, $44.5M FY19): FY 2019 funding will continue the fabrication and testing of up to 140 Leader Follower Palletized Load System (PLS) A1 vehicles for user operational assessment in FORSCOM identified units. Systems will go through an Army Test and Evaluation Command (ATEC) safety assessment and plan for Urgent Materiel Release based on the signed Leader Follower Directed Requirement. The issued Leader Follower systems will go through a 12 month Operational Technology Demonstration on CONUS installations to provide user feedback and assessment on the truck performance to inform a future milestone decision for a follow on Leader Follower program of record. Funding supports Robotic Combat Vehicle - Robotic Wingman (RCV-RW) Joint Capabilities Technology Demonstration (JCTD). Robotic Combat Vehicle - Robotic Wingman (RCV-RW)/Automated Convoy Operations (ACO) ($0.985M FY18, $2.298M FY19): FY19 funding continues to support Systems Engineering, Requirements, Cost Analysis and Technology Transition Plans, Software Integration Lab (SIL), and Robotic Combat Vehicle - Robotic Wingman (RCV-RW) Joint Capabilities Technology Demonstration (JCTD) transition to Program of Record. This will include cost, schedule and performance risk reduction efforts (e.g. M&S environment development). Funding also supports Squad Multipurpose Equipment Transport (SMET) Modular Mission Payloads (MMP) and Automation Concept Development. Robotic Combat Vehicle - Experimental Unit Prototypes ($38.904M FY19): RCV Risk Reduction effort will install by-wire kits onto M113 vehicles to enable them to be operated remotely. Platforms will be completed by the end of FY19 for integration with autonomy package and follow on shake out testing. The RCV Experimental Unit Prototyping effort will award multiple contracts to industry partners to develop mobility platform demonstrators, remote lethality systems and aided target recognition systems that are high risk subsystems for the RCV prototypes. Contractors will have approximately 18 months to get their systems ready for a system evaluation at the end of FY20. Virtual assessment tools will be used throughout the development process to get contractor designs into a gaming environment for early soldier evaluations and feedback.

US Army	4867W12001	Procurement	EOD Robotics Systems Recapitalization	MTRS Talon 5a robot used for investigation of suspicious objects and IED threats and Common Robotic System, Heavy to dispose of threats
US Army	0605053A	RDT&E	Ground Robotics (Squad Multipurpose Equipment Transport (SMET))	Squad Multipurpose Equipment Transport (SMET) will help to reduce Soldier loads by transporting mission specific equipment, resupply equipment, and supplies required for extended operations. The SMET will be capable of carrying the equipment currently required to support Infantry and Engineer Platoons in the Infantry Brigade Combat Team (IBCT) for a 72 hour mission without resupply. The SMET will reduce Soldier load, increase squad mobility during combat operations and dismounted maneuvers. SMET will have open architectures, a remote control and support casualty evacuation, power generation/offload and chemical/biological payloads. FY2019 RDTE funding supports the development and purchase of Technical Insertions, Logistics Support Data, and SMET Program of Record (POR) production contract development to include the Statement of Work (SOW) and Request for Project Proposal (RPP). FY2019 RDTE funding also supports Developmental testing at Aberdeen and the completion of the Technology Demonstration. Program management costs to include salaries, travel and miscellaneous expense for the SMET program will also be funded.
US Army	0604641A	RDT&E	TACTICAL UNMANNED GROUND VEHICLE (Small Unmanned Ground Vehicle)	Small Unmanned Ground Vehicle with no funding in FY18-20
US Army	4865M80400	Procurement	Robotic Combat Support System (RCSS)	Procurement of M160 Mine Flail and Route Clearance and Interrogation System (RCIS starts in FY20)
US Army	2888R68260	Procurement	AREA MINE DETECTION SYSTEM (AMDS)	Protection, marking and neutralization of explosive hazards using UGVs
US Army	0605053A	RDT&E	Ground Robotics (Robotics Enhanced Program (REP))	The Robotics Enhanced Program (REP) uses a "buy/lease, try and inform" methodology to evaluate Commercial Off the Shelf (COTS), Government Off the Shelf (GOTS) and Non-Developmental Item (NDI) robotics products that have the potential to enhance Soldier combat effectiveness. Actual operational user feedback and evaluation results obtained will inform emerging capabilities and requirements documents in support of a return on investment to support future Army decision making. Fiscal Year 2019 RDTE funding for the REP will be utilized to fund Iteration 19.1 and 19.2 and out-of-cycle iterations which will fund salaries, travel, ERDC and ATEC support, RDECOM support, CoE support, Battle Lab support, and associated experiments. REP will also prepare for and complete Knowledge Point 3 (KP3) in 4QFY19, which will provide a status of the REP to the Program Executive Officer.
US Army	0604017A	RDT&E	Robotics Development (Soldier Robotics Systems)	Soldier Borne Sensor (SBS) / Exoskeleton: Provide for the capability of transitioning and continuing development of Industry and DoD Exoskeleton efforts to augment the warfighter strengths and human performance to reduce Soldier load. Provide for the integration and evaluation of potential exoskeleton solutions and completion of initial technical and programmatic data to inform capability requirement generation and subsequent materiel development decision. (FY19 - $1.534M inc from $0.344M in

				FY18) UGV Soldier Robotics Development: Develop initial program cost estimates, conduct market surveys, perform/update Analysis of Alternatives (AoA) or letter of sufficiency, perform risk reduction activities and maturation technology efforts, initiate milestone documentation and prepare Request for Proposal (RFP). (FY19)
US Army	0605053A	RDT&E	Ground Robotics (Man Transportable Robotic System (MTRS) Inc II)	The Man-Transportable Robotic System (MTRS) Inc. II is a modular medium-sized system providing a multitude of standoff capabilities through different payloads for the Army. These capabilities include detect and confirm presence, identify, disposition, and counter hazards by providing a platform for payloads in support of current and future mission requirements. MTRS Inc. II will support current and future payload missions for the Engineer's route clearance platoons, Special Operational Forces (SOF) detachments, Chemical Biological Radiological and Nuclear (CBRN), and Explosive Ordnance Disposal (EOD) Units. FY 2019 RDTE funds will enable the MTRS Inc. II program to progress through the EMD phase and into LRIP by funding the following: Production Qualification Test asset procurement, test support, design efforts, contract data procurement, SEPM, travel, Virtual Clearance Training Suite development, and other expenses related to the MTRS Inc. II RDTE program.

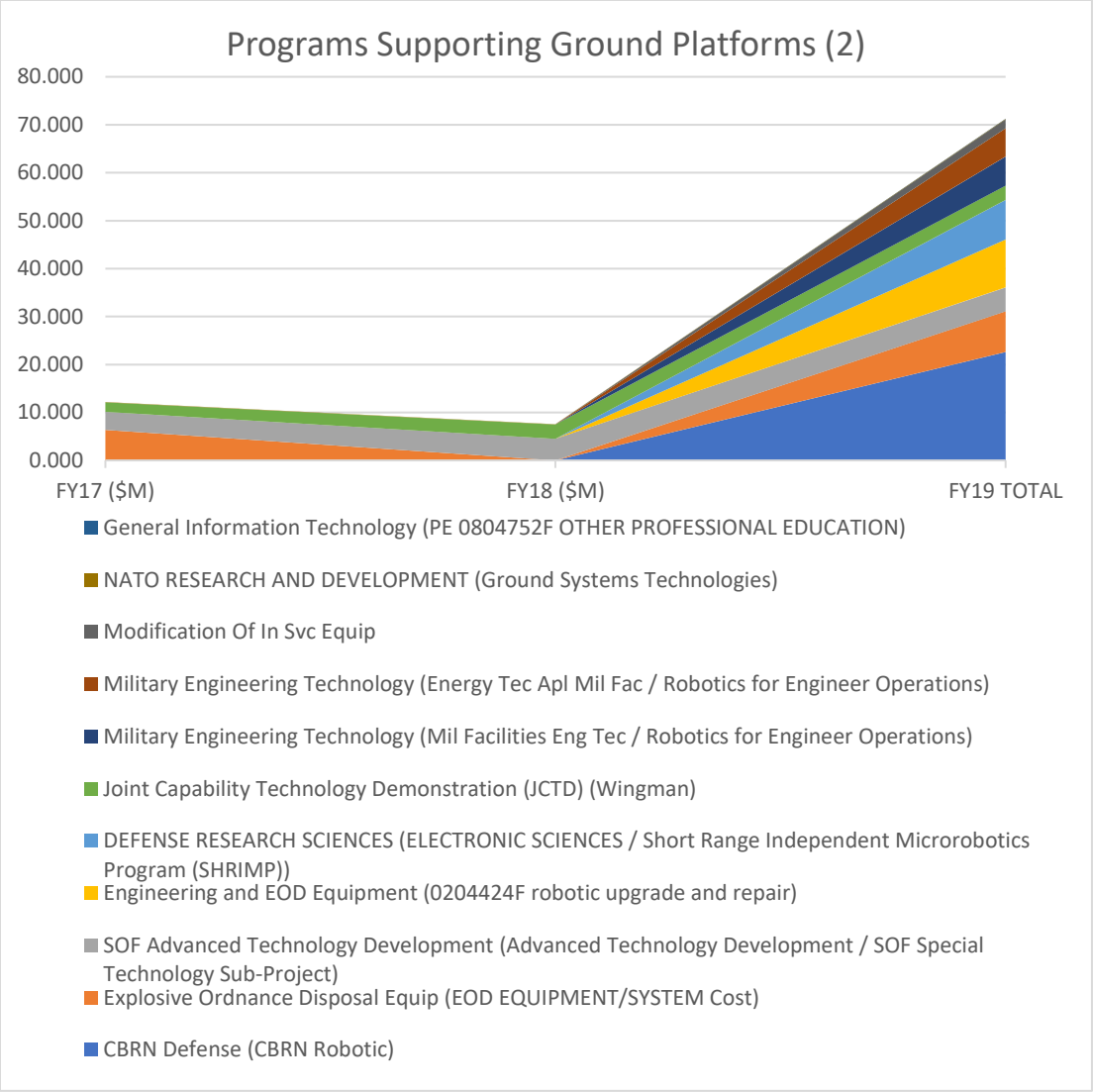


FIGURE 37: PROGRAMS SUPPORTING GROUND PLATFORMS

TABLE 29: LISTING OF PROGRAMS SUPPORTING GROUND PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Army	4516M01001	Procurement	CBRN Defense (CBRN Robotic)	Procurement of CBRN robotics and associated fielding labor (QinetiQ - 28 @ $702,360 ea)
US Navy	5509	Procurement	Explosive Ordnance Disposal Equip (EOD EQUIPMENT/SYSTEM Cost)	AEODRS Inc 1/2 ground robots
SOCOM	1160402BB	RDT&E	SOF Advanced Technology Development (Advanced Technology Development	In FY18/FY19, Continue developing unique robotic systems to reduce the load of the operator and augment human performance.

			/ SOF Special Technology Sub-Project)	
USAF	845100	Procurement	Engineering and EOD Equipment (0204424F robotic upgrade and repair)	EOD Robotic upgrade and repair until AEODRS Inc 3 is phase in
DARPA	0601101E	RDT&E	DEFENSE RESEARCH SCIENCES (ELECTRONIC SCIENCES / Short Range Independent Microrobotics Program (SHRIMP))	The Short Range Independent Microrobotics Program (SHRIMP) will develop microrobots with the ability to clandestinely enter tactical environments and perform close-proximity (within 10cm) functions. These ant-sized microrobots could obtain local sensing data, such as visual, audio, or chemical trace data, whereas similar capabilities today would require hand-placed sensors or not be performed at all. FY 2019 Plans: - Develop and demonstrate actuation mechanisms for microrobot mobility with high power efficiency and sufficient payload capacity. - Prove integration of lightweight control and navigation systems. - Demonstrate integration of robust and efficient modalities for locomotion. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 increase reflects program initiation.
OSD	0603648D8Z	RDT&E	Joint Capability Technology Demonstration (JCTD) (Wingman)	Wingman: FY 2018 Plans: Demonstrate the first unmanned system certified on the U.S. Army table VI scout gunnery course and refinement of the Wingman operating system. FY 2019 Plans: Conduct final Military Utility Assessment (MUA) of maneuver operations and Wingman technologies in cooperation with U.S. Central Command and U.S. Army. Transition components to Product Manager, U.S. Army Applique and Large Unmanned Ground Systems (PM USA ALUGS); Program Executive Officer, U.S. Marine Corps Land Systems; and U.S. Army Research, Development, Engineering Command. Complete the JCTD.
US Army	0602784A	RDT&E	Military Engineering Technology (Mil Facilities Eng Tec / Robotics for Engineer Operations)	Will develop robotic construction equipment capabilities allowing Engineers to conduct autonomous and semi-autonomous mobility, countermobility and construction missions. Design proof of concept for a prototype robotic obstacle-removal platform, and develop advanced construction methods for deployed forces. (New start program in FY19)
US Army	0602784A	RDT&E	Military Engineering Technology (Energy Tec Apl Mil Fac / Robotics for Engineer Operations)	Develop robotic construction capabilities for forward deployed Engineers. This includes autonomous site characterization for construction; debris and obstacle removal; horizontal infrastructure repair; obstacle emplacement; control methodologies for multiple robotic construction equipment to work collaboratively and cooperatively, and additive printing using concrete or other cementitious materials for onsite implementation and use. (Effort initiates in FY19)
US Army	8992DA0924	Procurement	Modification Of In Svc Equip	OCO funding for procurement of Robot Deployment System for Medium Mine Protected Vehicle (MMPV)
US Army	0603790A	RDT&E	NATO RESEARCH AND DEVELOPMENT (Ground Systems Technologies)	FY 2019 funding will be used to fund the continuation of cooperative projects in armored vehicle underbody blast protection and unmanned ground vehicles such as Hybrid Electric Project Agreement between US and Japan.
USAF	834010	Procurement	General Information Technology (PE 0804752F	Educational equipment including a Pioneer Power-Bot AGV Robot in FY17 (no note of what is funded in FY18/19)

			OTHER PROFESSIONAL EDUCATION)	

Programs Supporting Mobility

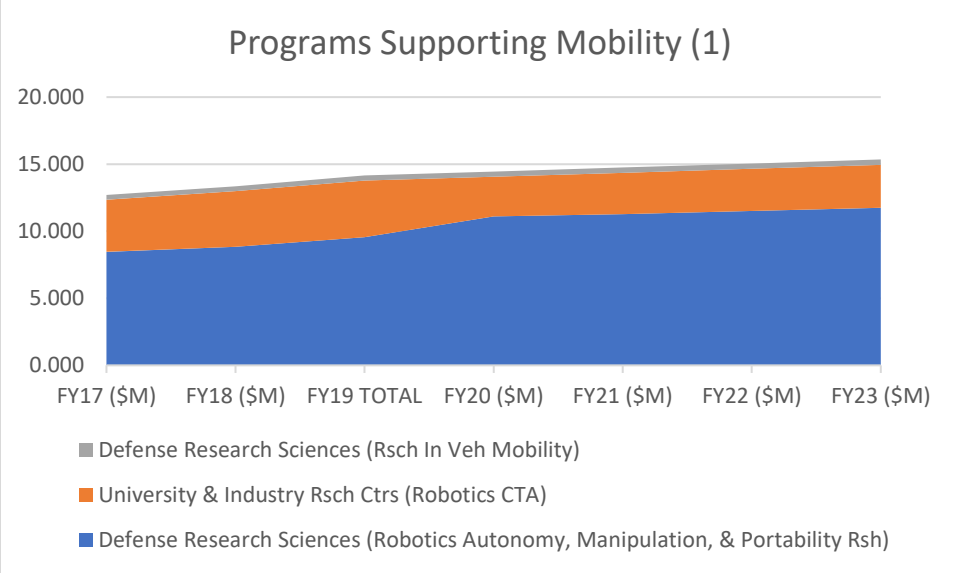


FIGURE 38: PROGRAMS SUPPORTING MOBILITY

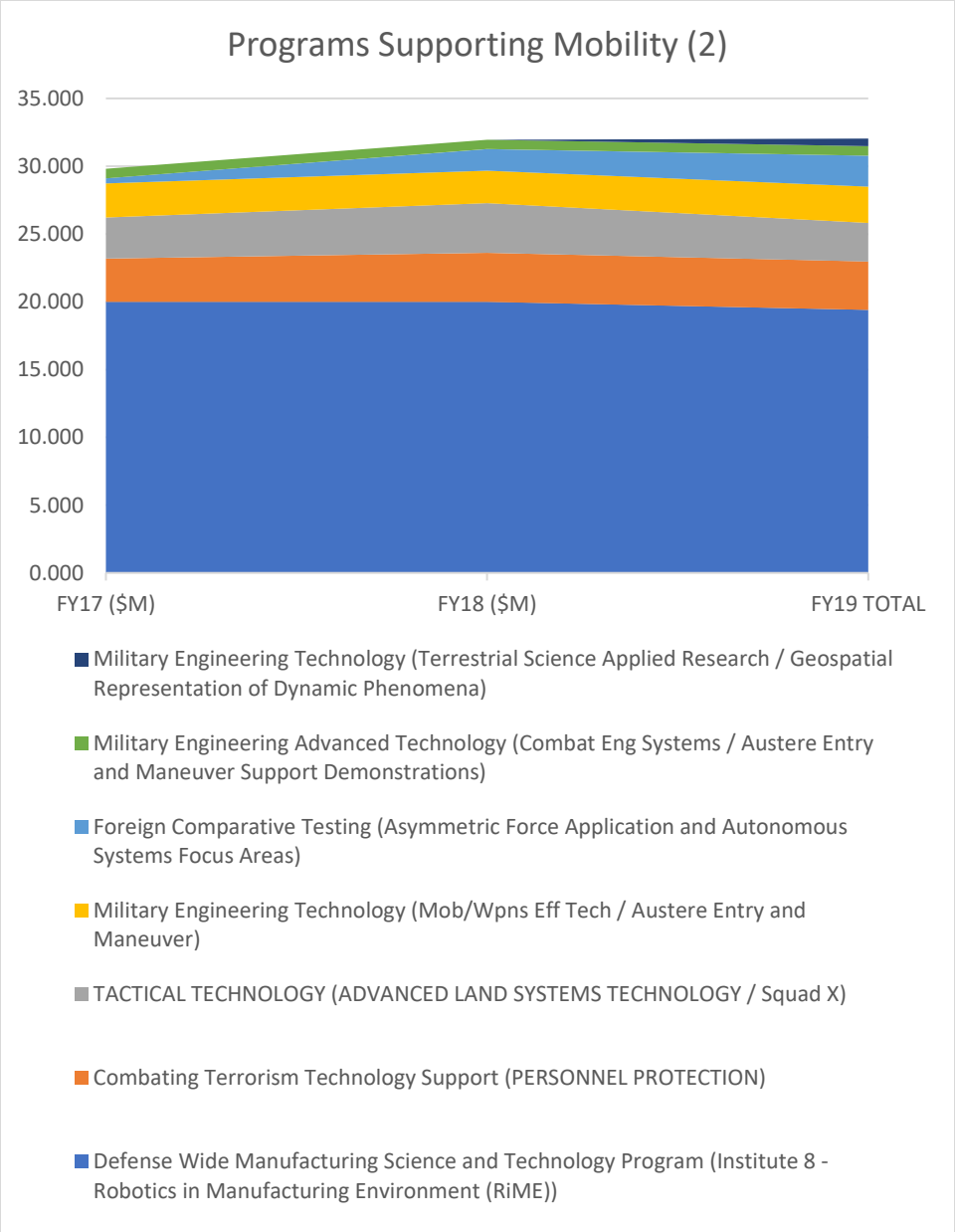


FIGURE 39: PROGRAMS SUPPORTING MOBILITY

TABLE 30: LISTING OF PROGRAMS SUPPORTING MOBILITY

Organization	PE Number	Funding Type	Title	Notes
US Army	0601102A	RDT&E	Defense Research Sciences (Robotics Autonomy, Manipulation, & Portability Rsh)	Autonomous mobility for small robotic systems, including autonomous operations in Global Positioning System (GPS) denied areas; investigate methods to enable the teaming of intelligent systems with Soldiers; perceptual and intelligence methods to enable an autonomous system to participate in squad level missions; enable unmanned air vehicles to interact with the environment while airborne; simulations of unmanned air system (UAS) swarm behavior to enable human-agent teaming

US Army	0601104A	RDT&E	University & Industry Rsch Ctrs (Robotics CTA)	Assess ability for robots to maneuver in unstructured environments, team with humans to execute complex missions, and perform autonomous mobile manipulation in ad hoc scenarios
US Army	0601102A	RDT&E	Defense Research Sciences (Rsch In Veh Mobility)	Develop control algorithms in a semi-autonomous robotic system engaged in extreme mobility scenarios
OSD	0603680D8Z	RDT&E	Defense Wide Manufacturing Science and Technology Program (Institute 8 - Robotics in Manufacturing Environment (RiME))	Institute 8 - Robotics in Manufacturing Environment (RiME): The Institute will focus on technology areas such as human robot interaction, adaption, learning, manipulation, autonomy, mobility and perception.
OSD	0603122D8Z	RDT&E	Combating Terrorism Technology Support (PERSONNEL PROTECTION)	IMPROVISED DEVICE DEFEAT (IDD): in FY18, Complete an East Coast-based technology requirement gathering capability exercise (TRG CAPEX) to develop and test advanced skills to maneuver hazardous duty robots in challenging, real-world scenarios. Complete development of a robot-mounted X-ray Backscatter system for VBIED diagnostics. Conduct a workshop that integrates EOD and Public Safety Bomb Technicians with engineers and roboticists to collaboratively design and develop new capabilities for VBIED response (FY19 also). Initiate development of a humanoid robot for use in IED Defeat operations in urban environments (FY19 also). Initiate the development of an enhanced spatial awareness capability for robotic platforms that can maintain 360-degree awareness of the platform's surrounding environment (FY19 also). In FY19, Initiate development of bomb disposal tools for deployment on, or by, small UAS-based platforms. Initiate development of a low cost obstruction avoidance and proximity alert system for robotic platforms. Initiate development of an electronic, user-updatable UAS Guidebook that can be used as a quick reference during response operations for identification and analysis of downed UAS platforms. Initiate development of a rapidly mountable backscatter X-ray system for small to medium sized robotic platforms.
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (ADVANCED LAND SYSTEMS TECHNOLOGY / Squad X)	Squad X: The goal of the Squad X program is to leverage advances in real-time situational awareness and mission command; organic three-dimensional dismount mobility; extended range tracking, targeting, and response; and unmanned mobility and perception in order to create a squad with substantial combat overmatch. The concept of overmatch at the squad level includes increased human stand-off, a smaller force density, and adaptive sensing to allow for responses at multiple scales. Squad X will explore advanced wearable force protection, advanced organic squad level direct and indirect trajectory precision weaponry, and non-kinetic precision capabilities. The end result of the Squad X program is an individual dismount unit outfitted with sensors, weaponry, and supporting technology to achieve unit level overmatch as well as the overall integration of unmanned assets alongside the dismounts to create an advanced, dismounted small unit.
US Army	0602784A	RDT&E	Military Engineering Technology (Mob/Wpns	Develop baseline model and simulation tools for autonomous ground resupply operations (FY18). Provide an updated version of a real-time hardware-in-the-loop simulation environment to investigate autonomous vehicle maneuver; develop software

			Eff Tech / Austere Entry and Maneuver)	to automatically detect mobility obstacles in near-real time (FY19).
OSD	0603133D8Z	RDT&E	Foreign Comparative Testing (Asymmetric Force Application and Autonomous Systems Focus Areas)	During FY 2019, FCT will focus on selecting projects supporting the below Asymmetric Force Application and Autonomous System Areas including Mobile unmanned systems that must maneuver in an environment with little or no human assistance.
US Army	0603734A	RDT&E	Military Engineering Advanced Technology (Combat Eng Systems / Austere Entry and Maneuver Support Demonstrations)	Mature and demonstrate simulation and decision support tools to ensure both manned and unmanned ground vehicle mobility in complex, urban, and constantly changing environments.
US Army	0602784A	RDT&E	Military Engineering Technology (Terrestrial Science Applied Research / Geospatial Representation of Dynamic Phenomena)	Will investigate new methods to identify, characterize, track and visualize battlespace objects that change with time (examples include rubble, bridge damage, vehicles, street markets, flooding and other weather induced effects) impacting Soldier and unmanned systems movement and maneuver in complex terrain. (new start in FY19)

Programs Supporting Communications & Data Management in Multiple Domains

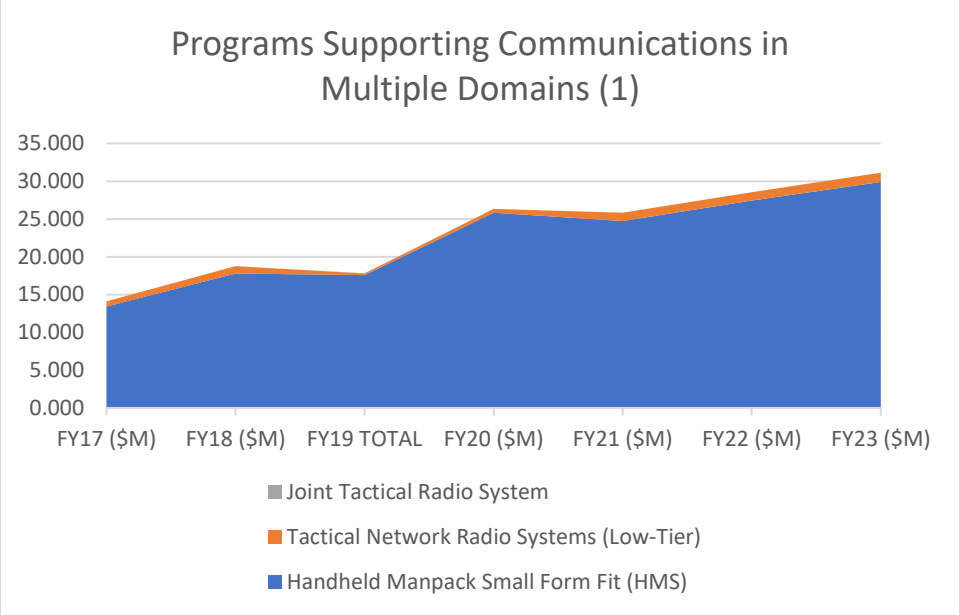


FIGURE 40: PROGRAMS SUPPORTING COMMUNICATIONS AND DATA MANAGEMENT IN MULTIPLE DOMAINS

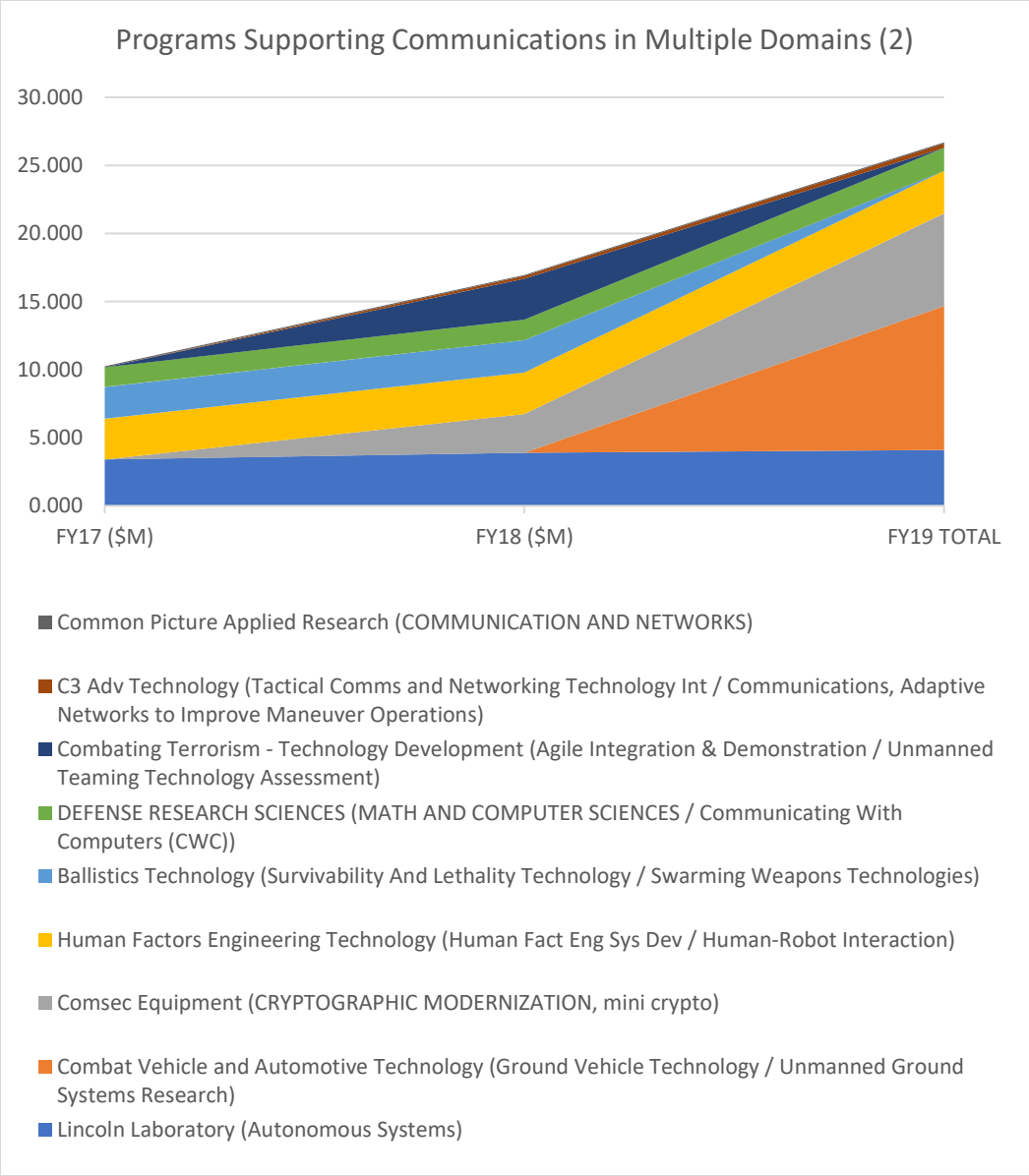


FIGURE 41: PROGRAMS SUPPORTING COMMUNICATIONS AND DATA MANAGEMENT IN MULTIPLE DOMAINS

TABLE 31: LISTING OF PROGRAMS SUPPORTING COMMUNICATIONS & DATA MANAGEMENT IN MULTIPLE DOMAINS

Organization	PE Number	Funding Type	Title	Notes
US Army	6458B95004	Procurement	Handheld Manpack Small Form Fit (HMS)	Radio hardware for data services to tactical end users including unmanned systems
US Army	0605042A	RDT&E	Tactical Network Radio Systems (Low-Tier)	HMS radios will provide voice and support for data services such as text, control graphics, imagery, video, and telemetry to Warfighters and tactical end user devices including unmanned systems
US Army	6450B90000	Procurement	Joint Tactical Radio System	Radio hardware for data services to tactical end users including unmanned systems

OSD	0602234D8Z	RDT&E	Lincoln Laboratory (Autonomous Systems)	FY 2018 Plans: Coordination of robot swarms will continue to add features that allow optimization of goals even with a great deal of uncertainty for example, “the fog of war”. These improvements rely on continuing research in multi-agent coordination and machine learning algorithms. One learning algorithm project will emulate biological thinking for adapting to changing knowledge. Advances in autonomous systems rely not only on improved algorithms, but also better interfaces between hardware and algorithms, as well as more suitable hardware. This project area will conduct research into better tactile interfaces for grasping and manipulation, with an additional focus on building autonomous systems that will perform within prescribed performance bounds. These research thrusts will have important applications in autonomous robot augmentation for the warfighter. Also, being aware that the noise of an autonomous Unmanned Aerial Vehicle (UAV) can compromise its mission, work on an electro-aerodynamic (EAD) propulsion system will lead to sustained noiseless flight. In addition, a study will provide an autonomous undersea mapping framework for future efforts. FY 2019 Plans: As autonomous systems play an increasingly important role in the DoD, work in autonomous undersea mapping will rely on new algorithms, new autonomous undersea vehicles, and communications to interface between distributed sources of information and distributed, multiple agents. Research on EAD UAVs will continue to improve performance and make the system more robust. Incorporation of algorithms from the commercial world will hasten the development of autonomous systems for the DoD. Incorporation of technology improvements from the commercial world will lead to improvements in lower Size, Weight, Power and Cost (SWaP-C) systems. Novel energy harvesting strategies will be explored to support a variety of missions.
US Army	0602601A	RDT&E	Combat Vehicle and Automotive Technology (Ground Vehicle Technology / Unmanned Ground Systems Research)	Will investigate vehicle behaviors to enable teamed robotic and autonomous systems to support specific capabilities supporting Army combat formations. Will research and design common user interfaces for remote lethality with limited targeting assist. Will research automation software and algorithms, increased robotic reliability and function, and determine certified safety procedures for soldier-operated armed UGVs. Will conduct experiments using various commercial network solutions. Funding was initiated in FY 19 for Combat Vehicle Robotics acceleration.
USAF	831010	Procurement	Comsec Equipment (CRYPTOGRAPHIC MODERNIZATION, mini crypto)	Mini crypto chip used to secure communications between unmanned systems (potentially across domain) - 229 in FY19 @ $30,000 ea)
US Army	0602716A	RDT&E	Human Factors Engineering Technology (Human Fact Eng Sys Dev / Human-Robot Interaction)	Will extend advances in multimodal, bidirectional communications models, including natural language solutions for small teams, to enhance Soldier collaborations with multiple heterogeneous agents in a distributed operational environment; enhance models of trust and transparency to include adaptive roles for both humans and agents and serve as basis for human centered design requirements in multi-agent systems; explore applications for bidirectional

				communication and trust and transparency to include both mounted and dismounted operations.
US Army	0602618A	RDT&E	Ballistics Technology (Survivability And Lethality Technology / Swarming Weapons Technologies)	Produce realistic models for targets in complex environments; determine reduced-bandwidth communications strategy between vehicles; implement these navigation technologies in simple experiments (e.g., ground or air robots).
DARPA	0601101E	RDT&E	DEFENSE RESEARCH SCIENCES (MATH AND COMPUTER SCIENCES / Communicating With Computers (CWC))	The Communicating With Computers (CWC) program is advancing human-computer interaction by enabling computers to comprehend language, gesture, facial expression and other communicative modalities in context. CWC advances will impact military application areas such as robotics and command and control.
US Army	0603125A	RDT&E	Combating Terrorism - Technology Development (Agile Integration & Demonstration / Unmanned Teaming Technology Assessment)	Identify components, technologies and enablers required to establish a manned unmanned teaming capability to provide enhanced combat power in complex and contested environments. Determine component priority by assessing unmanned capabilities in support of realistic mission scenarios. Primary components of the assessment include: Soldiers, unmanned ground vehicles, unmanned air vehicles, command and control, communications and lethality. (Effort concludes in FY18; planned progression of effort.)
US Army	0603794A	RDT&E	C3 Adv Technology (Tactical Comms and Networking Technology Int / Communications, Adaptive Networks to Improve Maneuver Operations)	Optimize networking solutions to meet the needs of autonomous platforms to support manned/unmanned-teaming (MUM-T). (FY19)
US Navy	0602235N	RDT&E	Common Picture Applied Research (COMMUNICATION AND NETWORKS)	Improved wireless communication systems; UUV data exfiltration

Programs Supporting Weapons

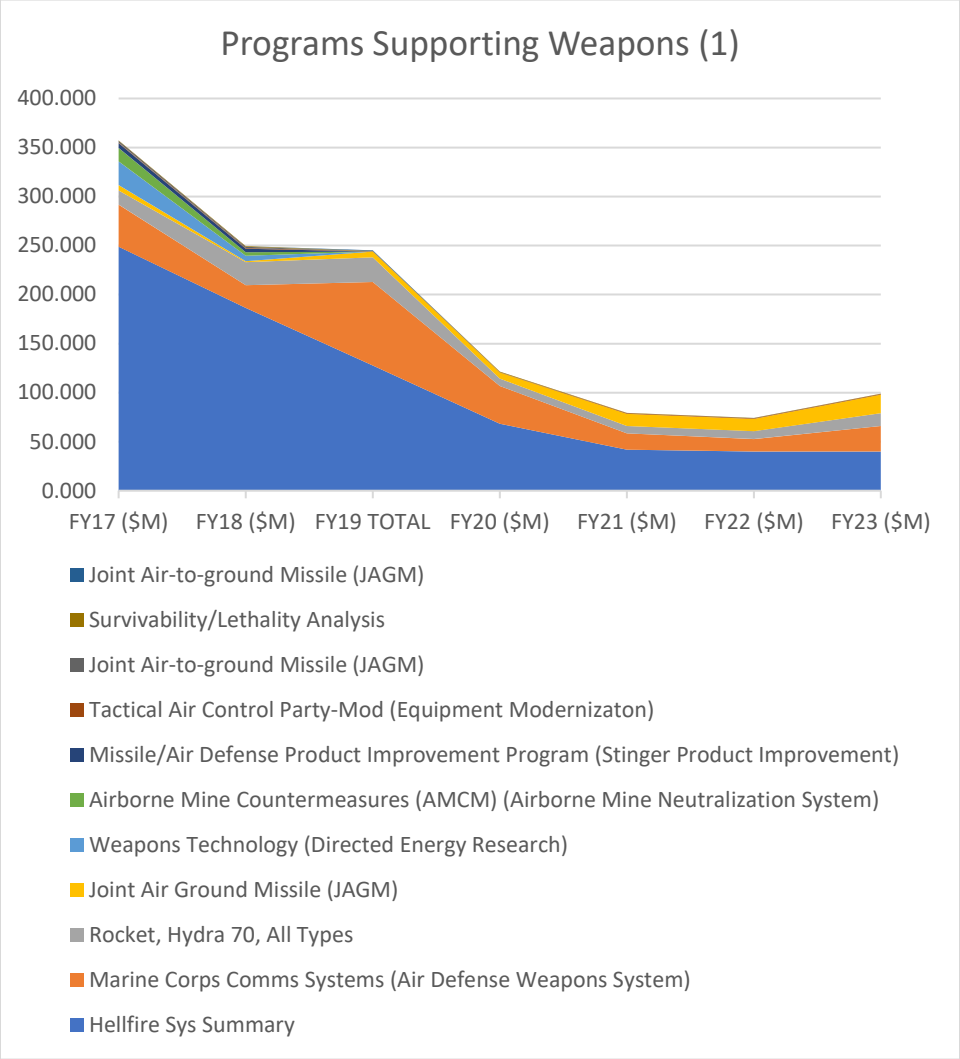


FIGURE 42: PROGRAMS SUPPORTING WEAPONS INTEGRATED ON UNMANNED SYSTEMS OR FOR C-UXS

TABLE 32: LISTING OF PROGRAMS SUPPORTING WEAPONS INTEGRATED ON UNMANNED SYSTEMS OR FOR C-UXS

Organization	PE Number	Funding Type	Title	Notes
US Army	1338C70000	Procurement	Hellfire Sys Summary	Hellfire missile procurement for UAS and helicopters
US Navy	0206313M	RDT&E	Marine Corps Comms Systems (Air Defense Weapons System)	Systems provide capabilities such as detect, track, identify, threat negation and lethal destruction, to include utilizing a slew-to-cue optic for a high energy laser engagement (FY18/19); in FY19 OCO Funding will purchase Coyote multi-mission C-UAS drone launchers, C-UAS Component Integration Kits for the Joint Lightweight Tactical Vehicle (JLTV) and a C-UAS C2 Network.
US Army	3246E37300	Procurement	Rocket, Hydra 70, All Types	Aviation rockets and small guided munitions used on both manned and unmanned platforms

US Navy	2248	Procurement	Joint Air Ground Missile (JAGM)	Air-launched missile system for unmanned and rotary wing aircraft
MDA	0603178C	RDT&E	Weapons Technology (Directed Energy Research)	The MDA mission is to develop a robust system to defend the United States against ballistic missile attacks at all ranges, in all phases of flight. Using Directed Energy weapons to negate a ballistic missile in boost phase, before a threat missile can deploy countermeasures, will revolutionize missile defense by dramatically reducing the role of interceptors. In FY 2010, the Airborne Laser program proved it is possible to acquire, track and destroy a boosting missile, addressing many aspects of the boost phase kill, but also underscoring the complexity and challenges of fielding such a weapon system. The experience gained from that successful first foray into directed energy system illuminates a new path that integrates a highly efficient, compact electric laser into a high altitude, low-Mach Unmanned Aerial Vehicle capable of flying in the stratosphere. Flying at low speed in relatively calm air at 60,000 feet significantly reduces the need for the complex beam pointing and atmospheric jitter compensation systems that were challenges for the Airborne Laser program. The key to realizing this future high altitude, unmanned directed energy system is the laser. The Directed Energy Research project funds the laboratory development of two high energy laser technologies, the DPAL with Lawrence Livermore National Laboratory (LLNL) and FCL with the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). Both laser technologies have considerable promise for scaling to very high average power while simultaneously achieving high system electrical-to-optical efficiencies, exceeding 40 percent, and very low system weight and volume. The MDA strategy is to reduce technical risk through dual path laboratory development and transition the laboratory development to industry in FY 2018 for high altitude unmanned platform integration and test.
US Navy	0604373N	RDT&E	Airborne Mine Countermeasures (AMCM) (Airborne Mine Neutralization System)	Development of Barracuda - a weaponized unmanned mine neutralization capability deployed from the MCM USV and stored onboard LCS; funding transitioned to 0603502N in FY18.
US Army	0203801A	RDT&E	Missile/Air Defense Product Improvement Program (Stinger Product Improvement)	The Stinger Block I missile is an advanced, fire-and-forget, short-range, man-portable, air defense weapon system. Stinger's mission is to provide the force with low altitude air defense against fixed and rotary wing aircraft, Unmanned Aircraft Systems (UAS) and cruise missiles (CM). Stinger is deployable from the shoulder or from a variety of platforms to include vehicles, helicopters and UAS.
USAF	0207444F	RDT&E	Tactical Air Control Party-Mod (Equipment Modernization)	Close Air Support System (CASS): CASS software is a Fires centric solution which consists of Close Air Support (CAS) and artillery fire support on the battlefield where digitally aided CASS enables efficient execution of a Joint Terminal Attack Controllers mission tasks utilized on all TACP-M systems. The CASS software provides interoperability with joint strike aircraft (F-35, A-10, F-16, F-15, F/A-18, AV-8B, B-52, etc.), Remotely Piloted Aircraft (RPA), Unmanned Aircraft System (UAS), artillery fire support systems, network-enabled weapons, and C2 nodes.
US Navy	0605450N	RDT&E	Joint Air-to-ground Missile (JAGM)	Joint Air-to-Ground Missile (JAGM) air-launched missile system for UAS and manned aircraft (funding realigned to PE 0605450M)

US Army	0605604A	RDT&E	Survivability/Lethality Analysis	The Project provides quantitative lethality and survivability analyses and data for fielded and developmental systems such as Army aviation systems including Unmanned Aerial Vehicles; Funding also provided for Developmental Air and Missile Defense Systems which provide Counter-UAS capabilities such as Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS) and Sentinel.
US Navy	0605450M	RDT&E	Joint Air-to-ground Missile (JAGM)	Joint Air-to-Ground Missile (JAGM) air-launched missile system for UAS and manned aircraft (previously funded in PE 0605450N)

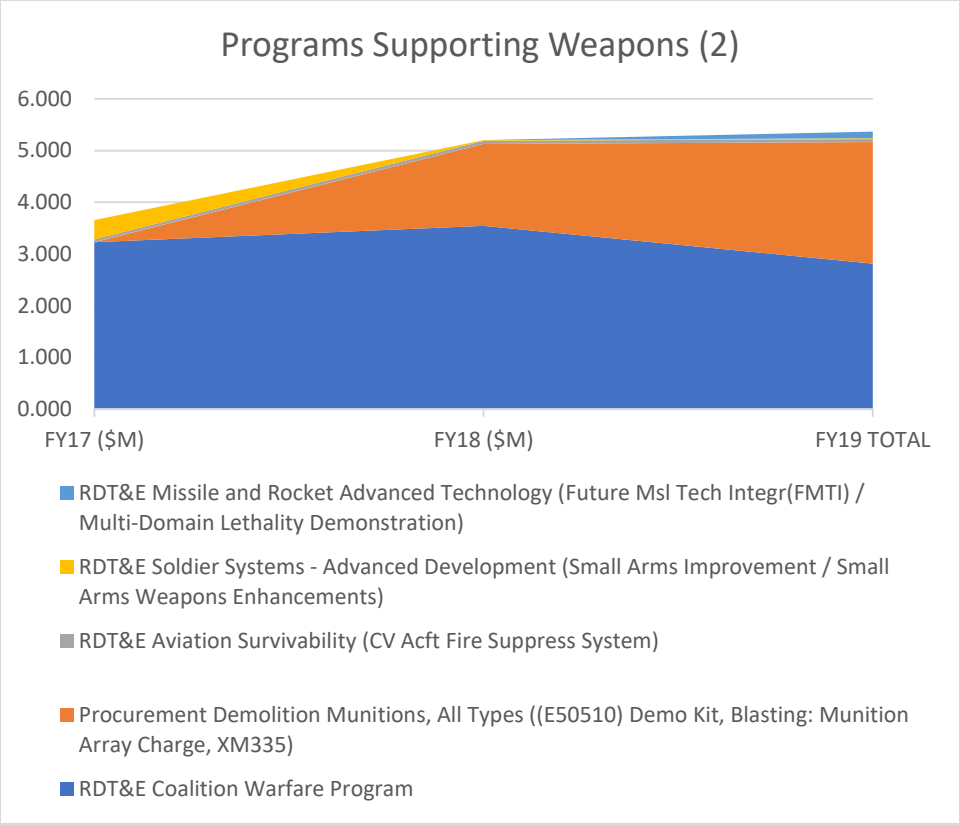


FIGURE 43: PROGRAMS SUPPORTING WEAPONS INTEGRATED ON UNMANNED SYSTEMS OR FOR C-UXS

TABLE 33: LISTING OF PROGRAMS SUPPORTING WEAPONS INTEGRATED ON UNMANNED SYSTEMS OR FOR C-UXS

Organization	PE Number	Funding Type	Title	Notes
OSD	0603923D8Z	RDT&E	Coalition Warfare Program	In FY19, Completion of efforts that will reduce size, weight, and power of imaging sensors, develop autonomous undersea power stations and improve capability of scalable warhead for an unmanned air vehicle.
US Army	2790E55400	Procurement	Demolition Munitions, All Types ((E50510) Demo Kit, Blasting: Munition Array Charge, XM335)	Munition array charge deployed by the Man Transportable Robotic System (MTRS)
US Navy	0603216N	RDT&E	Aviation Survivability (CV Acft Fire Suppress System)	Assess firefighter issues related to unmanned air vehicle systems including composites, weapons and fuel; assess firefighting operations impact on unmanned carrier launched airborne surveillance and strike

US Army	0603827A	RDT&E	Soldier Systems - Advanced Development (Small Arms Improvement / Small Arms Weapons Enhancements)	Armaments for Robots: Begins to initiate the intelligence/networking and weapons design and functions for a man-in-the-loop, small caliber defensive armaments system on an unmanned ground vehicle including the Warfighter/Robot interface. (FY18/FY19)
US Army	0603313A	RDT&E	Missile and Rocket Advanced Technology (Future Msl Tech Integr(FMTI) / Multi-Domain Lethality Demonstration)	Will mature component development of 1) multi-mode seeker (anti-radiation homing and imaging infrared) for target classification/discrimination and aim-point selection on critical target features and 2) warhead and fuse that maximizes lethal effects against multi-domain target sets; will conduct critical design review of component technologies; will perform test and evaluation of key enabling component technologies; will refine concepts for system integration; will mature modeling and simulation HWIL capabilities for testing and validation of integrated components. (new start in FY19 - description notes Manned-Unmanned Teaming but nothing specifically detailed in FY19 plans)

Programs Supporting Multi-Domain Navigation & Control

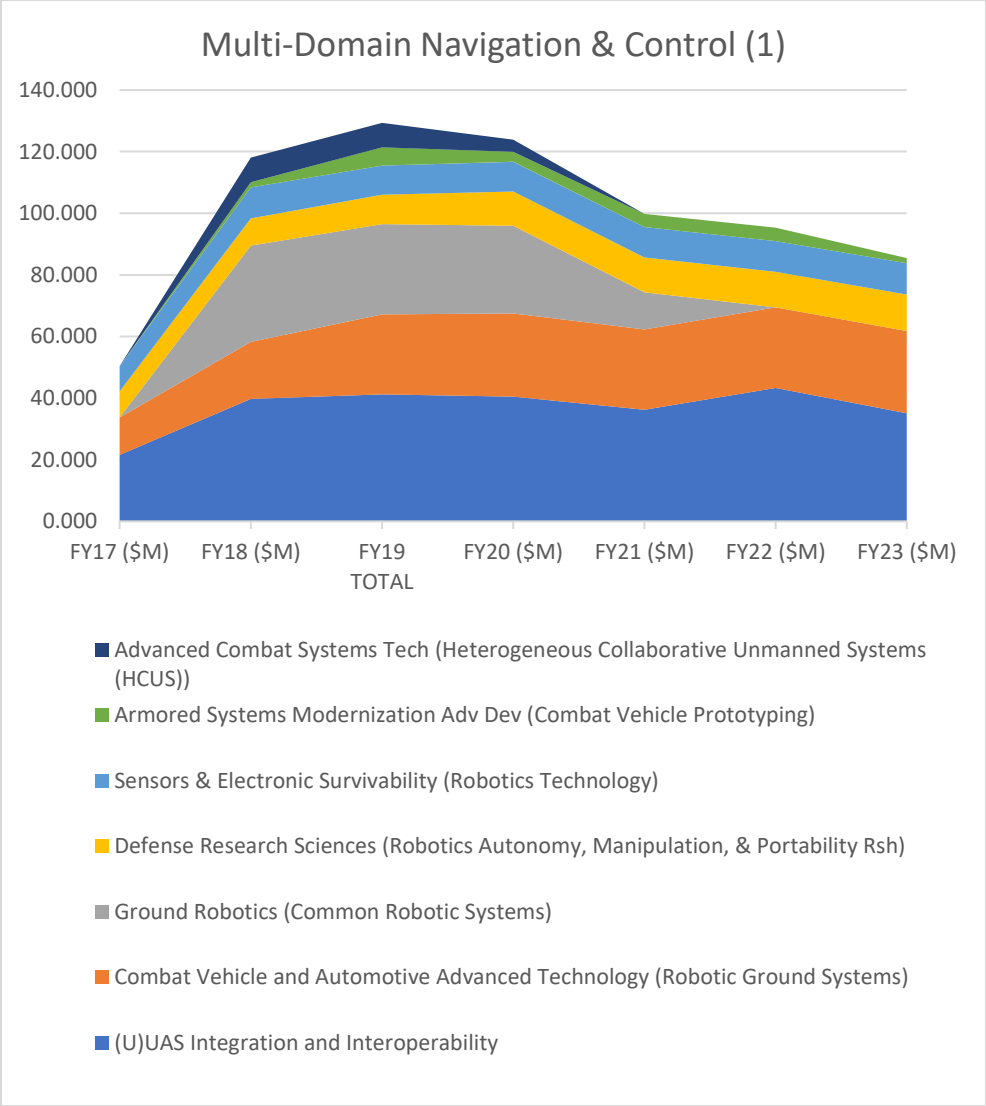


FIGURE 44: PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

TABLE 34: LISTING OF PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
US Navy	0305205N	RDT&E	(U)UAS Integration and Interoperability	Common Control System (CCS) in support of MQ-25 Stingray, MQ-8 Fire Scout, MQ-4C Triton and follow on UxS platforms: Inc 1 Vehicle Management, Inc 2 Mission Management/Mission Planning (MM/MP), Inc 3 cross-domain control of multiple dissimilar UxS
US Army	0603005A	RDT&E	Combat Vehicle and Automotive Advanced Technology (Robotic Ground Systems)	Unmanned Ground Systems Technology: Continue to mature and develop the modeling and simulation tools to support the design, development, testing, and evaluation of autonomous vehicles. Continue to mature and demonstrate hardware-in-the-loop / software-in-the loop integrations of the physics-based simulations with prototype hardware and software

				autonomous vehicle technologies. Begin to mature technologies for manned-unmanned teaming to further extend Autonomous Ground Resupply in a tactical environment, and perform sustainment mission operational experiments to get Warfighter feedback on system performance. Conduct operational experiments with unmanned Reconnaissance Surveillance and Target Acquisition (RSTA) missions leveraging autonomous ground platforms teamed with tethered unmanned aerial vehicles (UAVs). (FY18) Will mature and develop an improved and optimized distribution system that integrates new and emerging technologies across the full spectrum of operational and tactical supply movement operations. Will continue to optimize common interfaces and open architecture. Will mature hardware-in-the-loop simulators to optimize cargo & vehicle configurations and implementations of autonomous ground resupply on realistic routes. Will continue to improve test & evaluation procedures for robotic systems utilizing modeling and simulation tools that will increase vehicle and pedestrian safety along with robotic control and command. (FY19) Autonomous Ground Vehicle Architecture Integration and Demonstration: Publish and demonstrate modularity of an open Autonomous Ground Vehicle Reference Architecture (AGVRA) which will be the foundational architecture for all future autonomous ground vehicle development. Mature and demonstrate advanced vehicle behaviors for defensive maneuvers and tactical convoy formations built upon the open architecture. Mature and integrate off-road path planning software to enable robotic vehicles to perceive, classify and navigate complex, difficult terrains. Improve advanced vehicle behaviors for sustainment convoy operations to improve leader follower functionality, improved obstacle detection and avoidance, and increased platform speed. (FY18) Will mature and develop an improved and optimized distribution system that integrates new and emerging technologies across the full spectrum of operational and tactical supply movement operations. Will continue to optimize common interfaces and architecture for all future autonomous ground vehicle development. Will mature and define open architecture design, data buses and messages. Will exploit automation software and algorithms to increase platform autonomy in increasing complex environments and mission applications. Will mature & demonstrate scalable autonomy in a single material solution agnostic of platform. (FY19) Significant increase in priority in Unmanned Systems Software and autonomy with a strong desire to delivery more capability sooner than was planned in prior years.
US Army	0605053A	RDT&E	Ground Robotics (Common Robotic Systems)	The Common Robotic System - Individual (CRS(I)) is the Army's small sized (<25 lbs.) Soldier back-packable, remotely operated, common robotic system. The system provides dismounted Soldiers with increased standoff capability from hazardous threats. The system consists of a Universal Controller (UC), a suite of payloads, and open architecture common mobility platform allowing for future capability growth. The CRS(I) will be designed so the operator can quickly re-configure for other various missions by adding or removing modules and/or payloads. The CRS(I) will provide interrogation, detection, confirmation, and neutralization capabilities employed to support a wide spectrum of mobility missions for

				current and future forces. This capability provides commanders the ability to persistently monitor the Operating Environment (OE) while protecting and sustaining the force. The CRS(I) complements the Joint Integrated War-fighting Force by providing standoff to the Warfighter during major combat, stability, and homeland security operations. FY 2019 RDTE funding support up to two vendors to develop prototypes for submission to government down-select. An option will be issued for Low Rate Initial Production (LRIP) to provide 15 RDTE Production Qualification Test (PQT) articles. This funding also supports a government IPT to provide program management, test and evaluation, and programmatic risk mitigation to address Cyber Security Controls, interoperability (IOP), and analysis of collaborative operations with various Unmanned Systems (i.e. MTRS Inc. II, Light Reconnaissance, Short Range Reconnaissance UAS, etc.) assigned at Battalion and below.
US Army	0601102A	RDT&E	Defense Research Sciences (Robotics Autonomy, Manipulation, & Portability Rsh)	Improvements to robotic perception of the world; enable teaming of intelligent systems with soldiers; enable UAS to interact with environment (manipulation and flight control in extreme environments / swarm behavior)
US Army	0602120A	RDT&E	Sensors & Electronic Survivability (Robotics Technology)	Will demonstrate cognitive architecture with the integrated capabilities of perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility; assessment of autonomous capability of limbed robot; map-based approach for reasoning and understanding of environments; Explore hybrid modes of mobility to enable energy efficient mobility
US Army	0603645A	RDT&E	Armored Systems Modernization Adv Dev (Combat Vehicle Prototyping)	Integration and support services for the Squad Centric Mounted Maneuver (SCMM) project; ground movement target indicator radar, unmanned aerial system sensor, hardware for the head mount display subsystem, fabricates remaining hardware in support of SCMM vehicle integration, and hardware and support for the SCMM autonomy subsystem and vehicle electronics architecture subsystem. (FY18) Will initiate work on data fusion technology based on multiple sensor inputs for use in target identification and tracking, surveillance, and autonomous control. (FY19) Demonstrate Sensor Fusion/Crew Station requirements for manned and unmanned systems (which may include, but not limited to, data inputs from Global Positioning System (GPS), Light Detection and Raging (LIDAR), SOund Navigation And Ranging (SONAR), RAdio Detection And Ranging (RADAR), optical Infrared, UltraViolet (UV), etc.). (FY19)
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (Heterogeneous Collaborative Unmanned Systems (HCUS))	Develop heterogeneous unmanned platforms capable of autonomous, collaborative behaviors (UAV / UUV / USV) - JHU APL

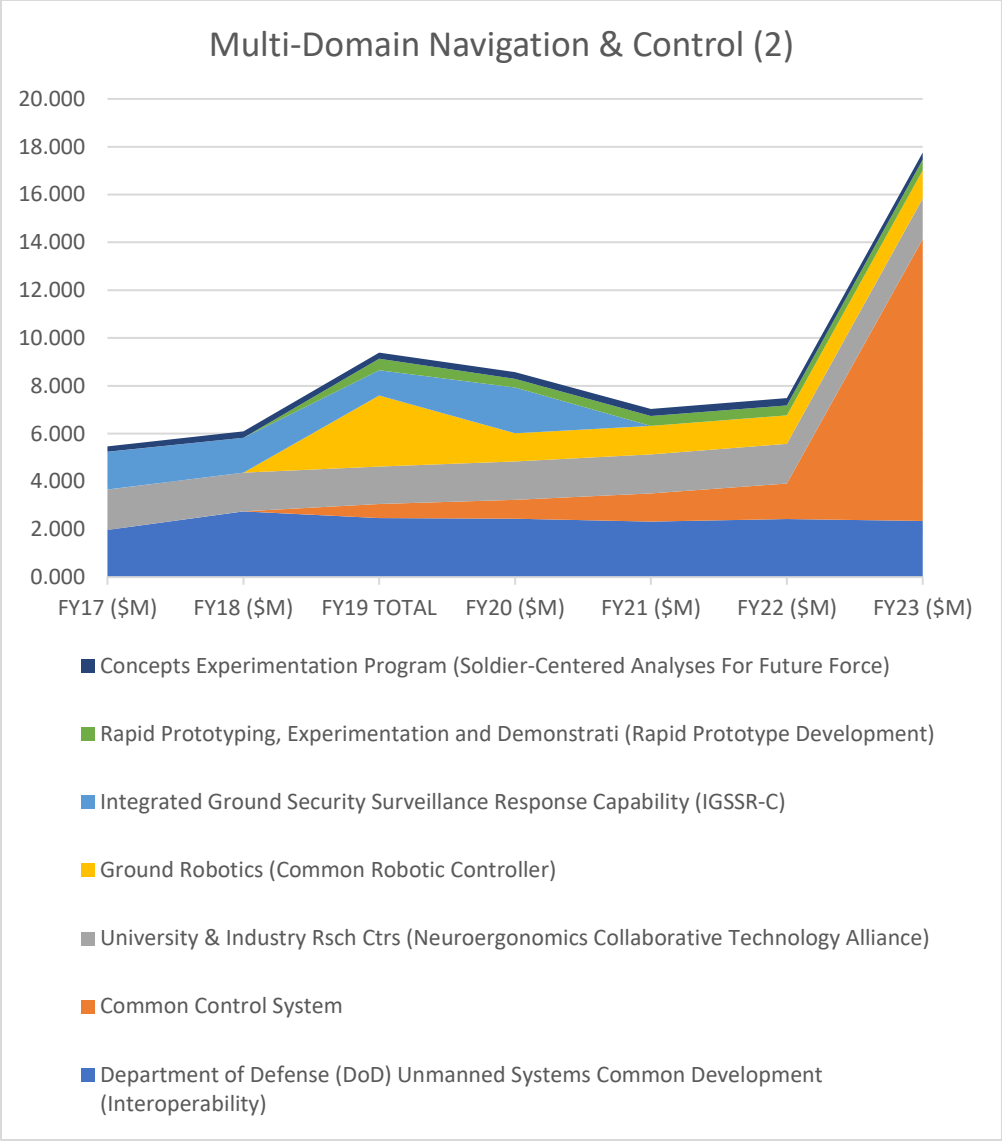


FIGURE 45: PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

TABLE 35: LISTING OF PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
OSD	0604400D8Z	RDT&E	Department of Defense (DoD) Unmanned Systems Common Development (Interoperability)	Interoperability: Main activities: Interoperability and Open Architecture, UxS Safety, UxS Development. In FY19, Support the continued development and implementation of the SAE working group for UAS Control Segment Architecture (UCS) interfaces and Joint Architecture Unmanned System (JAUS); Develop a Joint Communications Architecture for Unmanned systems (JCAUS) and demonstrate a JCAUS compliant prototypes to validate and further mature the architecture; Develop Safety standards and policy for Unmanned and Autonomous systems that will allow for the incorporation of Artificial Intelligence (AI); Continue support for Unmanned Systems Interoperability and Integration workshop/technical

				exchange meeting; Develop and Unmanned system autonomous test and Evaluation standards and architectures using modeling and simulation; Investigate a Cyber secure solution for integrating Artificial Intelligent systems into Unmanned Systems; Continue support to DoD Interoperability IPT.
US Navy	4250	Procurement	Common Control System	Common control system across all Navy unmanned systems in all domains (new start in FY19)
US Army	0601104A	RDT&E	University & Industry Rsch Ctrs (Neuroergonomics Collaborative Technology Alliance)	Intelligent systems research for manned-unmanned teaming (Next Generation Combat Vehicles/Future Vertical Lift)
US Army	0605053A	RDT&E	Ground Robotics (Common Robotic Controller)	Common Robotic Controller/Common Robotic System (Universal Controller) (CRS(UC)) improves Soldier situational awareness while reducing cognitive load on Soldiers and the robotics portfolio logistics footprint and provides the capability to individually and/or concurrently control multiple Unmanned Systems (UxS) platforms and control/monitor a mesh network without having to obtain and/or carry separate Operator Control Unit (OCU)s for each system. FY 2019 RDTE funds will be utilized to conduct user testing and select a Universal Controller.
US Army	0605029A	RDT&E	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	IGSSR-C is a software centric fusion engine that connects legacy and emerging FP systems, legacy Chemical, Biological, Radiological, and Nuclear (CBRN), unmanned systems, biometric identification and forensic data systems.
US Navy	0604030N	RDT&E	Rapid Prototyping, Experimentation and Demonstrati (Rapid Prototype Development)	Development of new technologies that provide advanced warfighting capabilities including unmanned systems, artificial intelligence, machine learning, and multi-domain operations. (the majority of funding seems to be focused towards the SURTASS-E towed sensor for large ships providing wide-area surveillance; previously funded in PE 0603382N.
US Army	0605326A	RDT&E	Concepts Experimentation Program (Soldier-Centered Analyses For Future Force)	Will develop cognitive workload models to assess next-generation combat vehicle (NGCV) crewman ability to control multiple unmanned assets in a combined Manned-Unmanned Teaming (MuM-T) environment to allow crewman to think and act decisively to shoot, move and communicate more effectively. (FY19)

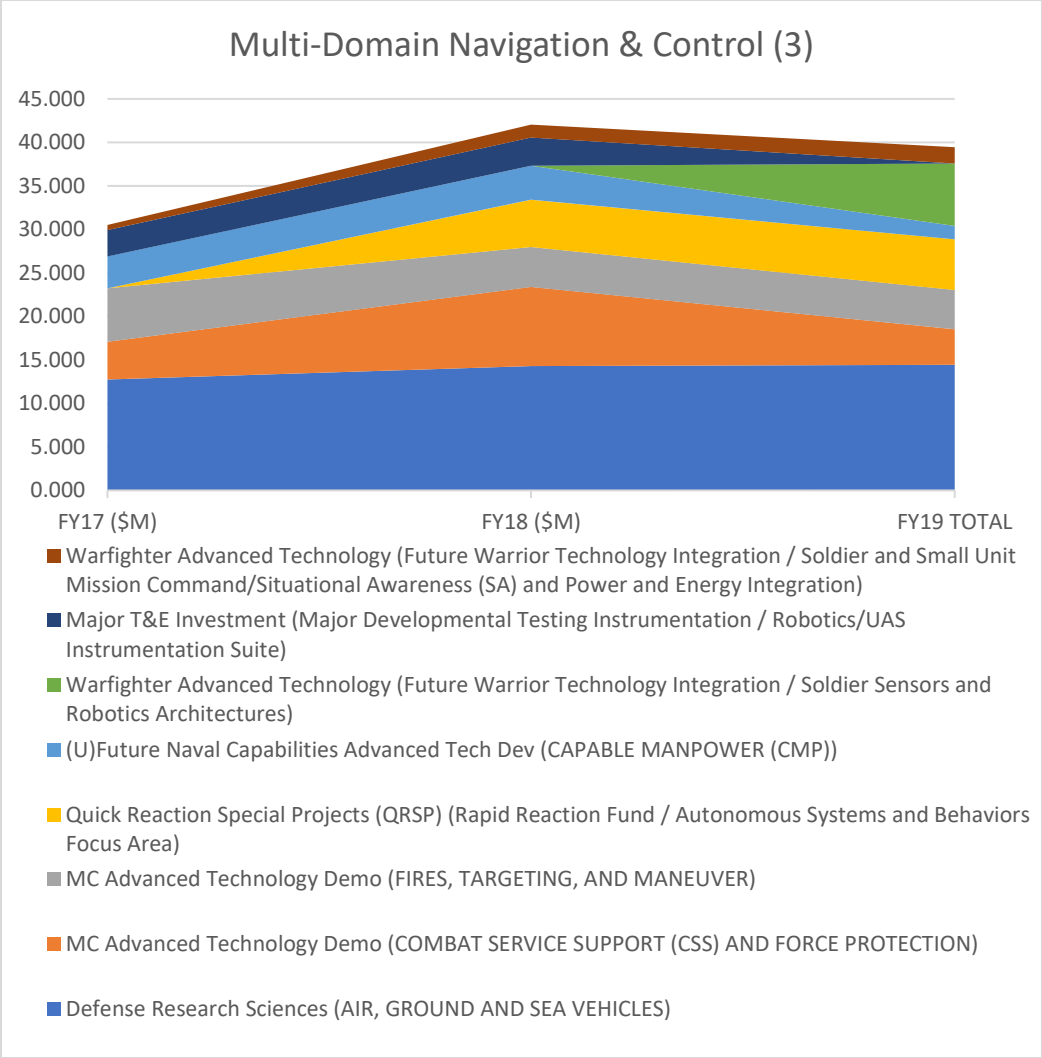


FIGURE 46: PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

TABLE 36: LISTING OF PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
US Navy	0601153N	RDT&E	Defense Research Sciences (AIR, GROUND AND SEA VEHICLES)	Efforts include unmanned handling operations for Naval operations, autonomous deck operations; autonomy challenges across all domains, collaboration among autonomous systems and MUMT, autonomous perception; small UAV propulsion
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (COMBAT SERVICE SUPPORT (CSS) AND FORCE PROTECTION)	Assessment of unmanned ground logistics delivery technologies that support infantry small unit operations; use of autonomous systems in support of medical evacuation over ground, surface (water), or air; investigation and assessment of logistics related emerging autonomous air delivery technologies and capabilities; evaluation and experimentation with technologies that can identify, neutralize, or destroy unmanned systems (aerial, ground, or surface); initiate integration and USMC experimentation of DARPA-developed technology for a full scale, modular, VTOL multi-mission UAS

				platform; FY 2018 to FY 2019 Increase/Decrease Statement: The funding decrease from FY 2018 to FY 2019 is mainly attributable to an FY 2018 $10M investment to support integration and experimentation with a Defense Advanced Research Projects Agency (DARPA)-initiated Vertical Take-Off and Landing (VTOL) developed technology prototype for a full scale, modular multi-mission unmanned air system (UAS). Funding completes experimental prototype development, flight testing, and validation of operating characteristics.
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (FIRES, TARGETING, AND MANEUVER)	Continue development and assessment of weaponized unmanned ground robotic systems; development of technologies that enhance the utility of autonomous systems; assessment and experimentation into the utility of robotic systems as platforms to support target acquisition and designation; assessment of the expeditionary utility of autonomous swarming technologies for unmanned air and ground systems; automate robotic control systems/software to reduce the burden of control and increase manned and unmanned teaming.
OSD	0603826D8Z	RDT&E	Quick Reaction Special Projects (QRSP) (Rapid Reaction Fund / Autonomous Systems and Behaviors Focus Area)	Autonomous Systems and Behaviors Focus Area: Autonomous Systems and Behaviors projects demonstrate capabilities to enhance joint forces, reduce the time to make critical decisions, and protect warfighters through increased use of autonomous and human-machine collaborative systems. Example projects include power systems to facilitate increased performance of unmanned systems, enhanced capabilities for multiple autonomous systems to cooperatively interact, autonomous operation in complex terrain, development of sensors for integration aboard unmanned platforms, improvements to data ex-filtration from unmanned sensors, human-machine collaborative decision making, and experiments to counter emerging unmanned threats from potential adversaries. These projects will also examine common software platforms to reduce development cost, increase collaboration among manned and unmanned vehicles, increase agility through rapid customization of autonomous systems' architectures, and inform requirement decisions for the autonomy community of interest to design affordable systems. FY 2019 Plans: RRF investment decisions for Autonomous Systems and Behaviors are made during the execution years in response to DoD, CCMD, Service, and other government organization priorities. RRF anticipates supporting six to seven projects in FY 2019.
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (CAPABLE MANPOWER (CMP))	Complete UAS Control Station Human Machine Interface (FY14-02); Initiate Manned and Unmanned Common Planning Picture (FY18-02): software that enables simultaneous manned/unmanned (UUV/UAV) event planning and briefing (realigned within this PE to UW-FY18-01 under a new Undersea Warfare R-2 Activity); assessment process for the selection of unmanned aerial systems personnel (FY19)
US Army	0603001A	RDT&E	Warfighter Advanced Technology (Future Warrior Technology Integration / Soldier Sensors and Robotics Architectures)	Will mature and demonstrate sensors and robotics architectures that enable dismounted linkages and ease of integration for existing and emerging ground and aerial robots; will mature Soldier-organic data management and distribution technologies for integration into Soldier-borne electronic devices, sensors, and robotics; will develop an integration architecture of sensors and robotics for the Nett Warrior system to increase situational awareness and stand-off

				protection; will identify common sensors that convey alerts and summary data within a sensor configuration that synthesizes data from multiple sensors; will increase image and sensing product quality and timeliness from small unit sensors and robotic platforms; will identify commercial virtual environment software to assess Nett Warrior and sensor and robotic interfaces in a dynamic mission context. (FY19) Effort supports Army S&T strategy priorities of autonomous systems operated or worn by Soldiers.
US Army	0604759A	RDT&E	Major T&E Investment (Major Developmental Testing Instrumentation / Robotics/UAS Instrumentation Suite)	Continues EMD phase contract activity for the Robotics/UAS Instrumentation Suite. This program will procure instrumentation to be installed on aerial and ground platforms to collect performance test data. Initial instrumentation acquisition will focus on Global Position System (GPS) tracking and accuracy. (FY18 - Decrease due to EMD activity completion for phase one. Program will continue in the out years.)
US Army	0603001A	RDT&E	Warfighter Advanced Technology (Future Warrior Technology Integration / Soldier and Small Unit Mission Command/Situational Awareness (SA) and Power and Energy Integration)	Integrate and assess Soldier carried unmanned ground and aerial vehicles and physiological status monitor sensors within the Nett Warrior system architecture to understand the human systems integration challenges of interfacing Soldiers with sensors and robotics. (FY18) Demonstrate advanced Global Positioning System (GPS) denied navigation and environmental sensing algorithms for Soldier borne sensor platforms. (FY19)

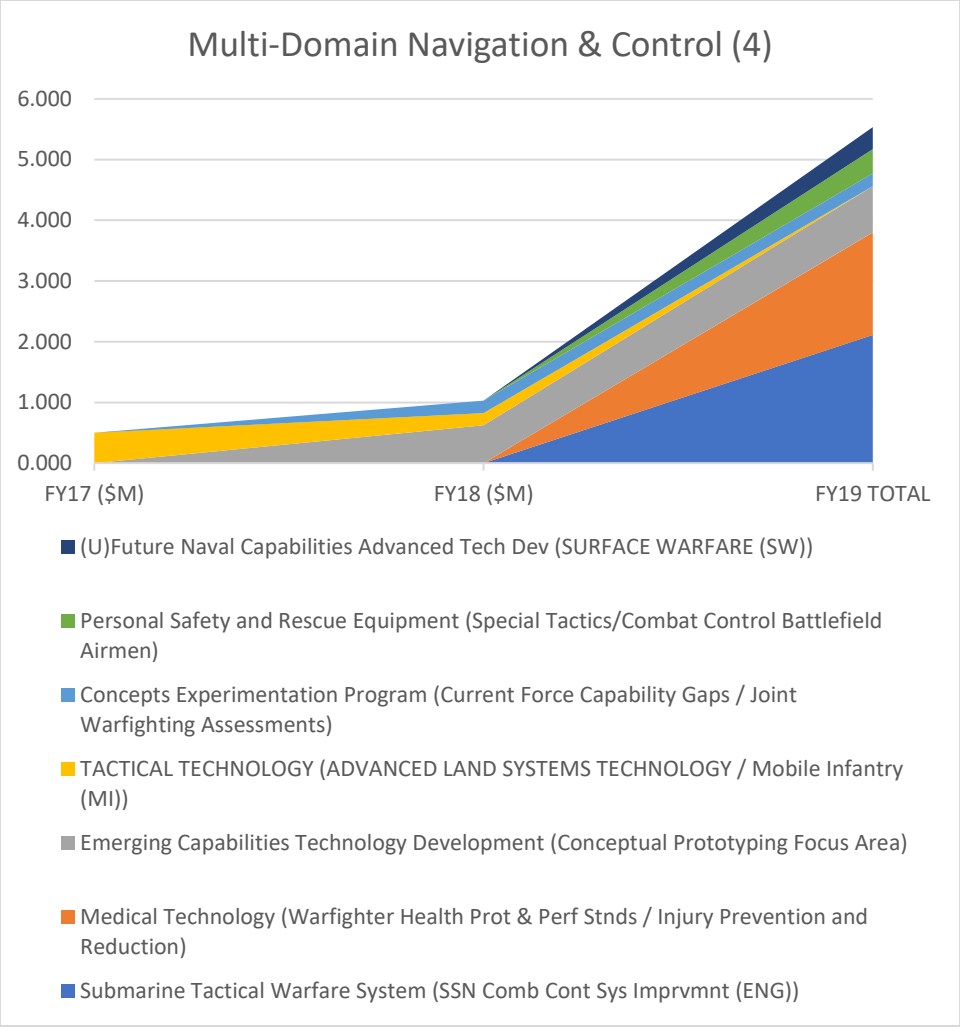


FIGURE 47: PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

TABLE 37: LISTING OF PROGRAMS SUPPORTING MULTI-DOMAIN NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
US Navy	0604562N	RDT&E	Submarine Tactical Warfare System (SSN Comb Cont Sys Imprvmnt (ENG))	Efforts in FY19 to integrate of a common UxV interface that will be delivered with APB 19
US Army	0602787A	RDT&E	Medical Technology (Warfighter Health Prot & Perf Stnds / Injury Prevention and Reduction)	Identify cognitive and sensory performance metrics associated with optimal manned/unmanned teaming (MUM-T) and identify physiological and behavioral fitness for duty metrics to operate in MUM-T paradigms (FY19); Increased funding in FY19 for Medical Aspects of Man-Machine Teaming (MUM-T) due to normal progression of the effort and the fact that it became a new high priority program in FY18
OSD	0603699D8Z	RDT&E	Emerging Capabilities Technology Development	Conceptual Prototyping Focus Area: Focus areas for prototyping projects include manned-unmanned combat teaming.

			(Conceptual Prototyping Focus Area)	
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (ADVANCED LAND SYSTEMS TECHNOLOGY / Mobile Infantry (MI))	Mobile Infantry (MI): The Mobile Infantry (MI) program will explore the development of a system-based, mixed team of mounted/dismounted warfighters, and semi-autonomous variants of platforms.
US Army	0605326A	RDT&E	Concepts Experimentation Program (Current Force Capability Gaps / Joint Warfighting Assessments)	Support provided for Man Unmanned Teaming, (Ground/Air) (MUM-T) in FY18 / FY19
USAF	842990	Procurement	Personal Safety and Rescue Equipment (Special Tactics/Combat Control Battlefield Airmen)	Standardized equipment to support Air Force Special Operations Command Mission (including unmanned capabilities)
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (SURFACE WARFARE (SW))	Unmanned systems common control

Programs Supporting Air Navigation & Control (not Autonomy Related)

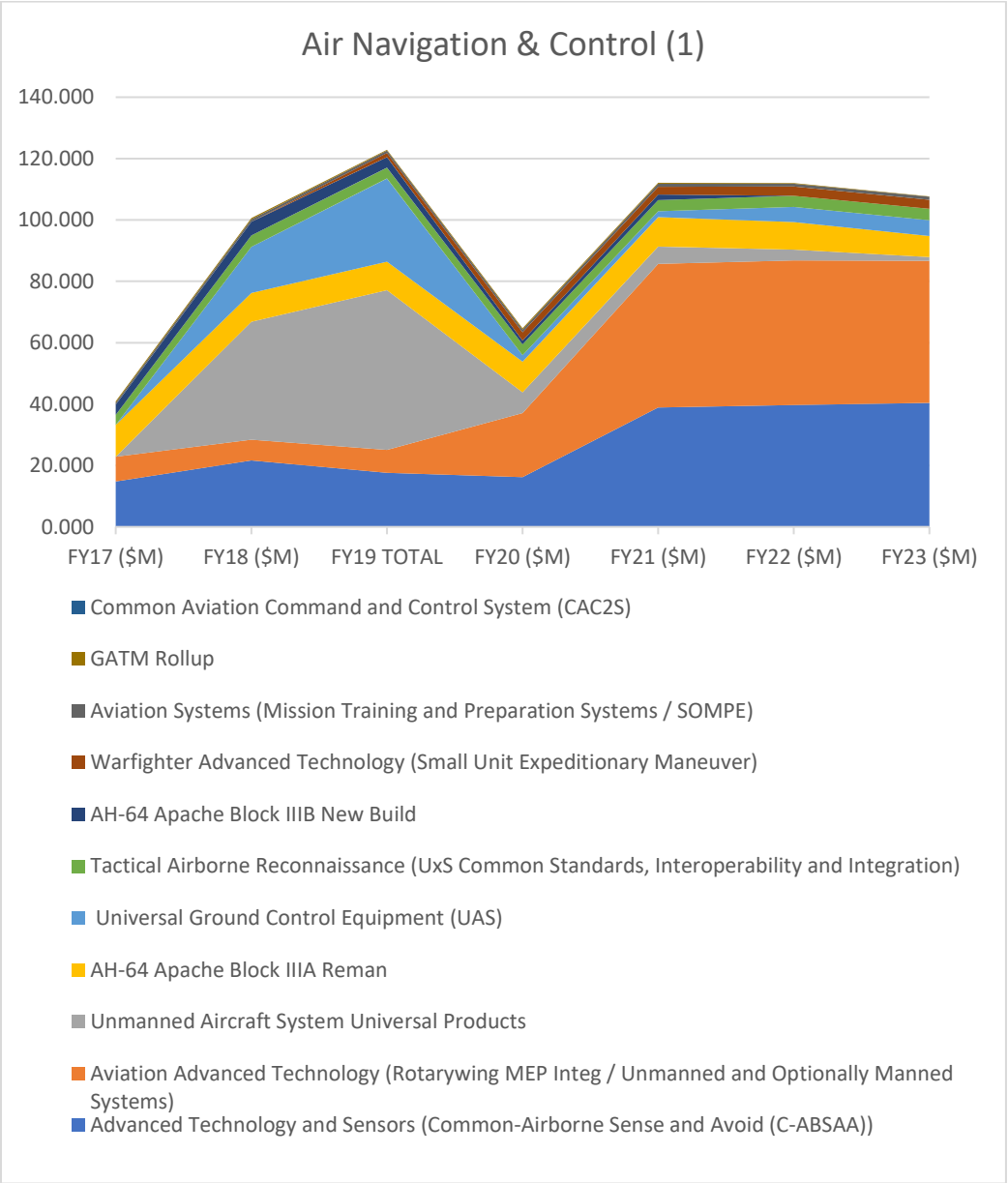


FIGURE 48: AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL (NOT AUTONOMY RELATED)

TABLE 38: LISTING OF AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
USAF	0604257F	RDT&E	Advanced Technology and Sensors (Common-Airborne Sense and Avoid (C-ABSAA))	Develop Sense and Avoid (SAA) technology and capabilities for Group 4-5 remotely piloted aircraft (RPA). Group 4-5 RPA platforms will be expected to integrate C-ABSAA capability into their unique systems either via retrofit or in design, development, and/or production.
US Army	0603003A	RDT&E	Aviation Advanced Technology (Rotarywing	Unmanned and Optionally Manned Systems: Integrate and demonstrate third party vendor pilot aiding software and advanced human machine interface technologies in

			MEP Integ / Unmanned and Optionally Manned Systems)	simulations to inform cockpit development programs for both legacy fleet aircraft upgrades and future aircraft procurements. Demonstrate software integration within an open systems, modular architecture based system. (FY18) Will continue the development, integration and demonstration of third party vendor software and advanced human machine interface technologies in simulations to enable increased manned and unmanned teaming capabilities and to inform crew station development programs for both legacy fleet aircraft upgrades and future aircraft procurements. Will continue to demonstrate software and hardware integration within an open systems, modular architecture based system. (FY19) Advanced Teaming: Develop and mature teaming algorithm development focused on resupply, reconnaissance and surveillance mission areas. Integrate and demonstrate sensor and processing technology to support teaming behavior for heterogeneous platform formations. (new start in FY19)
US Army	0607143A	RDT&E	Unmanned Aircraft System Universal Products	FY2019 Universal Product Base funding of $52.019 Million will be used for continuing the development of modifications needed to address UGCS obsolescence, maintain interoperability, increase commonality for the Gray Eagle (MQ-1C) and Shadow (RQ-7) Programs of Record, including System Engineering, Logistics, and Program Management. Universal Products (UGCS and UGDT) Improvements ($33.009M FY18, $47.244M FY19): Funding continues to support Development of Universal Products Improvements to include: Hardware, Software and documentation to ensure a supportable UGCS and UGDT that is interoperable and increases commonality. The UGCS and UGDT will be used across Army UAS. (FY19 Funding increased from $25.794 Million to $52.019 Million in FY2019 in order to support the Developmental of Universal Products) Training Device Improvements (~5M in FY18/19): Funding supports increased training capability of Unmanned Aircraft Systems to support Manned Unmanned Training (MUMT), Live/Virtual and Constructive Integrated Architecture (LVC-IA), and other PEO Aviation training devices. (FY19 Funding decreased due to economic adjustments)
US Army	5757A05111	Procurement	AH-64 Apache Block IIIA Reman	UAS control from manned vehicle; Manned/Unmanned Teaming Extended Capability (MUMT-X)
US Army	0028A02706	Procurement	Universal Ground Control Equipment (UAS)	Universal GCS for UAS (MQ-1C / Shadow)
US Navy	0603261N	RDT&E	Tactical Airborne Reconnaissance (UxS Common Standards, Interoperability and Integration)	Development of UAS technical standards to include associated modeling and simulation across Fleet CONOPS scenarios; Demonstrate Manned/Unmanned Interoperability; develop Unmanned Systems Naval Interoperability Profiles in support of approved naval CONOPS
US Army	5840A05133	Procurement	AH-64 Apache Block IIIB New Build	Manned/Unmanned Teaming Extended Capability (MUMT-X)
US Army	0603001A	RDT&E	Warfighter Advanced Technology (Small Unit Expeditionary Maneuver)	Will demonstrate and support the transition of advanced personnel airdrop safety technologies and cargo airdrop from nontraditional platforms in support of interoperability with manned-unmanned teaming (MUM-T) assets. (FY19)

SOCOM	1160403BB	RDT&E	Aviation Systems (Mission Training and Preparation Systems / SOMPE)	Special Operations Mission Planning and Execution (SOMPE) provides the interoperable environment for SOF adaptive planning to integrate global operations including unmanned aerial systems command and control.
US Army	8859AA0711	Procurement	GATM Rollup	Upgrade of existing avionics and procurement of new systems to meet worldwide GATM requirements for rotary wing aircraft and UAS.
USMC	4644	Procurement	Common Aviation Command and Control System (CAC2S)	Future procurement of C2 systems for UAS (not currently baselined)

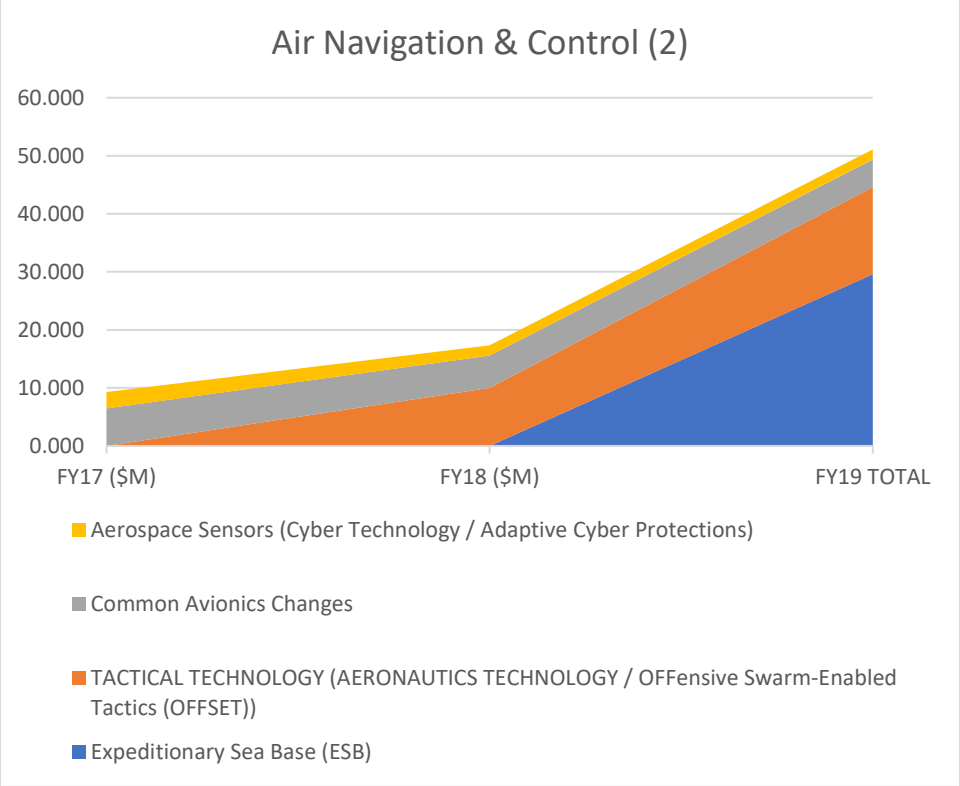


FIGURE 49: AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL (NOT AUTONOMY RELATED)

TABLE 39: LISTING OF AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes
US Navy	3039	Procurement	Expeditionary Sea Base (ESB)	Antennas and control systems for STUAS and MQ-8C Fire Scout UAV
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (AERONAUTICS TECHNOLOGY / OFFensive Swarm-Enabled Tactics (OFFSET))	OFFensive Swarm-Enabled Tactics (OFFSET): program will design, develop, and demonstrate a swarm system architecture to advance the innovation, interaction, and integration of novel swarm tactics. FY 2019 Plans: - Conduct additional capability-based field experimentation events that demonstrate swarm tactics for scaled missions of relevance to urban combat operations. - Assess technology maturity and anticipate technology trends to identify research and development needs and gaps. - Initiate Swarm Sprints for

				specific technology thrust areas relevant to human-swarm teaming.
US Navy	0577	Procurement	Common Avionics Changes	Navigation equipment for MQ-4C, MQ-8B/C, MQ-25A
USAF	0602204F	RDT&E	Aerospace Sensors (Cyber Technology / Adaptive Cyber Protections)	Adaptive Cyber Protections: Develop avionics protection tools and capabilities to enable manned and unmanned aircraft, avionics, and related support equipment to automatically adapt to and withstand cyber attacks.

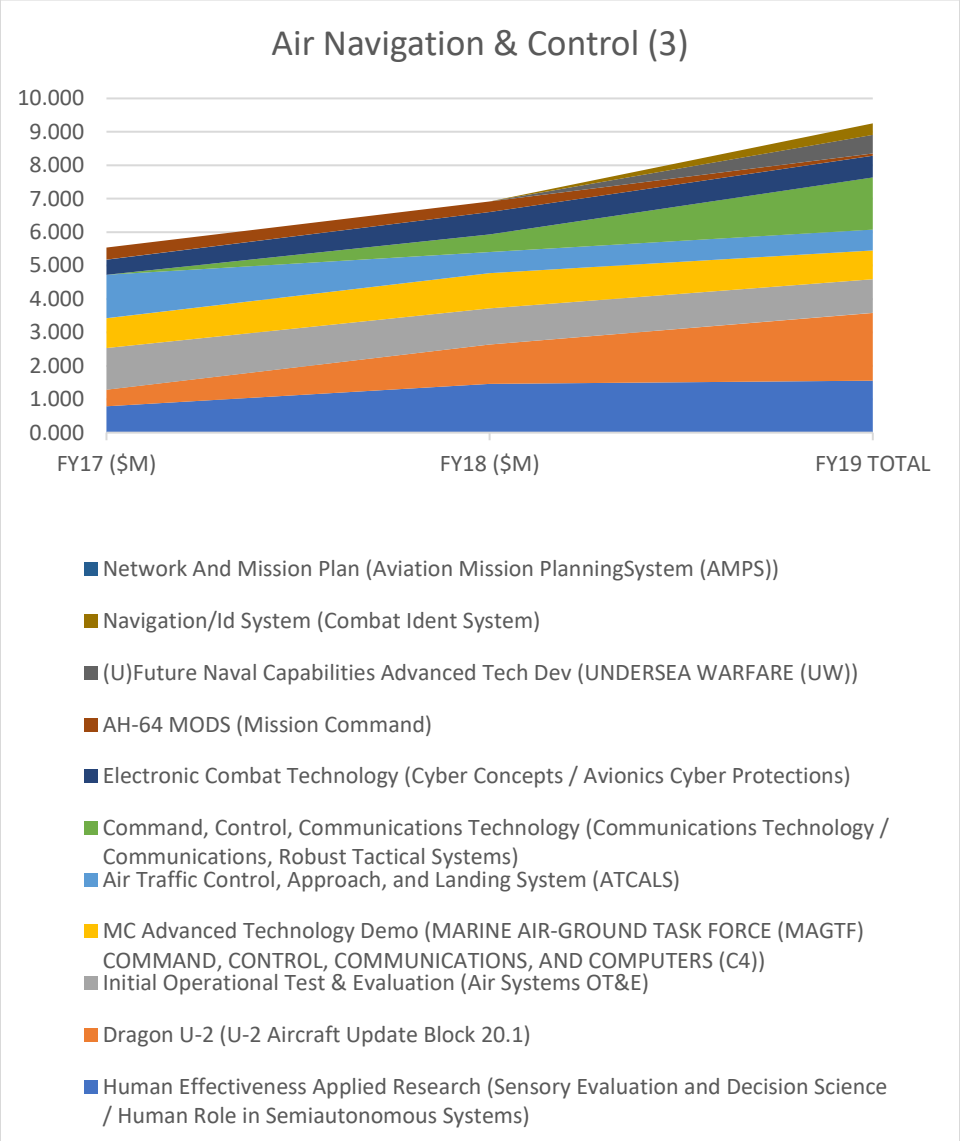


FIGURE 50: AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL

TABLE 40: LISTING OF AIR PROGRAMS SUPPORTING NAVIGATION AND CONTROL

Organization	PE Number	Funding Type	Title	Notes

USAF	0602202F	RDT&E	Human Effectiveness Applied Research (Sensory Evaluation and Decision Science / Human Role in Semiautonomous Systems)	Refine airman-system cooperative decision aids and interfaces that support distributed unmanned system control concepts in limited communication environments.
USAF	0305202F	RDT&E	Dragon U-2 (U-2 Aircraft Update Block 20.1)	U-2 Aircraft Update Block 20.1: aircraft sustainment and/or enhancement development including Open Mission Systems and Unmanned Aerospace Systems Command and Control Standard Initiative (OMS/UCI) standards compliance (FY19)
USAF	0605712F	RDT&E	Initial Operational Test & Evaluation (Air Systems OT&E)	Air Systems OT&E: Global Hawk Ground Segment Modernization Program GH GSMP (Plan for OA FY18/Conduct OA FY19); MQ-9 Reaper Hunter-Killer Block 50 Ground Control Station (MQ-9 Block 50 GCS) (Plan for OA FY18/Conduct OA FY19); RQ-4B Global Hawk Block 30 Multi-Spectral Intelligence (MSI) (Conduct OUE FY18, Plan for IOT&E FY19)
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (MARINE AIR-GROUND TASK FORCE (MAGTF) COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4))	Continue development and assessment of systems that permit unmanned aerial system (UAS) operations in a global positioning system (GPS) denied environment (concluded in FY19)
USAF	0305114F	RDT&E	Air Traffic Control, Approach, and Landing System (ATCALS)	Next Generation (NextGen) Air Transportation System (ATS): in FY18, Continue to support requests for implementation of UAS Ground Based Sense and Avoid (GBSAA) capability at new locations; Continue to develop policy and strategy for UAS implementation in global civil and military airspace. In FY19, Will continue to coordinate with interagency partners to promote UAS integration into civil airspace.
US Army	0602782A	RDT&E	Command, Control, Communications Technology (Communications Technology / Communications, Robust Tactical Systems)	Develop solutions to provide reliable voice/data links for the next generation combat vehicles, and tele-operation and data links for Manned/Unmanned-Teaming (MUM-T); develop components to improve resilience of Air-to-Air and Air-to-Ground links for future vertical lift and next generation unmanned aerial system (FY19)
USAF	0603270F	RDT&E	Electronic Combat Technology (Cyber Concepts / Avionics Cyber Protections)	Avionics Cyber Protections: in FY18/FY19, Continue to extend research on a suite of protection tools with focus on their application to unmanned aircraft system platforms.
US Army	2706AA6605	Procurement	AH-64 MODS (Mission Command)	Manned/Unmanned Teaming
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (UNDERSEA WARFARE (UW))	UAS control technologies
US Navy	0604777N	RDT&E	Navigation/Id System (Combat Ident System)	Development of small form factor IFF for unmanned aircraft systems (FY19)

US Army	8658AA0712	Procurement	Network And Mission Plan (Aviation Mission Planning System (AMPS))	Automated mission planning for Army aircraft including UAS (support will be provided in a future release)

Air Programs Supporting Autonomy

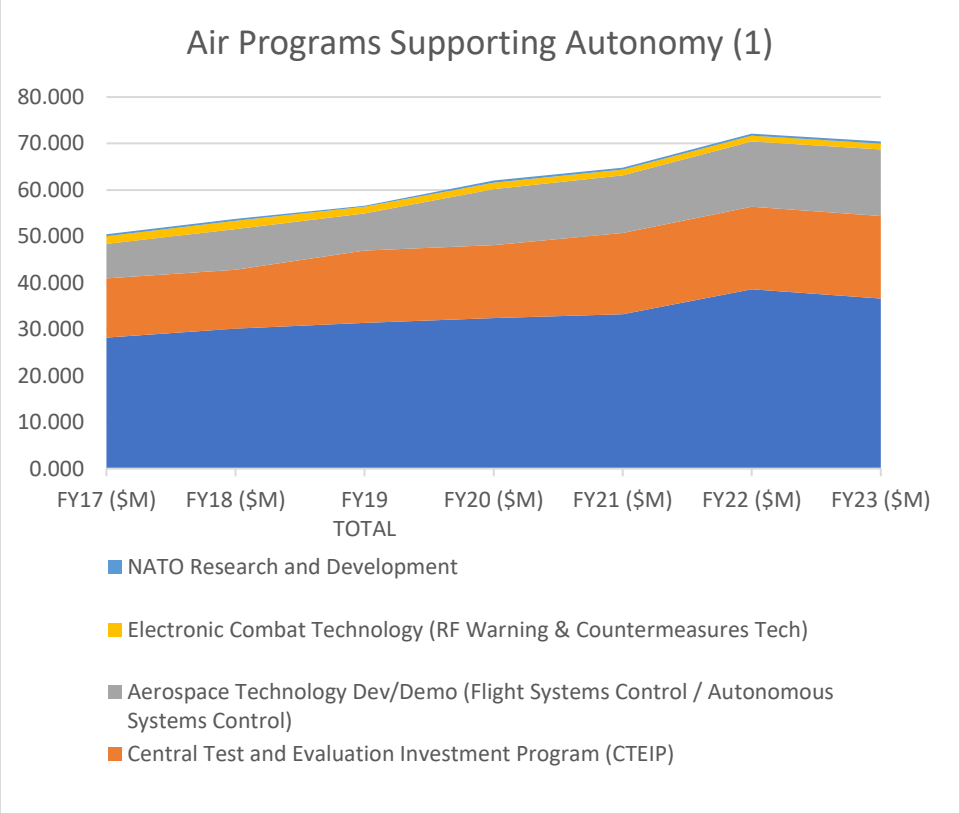


FIGURE 51: AIR PROGRAMS SUPPORTING AUTONOMY

TABLE 41: LISTING OF AIR PROGRAMS SUPPORTING AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
USAF	0602201F	RDT&E	Aerospace Vehicle Technologies (Flight Controls and Pilot-Vehicle Interface)	Advanced Flight Controls Technologies (~7M FY18/FY19): Develop technologies for advanced control-enabled capabilities, including flight controls, components, integrated vehicle management systems and software and system certification techniques for both manned and remotely piloted aircraft. In FY19 Complete the development of advanced automation capabilities for mobility aircraft and transition to advanced development. Continue the development of trusted autonomy approach, integrating certification processes and autonomy development. Manned and Unmanned Teaming Technologies (~18M FY18/FY19): Develop technology for flight control systems that will permit safe interoperability between manned and remotely piloted aircraft and effective teaming in adverse and contested environments. In FY19 Continue development, demonstration, and assessment of advanced

				control automation techniques. Continue the development of mixed initiative control techniques for teams of remotely piloted aircraft and/or manned-unmanned teams in contested, dynamic mission environments, as well as for the integration of unmanned systems into controlled airspace and airbase operations. Continue the development of robust, affordable UAS operations in a terminal airspace environment. Continue the development of autonomous behaviors for safe, loyal wingman. Flight Controls Technologies Modeling and Simulation (~5M in FY18/FY19): Develop tools and methods for capitalizing on simulation-based research and development of future aerospace vehicles. In FY19 Continue modeling and simulation efforts to evaluate emerging autonomous and robust flight control technologies and concepts, as well as assess mission-level performance of integrated aerospace systems. Continue analyses of automated unmanned air systems and manned-unmanned teams in controlled airspace and airbase operations, as well as in adversarial mission environments. Continue trade studies of vehicle concepts for strike, mobility and reconnaissance. Continue manned-unmanned teaming evaluations. Continue development of autonomy for tactical aircraft operations.
OSD	0604940D8Z	RDT&E	Central Test and Evaluation Investment Program (CTEIP)	Joint Improvement and Modernization (JIM) projects includes The Unmanned Systems T&E Improvements (UAS-TEI) project that develops improved test capability of the Services LVC unmanned autonomous systems test environments. (FY18) Complete requirements and development and initiate concept development and preliminary design for the Unmanned Systems T&E Improvements (UAS-TEI) project that develops improved test capability of the Services LVC unmanned autonomous systems test environments. (FY19) Complete Initial Operational Capability and continue system development for the Swarm Autonomy and UAV Scoring project to upgrade existing High Speed Maneuverable Surface Targets (HSMST) with semi-autonomous control for testing against representative surface swarming threats. Initiate preliminary design for the Real Time Casualty Assessment capability. (FY19) Complete development of the Pulsed Doppler Emitter Capability Payload for Aerial Targets (PDEC-163) to develop kinematic threat representations and threat representative emissions to provide the DDG-1000 OT SUT with the ability to collect data necessary for COTF to accredit the DDG-1000's fire control loop weapons system response to threat targets. (FY19)
USAF	0603211F	RDT&E	Aerospace Technology Dev/Demo (Flight Systems Control / Autonomous Systems Control)	Autonomy Systems Control: in FY19, Continue development and demonstration of technologies for situational awareness, autonomous control, and survivability for unmanned systems and manned platforms. Continue demonstration of autonomous and safe airspace interoperability for manned and remotely piloted aircraft systems. Continue development and demonstration of airborne control of teams of unmanned aircraft. Continue development and demonstration of reduced crew operations of future mobility aircraft. Continue development of unmanned sense-and-avoid technologies for ground and air operations. Continue development of technologies to reduce risk for transition of collision avoidance technologies to 4th and 5th-gen aircraft. Continue development of foundational autonomy for unmanned

				systems and spiral demonstrations of capability. (Justification for this decrease is due to due to Department of Defense deflation)
USAF	0603270F	RDT&E	Electronic Combat Technology (RF Warning & Countermeasures Tech)	Continue research into innovative electronic attack concepts/techniques including use of closed loop, cooperatively controlled, distributed unmanned aerial vehicles and their performance against integrated air defense networks and adaptable techniques for use against any threats. (FY18) Initiate the study, research and/or development of merged autonomy and electronic warfare technologies. (FY19)
USAF	0603790F	RDT&E	NATO Research and Development	International Cooperative Research and Development: FY19 cooperative projects involve RDT&E efforts in human performance, information systems, aerospace systems, munitions, materials and manufacturing, sensors, space situational awareness, missile warning, military satellite communications, global positioning systems, responsive space capabilities, cyber network defense and information assurance, and space vehicles. These projects include Real-time Decentralized Task Allocation for Heterogeneous Swarming UAV; Improved Durable Engines for UAVs; Bio-Inspired Technologies for Unmanned Autonomous Systems; Improved Elements for Next Gen RF-Directed Energy Weapons, Lasers and Detectors for UAS Systems.

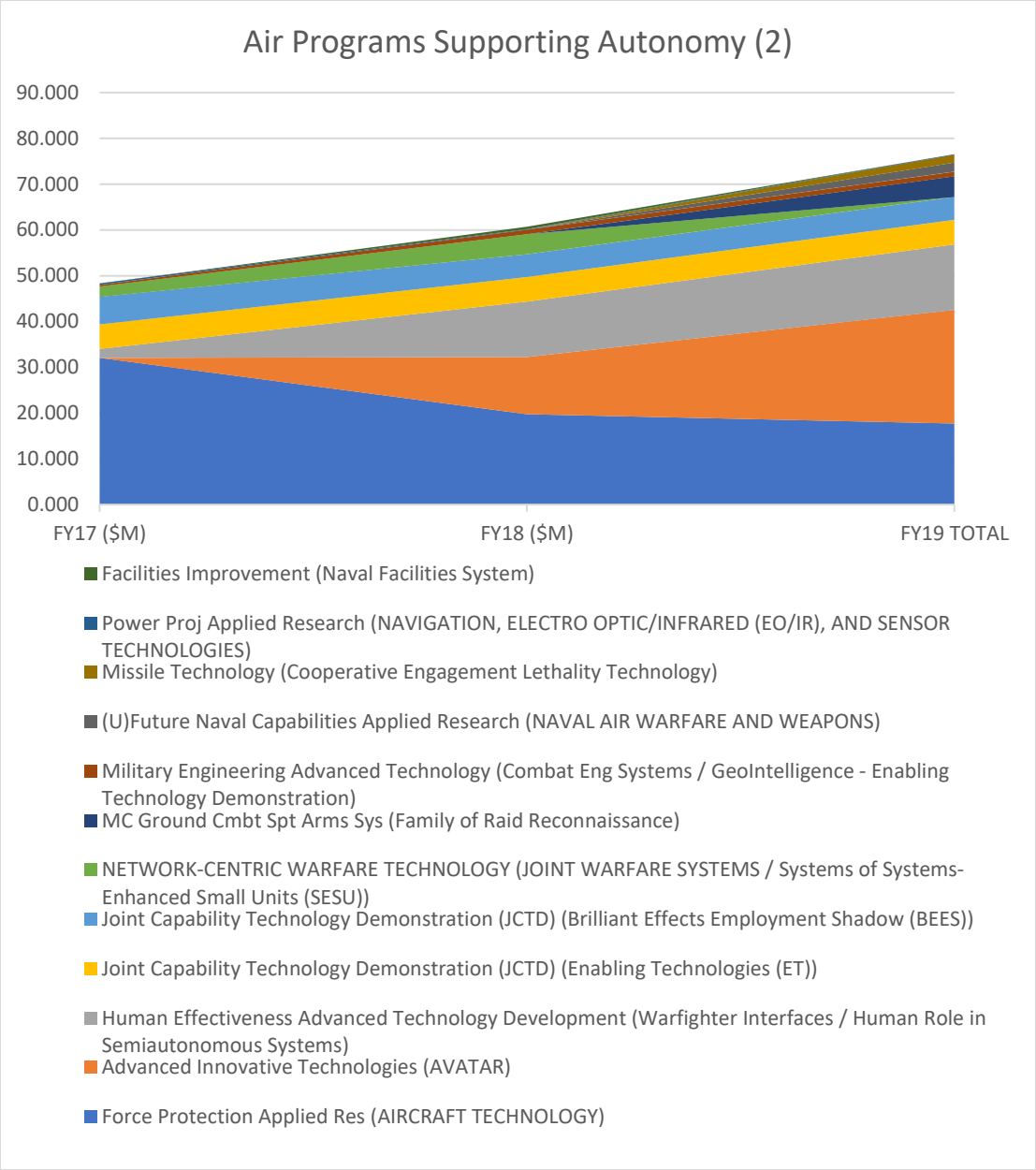


FIGURE 52: AIR PROGRAMS SUPPORTING AUTONOMY

TABLE 42: LISTING OF AIR PROGRAMS SUPPORTING AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
US Navy	0602123N	RDT&E	Force Protection Applied Res (AIRCRAFT TECHNOLOGY)	Efforts relating to unmanned operations aboard an aircraft carrier (handling, deck operations, short takeoff and landing, automated launch and recovery); autonomy and supervisory control of heterogeneous UAS; autonomy to support combined unmanned / manned air systems/units; propulsion technologies

OSD	0604250D8Z	RDT&E	Advanced Innovative Technologies (AVATAR)	In FY19, Demonstrate autonomy algorithms on surrogate aircraft; Integrate prototype Pilot-Vehicle Interface (PVI) into manned command and control aircraft; Conduct preliminary flight-testing of prototype manned-unmanned teaming capabilities to confirm design and functionality; Complete design review and execute vendor down-select; Continue open systems architecture refinement; Continue autonomous flight behavior algorithm refinement; Continue mission and operational effectiveness analysis.
USAF	0603456F	RDT&E	Human Effectiveness Advanced Technology Development (Warfighter Interfaces / Human Role in Semiautonomous Systems)	Human Role in Semiautonomous Systems: in FY18, Develop human-machine interface (controls, displays, and decision support) to enable effective manned-unmanned tactical flight operations. Develop and demonstrate control techniques to direct maneuvers and tactics at manageable pilot workload levels. Develop and demonstrate architectures and interfaces to enable manned-machine teaming for the tactical air environment. Develop external contingency management methods for flight operations. Demonstrate pilot-vehicle interface capabilities in high-fidelity virtual simulation to assess pilot performance and mission effectiveness. In FY19, Flight demonstrate airman-directed control and management of multiple unmanned tactical behaviors. Develop and integrate decision support and embedded intelligent agent capabilities to assess and reason about manned-unmanned team performance and overall mission effectiveness. Demonstrate adaptive human-machine interfaces and task allocation methods in virtual and live tests. Initiate m x n cooperative teams in networked simulation environments.
OSD	0603648D8Z	RDT&E	Joint Capability Technology Demonstration (JCTD) (Enabling Technologies (ET))	Enabling Technologies (ET): In FY17, 1) Autonomous Mission Package Planning and Execution (AMPEE) - AMPEE demonstrated a mission planning system and the ability to conduct cognitive netted distributed electronic warfare on multiple class unmanned aerial systems. 2)Scanning Infrared Sensor for Unmanned Air Vehicle Detection and Tracking (SISUDT), a prototype fixed-site, multi-sensor counter-unmanned aerial system (C-UAS) to detect, track, and identify group one and two UASs near forward operating bases. One SISUDT prototype was deployed in support of Operation Inherent Resolve for an in-theater validation of infrared UAS detection.
OSD	0603648D8Z	RDT&E	Joint Capability Technology Demonstration (JCTD) (Brilliant Effects Employment Shadow (BEES))	FY 2018 Plans: Begin flight demonstrations of UAS required behaviors. Fight demonstrations of EW and ISR autonomous actions. Continue laboratory testing of integrated EW and ISR payloads to include cooperative autonomous behaviors. FY 2019 Plans: Conduct a joint military utility assessment of autonomous EW and ISR behaviors as part of an integrated mission package in an operationally representative environment. Transition the capability in coordination with the Air Force Life Cycle Management Center (AFLCMC) Fighter Bomber Program Office to a Service program of record.
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (JOINT WARFARE SYSTEMS / Systems of Systems-Enhanced Small Units (SESU))	System-of-Systems-Enhanced Small Unit (SESU) program will develop and demonstrate adaptive kill-web capabilities based on a system-of-systems architecture that enables a small unit of U.S. forces to prevail against a much larger near-peer adversary force in a contested environment. In FY18, Develop architectures for autonomous drones to provide land warfighters with targeting, situation awareness, and terrain knowledge. A major thrust within the SESU program will be

				systems architecture and technology to enable manned-unmanned teaming with a focus on C3 and autonomy of the unmanned platforms. In FY19, Develop C3 and situation understanding technologies.
US Navy	0206623M	RDT&E	MC Ground Cmbt Spt Arms Sys (Family of Raid Reconnaissance)	Initiate research and development of Unmanned Logistics System (ULS) - Air, specifically the integration and development of autonomy aspects for a distribution system of support for resupply and air drops. Developed capabilities will also add retrograde and unit to unit transit re-distribution not inherent with air drop alone. Release EMD contract and LRIP contract aligned to milestone B and C. Certifications include information assurance and net ready.
US Army	0603734A	RDT&E	Military Engineering Advanced Technology (Combat Eng Systems / GeoIntelligence - Enabling Technology Demonstration)	Demonstrate analytical tools and algorithms using multiple sensor types (LiDAR/optical), platforms (UAVs/satellites) over time to build tactical decision aids suitable for use on mobile devices to provide geospatial analysis to the Army, other Services, and DoD, in support of mission planning and operations (such as small units in an urban setting). FY19: develop man/machine learning algorithms to automate production processes, to enable change detection, and to support learning by manned and autonomous systems with the capability to collect and/or complete 3D high-resolution common operating picture of complex and urban terrain.
US Navy	0602750N	RDT&E	(U)Future Naval Capabilities Applied Research (NAVAL AIR WARFARE AND WEAPONS)	Enhance offensive and defensive capabilities of missiles by maturing new technologies such as unmanned naval aviation / autonomy
US Army	0602303A	RDT&E	Missile Technology (Cooperative Engagement Lethality Technology)	Develop missile technology path to supervised autonomous target detection and cooperative engagement/manned-unmanned teaming for offensive, multiple simultaneous engagement capabilities. FY19: Will develop optimized missile design with multi-effects lethal mechanism, man-in-the-loop and loiter capability for situational awareness, targeting, and lethal effects against hard and soft targets. WIll develop application-based fire control unit software hosted on a commercial end user device, extended range datalink enablers, and GPS/comms denied navigation/targeting technologies.
US Navy	0602114N	RDT&E	Power Proj Applied Research (NAVIGATION, ELECTRO OPTIC/INFRARED (EO/IR), AND SENSOR TECHNOLOGIES)	FY18 effort for UAS-based electronic warfare; autonomous soaring for long range EW sensor delivery
US Navy	0603725N	RDT&E	Facilities Improvement (Naval Facilities System)	The Unmanned Aerial Vehicle for Facilities Inspection has potential safety benefits by providing imagery of areas that may be deemed dangerous. The unmanned system will provide the necessary data processing, sensors, automatic control and communications in order to initiate autonomous systems to support Facilities Inspection Programs to include Airfield Pavements, Petroleum Oil Lubricant (POL) Facilities, Tall Towers, Roofing, etc. The autonomous nature of this technology will significantly increase inspection and design efficiency via faster execution and lower labor costs. Augmented Reality (AR) systems are being tested and evaluated for design and assessment uses.

Programs Supporting Sensors & Payloads Used for ISR, Targeting, etc.

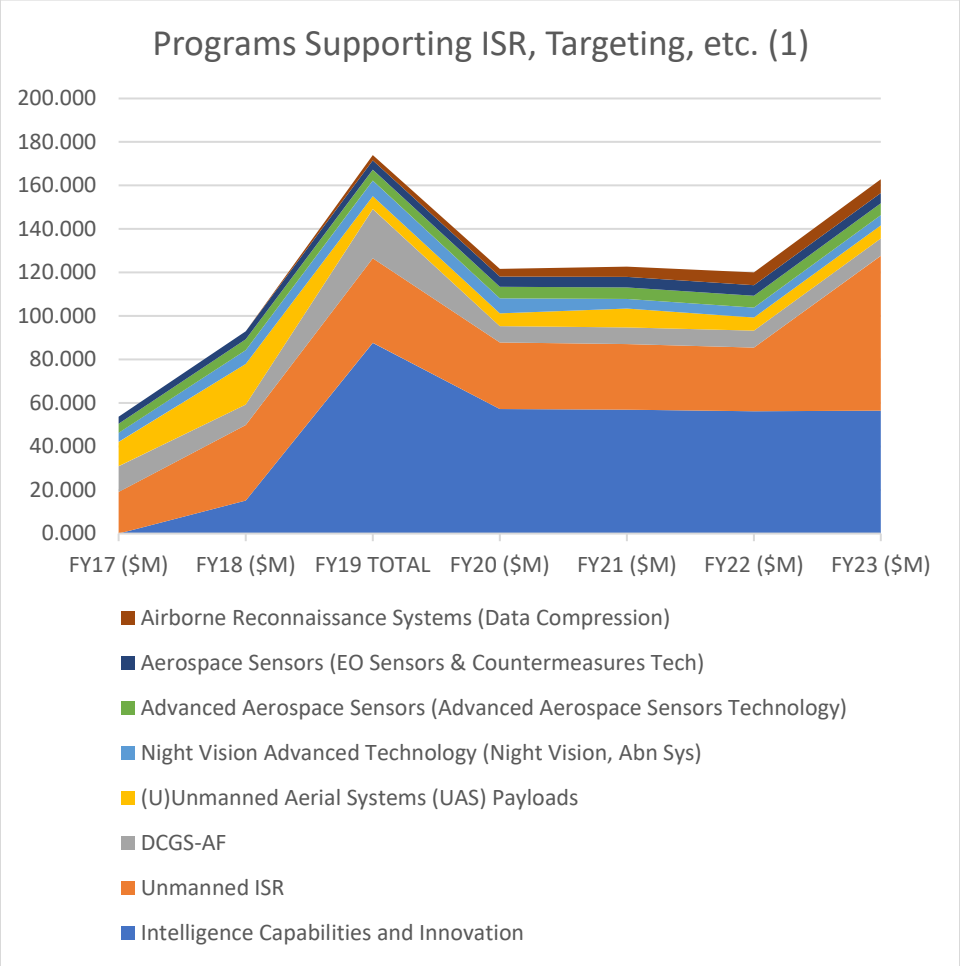


FIGURE 53: PROGRAMS SUPPORTING ISR, TARGETING, ETC.

TABLE 43: LISTING OF PROGRAMS SUPPORTING ISR, TARGETING, ETC.

Organization	PE Number	Funding Type	Title	Notes
OSD	0305245D8Z	RDT&E	Intelligence Capabilities and Innovation	Beginning in FY 2019, ICI also funds Project Maven which fields increasing amounts of automation to Full Motion Video (FMV) ground exploitation stations for Tactical Unmanned Aerial Vehicles (TUAVs), Medium Altitude and High Altitude ISR platforms. Project Maven will use Rapid prototype sprints to field increasing amounts of automation to FMV ground exploitation stations for TUAVs, Medium Altitude and High Altitude ISR platforms. Maven will use artificial intelligence, deep learning, and computer vision algorithms to detect, classify, and track objects within FMV images (e.g., person, vehicle, and weapon). This initiative brings artificial intelligence, deep learning, and computer vision into the process of object detection, identification, and tracking at computer process speed versus human speed. Incorporating computer vision and algorithms will reduce the human burden and provide efficient and effective exploration of data. Project

				Maven will develop algorithms focused on tactical UAV FMV automatic target recognition (ATR) and an operational PED environment for platforms and ground stations. AW will build capabilities, integrate AI and machine learning (ML) to provide actionable intelligence and enhance military decision-making by providing algorithms for object detection, classification and user alerts.
SOCOM	1160434BB	RDT&E	Unmanned ISR	Special Applications for Contingencies (SAFC) ($29.499M FY18, $20.679M FY19): in FY18/FY19, Continues development and combat evaluation of selected sensor delivery platforms and mounted or deliverable ISR capabilities for global contingencies including short-notice requirements. Continues evaluation of unique sensor technologies, persistent stare and quick reaction systems. Group 1 UAS (<20 lbs) ($~0.3M FY18/FY19): in FY19, Continues integration and testing of SOF-unique mission kits, mission payloads, and modifications to the small tactical UAS and ground control station, to include but not limited to: improved capabilities for geolocation, collection of push-to-talk, communications, specialized tagging, tracking, and locating, and enhanced communications relay and work to miniaturize previously developed payloads. Group 2 UAS (21-55lbs) ($4.912M FY18, $6.262M FY19): in FY19, Continues integration and testing of SOF-unique mission capabilities to the medium tactical UAS, to include but not limited to: signals intelligence gathering, full motion video, and geo-location. Group 3 UAS (55-1320 lbs) ($5M FY19 OCO): in FY19 OCO, Develops various advanced payloads to support ISR payload requirements in support of SOF missions to include counterterrorism execution order missions. Current Service payloads are insufficient for precision application of SOF mission sets. Group 4 UAS (>1320 lbs, higher than flight level 180) ($6.7M FY19 OCO): Develop and integrate Beyond Line of Sight (BLOS) wiring harnesses required to operate SOF-unique sensors, VORTEX encrypted data link capability, and Persistent Close Air Support (PCAS) collaborative engagement management capabilities on the SOF Gray Eagle Extended Range UAS.
USAF	846080	Procurement	DCGS-AF	System that exploits ISR data from remotely piloted aircraft (RPA) among other platforms
US Navy	0305242M	RDT&E	(U)Unmanned Aerial Systems (UAS) Payloads	Initiate a Field User Evaluation of the Spectral Bat V4 payload. Continue development of a Tactical EO/IR SIGINT Integrated for Targeting (TEISIT) payload system. Continue development of Wide Area Surveillance software. (this PE was restructured in FY19 and the project totals have been provided rather than breaking out each)
US Army	0603710A	RDT&E	Night Vision Advanced Technology (Night Vision, Abn Sys)	UAS payload efforts mature and demonstrate small, lightweight, and modular payloads (e.g. electro-optical/infrared, laser radar, designator) to support target detection, identification, location, tracking, and targeting of tactical targets for the Brigade Combat Team
USAF	0603203F	RDT&E	Advanced Aerospace Sensors (Advanced Aerospace Sensors Technology)	This project area develops and demonstrates aerospace sensor and processing technologies for intelligence, surveillance, reconnaissance, target, and attack radar applications in both manned and unmanned platforms, including electro-optical sensors and electronic counter-countermeasures for radars. Persistent Sensing in Contested Environment Technologies (X and S- bands for synthetic aperture radar); Passive Radio

				Frequency Sensing Technologies (millimeter-wave hardware and software radio frequency sensor suite); Long Range Sensing Technologies (radio frequency sensor technology); Passive Electro-Optical Sensing for Surveillance and Reconnaissance Technologies (IR search and track, hyperspectral imaging, target detection software, etc.); Laser Radar for Non-Cooperative Identification.
USAF	0602204F	RDT&E	Aerospace Sensors (EO Sensors & Countermeasures Tech)	Passive Electro-Optical/Infrared Sensing in Contested Environments ($8.157M FY18, $13.674M FY19): Select promising technology options for hyperspectral imaging on small unmanned aircraft systems and advance their technology readiness level. (FY18) Complete and test in a laboratory environment, a pathfinder for small size, weight and power hyperspectral imaging for a small unmanned aircraft system. (FY19) Laser Radar Sensing in Contested Environments ($16.316M FY18, $15.146 FY19): Continue development of a reduced size, weight and power laser amplifier suitable for laser radar applications such as synthetic aperture ladar and unmanned aircraft systems based active sensing. Enhance efforts to develop an end-to-end laser system computer model. Integrate the software with other system-level models. Continue component development for low cost, low size, weight and power laser radar suited for implementation on an unmanned aircraft system. (FY19)
USAF	0305206F	RDT&E	Airborne Reconnaissance Systems (Data Compression)	Data Compression: provides the warfighter a capability to efficiently compress and decompress airborne Intelligence, Surveillance and Reconnaissance (ISR) sensor data and transmit near real time to tactical users through current and future bandwidth limited commercial Satellite Communications (SATCOM) or military SATCOM. In FY19: Will support integration of compression capabilities into operational sensors including, but not limited to Global Hawk MP-RTIP/EISS, and Reaper/LynxSAR

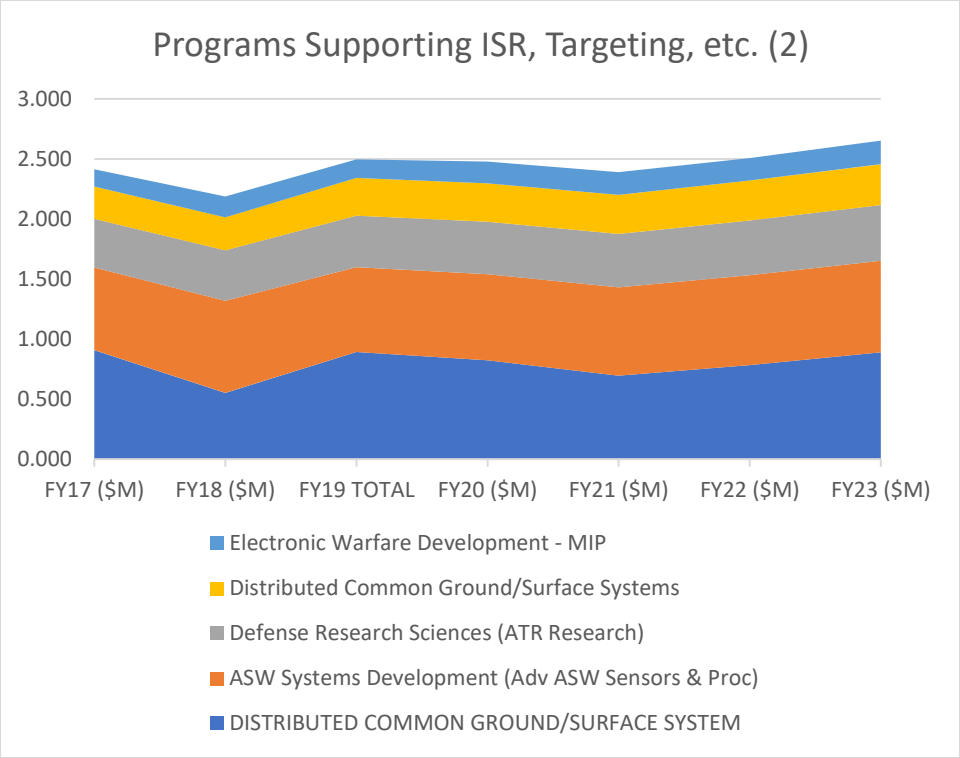


FIGURE 54: PROGRAMS SUPPORTING ISR, TARGETING, ETC.

TABLE 44: LISTING OF PROGRAMS SUPPORTING ISR, TARGETING, ETC.

Organization	PE Number	Funding Type	Title	Notes
SOCOM	020401INTL	Procurement	DISTRIBUTED COMMON GROUND/SURFACE SYSTEM	System that exploits ISR data from manned and unmanned sensors
US Navy	0603254N	RDT&E	ASW Systems Development (Adv ASW Sensors & Proc)	Development of payload technologies for ASW that can be integrated on manned and unmanned aircraft; technologies include sonobuoy communication links, laser technologies, EO and multispectral cameras, radar, Magnetic Anomaly Detection (MAD) sensors
US Army	0601102A	RDT&E	Defense Research Sciences (ATR Research)	Target tracking and identification - resource constrained computation platforms for unmanned systems
SOCOM	0305208BB	RDT&E	Distributed Common Ground/Surface Systems	System that exploits ISR data from manned and unmanned sensors
US Navy	0304270N	RDT&E	Electronic Warfare Development - MIP	Continue all task to develop an unmanned, autonomous, remote collection and surveillance system

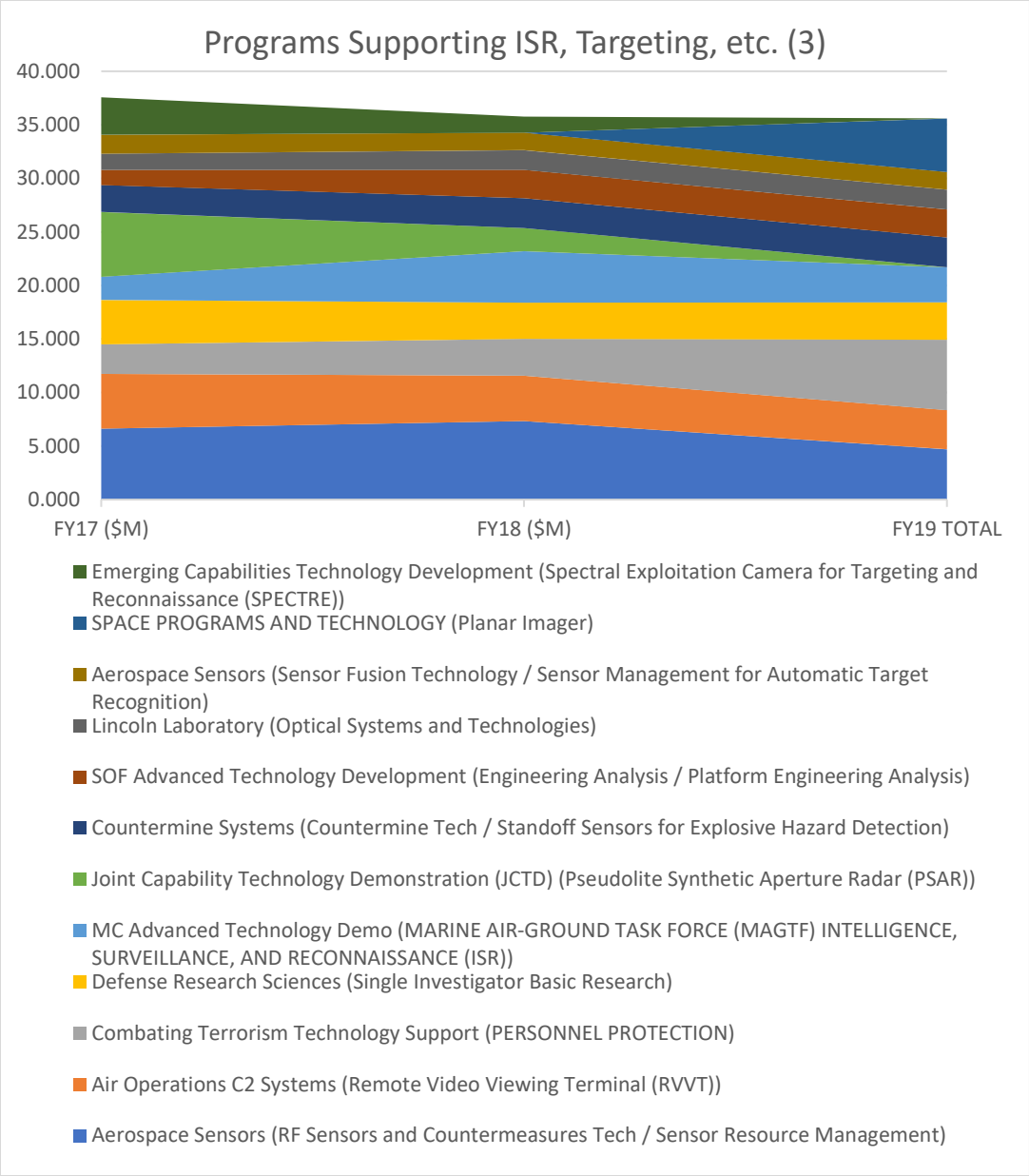


FIGURE 55: PROGRAMS SUPPORTING ISR, TARGETING, ETC.

TABLE 45: LISTING OF PROGRAMS SUPPORTING ISR, TARGETING, ETC.

Organization	PE Number	Funding Type	Title	Notes
USAF	0602204F	RDT&E	Aerospace Sensors (RF Sensors and Countermeasures Tech / Sensor Resource Management)	Sensor Resource Management: Develop technology to enable optimization of sensor resources in contested environments on own-ship and multiship in manned, unmanned and manned/unmanned teaming concepts. In FY19: The radio frequency countermeasures technology work performed in fiscal year 2018 in this effort, was moved in fiscal year 2019 to Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technology effort. Assess fidelity of sensor resource manager Air Force Simulation models with

				leveraged flight test data (radar, electro-optical/infrared) collected under Defense Advanced Research Projects Agency's System of Systems Integration Technology and Experimentation Program. Complete single ship sensor resource management effort resulting in radio frequency multi-function/multi-mode use cases for size, weight and power constrained platforms. FY 2018 to FY 2019 Increase/Decrease Statement: FY 2019 decreased compared to FY 2018 by $5.263M. Decrease is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.
USMC	4640	Procurement	Air Operations C2 Systems (Remote Video Viewing Terminal (RVVT))	Exploitation of FMV from ISR assets (Raven, Puma, Shadow, Predator, Fire Scout, Micro-UAS)
OSD	0603122D8Z	RDT&E	Combating Terrorism Technology Support (PERSONNEL PROTECTION)	In FY18, Complete development of counter unmanned aerial vehicle capabilities; Continue the development of a multi-modal system to detect, identify and mitigate unmanned aerial threats to tactile vehicles and other mobile platforms in terrestrial and maritime environments; Initiate the development of advanced systems to detect and mitigate unmanned aerial threats using novel detection and mitigation modalities; Initiate development of a robust Electromyography (EMG) sensor system comprised of electrodes, sampling electronics and processing electronics capable of integration into a robotic/human augmentation platform; Initiate development of an air deployable unmanned aerial system that is capable of dashing ahead of the V-22 and providing at least 8.5 minutes of overhead intelligence, surveillance and reconnaissance (ISR) at the landing zone or drop zone prior to the force arrival. In FY19, Complete the development of a multi-modal system to detect, identify and mitigate unmanned aerial threats to tactile vehicles and other mobile platforms in terrestrial and maritime environments; Continue development of an air deployable unmanned aerial system that is capable of dashing ahead of the V-22 and providing at least 8.5 minutes of overhead intelligence, surveillance and reconnaissance (ISR) at the landing zone or drop zone prior to the force arrival; Continue development of a robust Electromyography (EMG) sensor system comprised of electrodes, sampling electronics and processing electronics capable of integration into a robotic/human augmentation platform; Continue the development of advanced systems to detect and mitigate unmanned aerial threats using novel detection and mitigation modalities; Initiate the development of a vehicle mounted, tethered aerial platform capable of carrying a wide variety of payloads to fill various mission needs. CUAS On the Move (MACE)/MAFIA Integration/BEAM, MACE, CORIAN Integration - Develop a system to provide a mobile platform to precisely detect, identify and mitigate sUAS threats; integrate the system into an existing command/control system; and ensure compliance with other systems. Soldier Worn CUAS/Single Node Capability - Develop a system to provide a dismounted squad with the ability to precisely detect, identify and mitigate sUAS threats by reducing the size and increasing the capability of a single node minimal degradation to operational performance.

US Army	0601102A	RDT&E	Defense Research Sciences (Single Investigator Basic Research)	Processing of sensing data for autonomous unmanned air/ground systems
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (MARINE AIR-GROUND TASK FORCE (MAGTF) INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR))	Continue examination and assessment of technologies that support future employment of UAS operations from seabased platforms; deployable UAS that can dash ahead of MV-22 aircraft to conduct final reconnaissance of objective area to update threat situation in route to objective area; initiate development and assessment of an expeditionary drone deployment system (in order to automate UAS ground handling, control, launch, and recovery) to enable mission-level tasking and untrained operations of a fleet of small UAS (FY18). Assess systems to combine sensor and telemetry data from multiple unmanned platforms (ground, surface (water), and air) in order to provide a more relevant and usable tactical picture; Initiate efforts to provide a small, lightweight, semi-autonomous system that can self-navigate structure interiors while simultaneously visibly inspecting and creating real-time three-dimensional (3D) maps. FY 2018 to FY 2019 Increase/Decrease Statement: The funding decrease from FY2018 to FY2019 is due to a reduced investment in investigating, developing and/or assessing technologies that: automate UAS management efforts and narrowing focus on efforts that seek to enhance sensor payload management (focusing on commercial off-the-shelf small UASs).
OSD	0603648D8Z	RDT&E	Joint Capability Technology Demonstration (JCTD) (Pseudolite Synthetic Aperture Radar (PSAR))	Pseudolite Synthetic Aperture Radar (PSAR): in FY18 project is completed, Fly prototypes on surrogate manned aircraft. Repackage prototypes to meet pseudolite platform space, weight, power and cooling constraints. Integrate a down-link communications system for transfer of SAR data. Complete integration of SAR prototypes on pseudolite aircraft. Perform operational demonstration and military utility assessment. Transition to U.S. Navy Program Executive Office, Space. Complete the JCTD.
US Army	0602712A	RDT&E	Countermine Systems (Countermine Tech / Standoff Sensors for Explosive Hazard Detection)	Investigate modular sensor components including unique radars, EO/IR sensors, wire detection techniques, and sensitive radio frequency technologies to remotely detect explosive hazards and indicators of emplacement such as command wires and initiation devices for application to small unmanned air and ground platforms. (FY19)
SOCOM	1160402BB	RDT&E	SOF Advanced Technology Development (Engineering Analysis / Platform Engineering Analysis)	In FY19: Continues to assess concepts and prototypes that provide increased ballistic protection of air, ground and undersea mobility platforms to include manned and unmanned UAVs, and mobility platform improvements to meet emerging threats. Assess and evaluate advanced precision guided munitions and scalable effects weapons. Identify, assess and evaluate improved C4 systems that incorporate significant improvements to operate in contested environments, systems that improve situational awareness on the battlefield, and next generation manned and unmanned ISR systems and common sensors and sensor suites.
OSD	0602234D8Z	RDT&E	Lincoln Laboratory (Optical Systems and Technologies)	Development of a small laser radar in FY 2018 will allow real-time 3D images on a small unmanned air vehicle. In FY19 Design will commence on integration of a 3D laser radar into an unmanned air vehicle.

USAF	0602204F	RDT&E	Aerospace Sensors (Sensor Fusion Technology / Sensor Management for Automatic Target Recognition)	Sensor Management for Automatic Target Recognition: Conduct live demonstration of decentralized asset management with real and synthetic unmanned aerial vehicles to include target identification, passive geolocation, and context-sensitive target prioritization. (FY18)
DARPA	0603287E	RDT&E	SPACE PROGRAMS AND TECHNOLOGY (Planar Imager)	Planar Imager: The Planar Imager program will develop a low size, weight, and power (SWaP) electro-optical (EO) imager using photonic integrated circuits (PICs) and other novel approaches to replace conventional telescopes for high altitude, long endurance Unmanned Aerial Vehicle (UAV) persistent platforms and space-based EO sensors for Intelligence, Surveillance, and Reconnaissance (ISR).
OSD	0603699D8Z	RDT&E	Emerging Capabilities Technology Development (Spectral Exploitation Camera for Targeting and Reconnaissance (SPECTRE))	Spectral Exploitation Camera for Targeting and Reconnaissance (SPECTRE): will develop and demonstrate a greatly reduced size, weight, and power (SWaP) hyperspectral imaging (HSI) capability that is compatible with multiple manned and unmanned platforms across the Department of Defense (DoD). In FY 2018, designs will continue and the telescope and the pod will begin construction, integration, and lab testing. FY 2018 will complete the development and build efforts for SPECTRE leading to a flight test in FY 2019 and planned transition to a deployed unmanned aerial system. This effort also informs Program Objective Memorandum (POM) efforts for two Army program of record aerial systems.

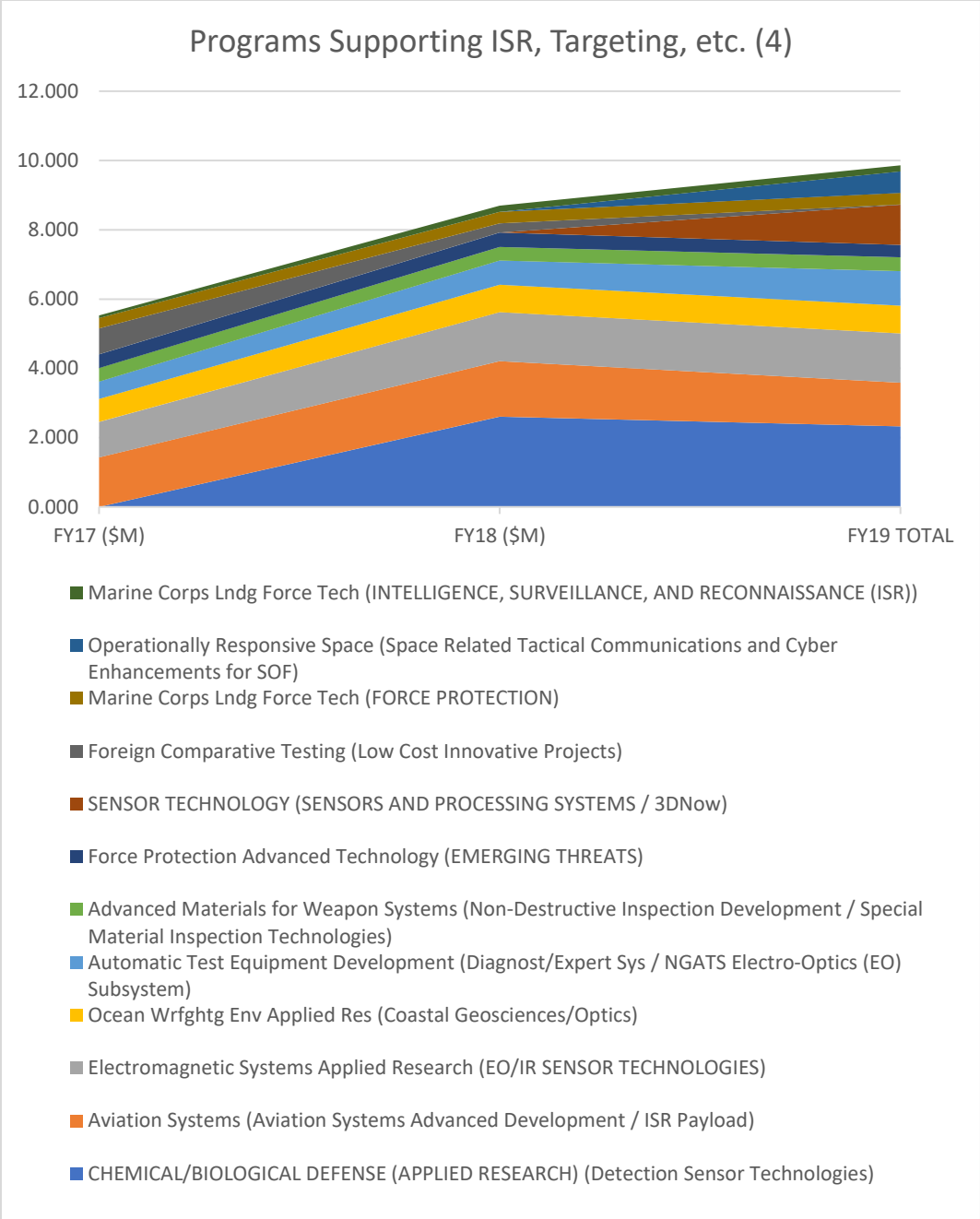


FIGURE 56: PROGRAMS SUPPORTING ISR, TARGETING, ETC.

TABLE 46: LISTING OF PROGRAMS SUPPORTING ISR, TARGETING, ETC.

Organization	PE Number	Funding Type	Title	Notes
CBDP	0602384BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (APPLIED RESEARCH) (Detection Sensor Technologies)	Detection Sensor Technologies: Continue the development of sensors for mobile applications, including development for unmanned systems.

SOCOM	1160403BB	RDT&E	Aviation Systems (Aviation Systems Advanced Development / ISR Payload)	ISR Payload Sensor Technology supports development, integration, and testing of sensor miniaturization efforts to adapt large (Group 4-5) unmanned aircraft system (UAS) ISR capabilities on all SOF UAS ISR platforms. FY18/FY19 Plans: Continues spiral development to increase the smaller SOF ISR platforms' capabilities through incremental development, integration, and testing. Decrease of $0.345 million is due to higher command priorities.
US Navy	0602271N	RDT&E	Electromagnetic Systems Applied Research (EO/IR SENSOR TECHNOLOGIES)	Developing capabilities for high resolution, wide field of view sensors on modest sized UAS platforms; autonomous sensing for UAV platforms and networked sensing over multiple sensors and/or sensor platforms
US Navy	0602435N	RDT&E	Ocean Wrfghtg Env Applied Res (Coastal Geosciences/Optics)	Demonstrate an extremely compact hyperspectral imager (HSI) employed to retrieve coastal environmental products, ultimately from very small unmanned aerial vehicles (UAVs), by modifying a prototype sensor, incorporating smartphone technology for control and processing and evaluate the performance for quantitative retrieval of environmental products
US Army	0604746A	RDT&E	Automatic Test Equipment Development (Diagnost/Expert Sys / NGATS Electro-Optics (EO) Subsystem)	Next Generation Automatic Test System (NGATS) electro-optics (EO) subsystem: Complete integration/testing of EO subsystem (FY19)
USAF	0603112F	RDT&E	Advanced Materials for Weapon Systems (Non-Destructive Inspection Development / Special Material Inspection Technologies)	Special Material Inspection Technologies: in FY18/FY19, Continue to develop hand-held and robotic technologies for visual inspections that will realize human-assisted inspection capabilities and begin to provide capabilities for automated multi-spectral characterization.
US Navy	0603123N	RDT&E	Force Protection Advanced Technology (EMERGING THREATS)	Development of autonomous unmanned harbor defense systems for perimeter patrol and threat interdiction; develop sensors and countermeasures for threats such as UUVs (FY18); Ongoing development of Autonomous Maritime Asset Protection capabilities for detection, classification, and defeat of small unmanned air, surface, and subsurface threats to naval installations through fusion of electrooptic sensors, acoustic sensors and countermeasures technologies demonstrated under this program.
DARPA	0603767E	RDT&E	SENSOR TECHNOLOGY (SENSORS AND PROCESSING SYSTEMS / 3DNow)	3DNow program aims to develop technologies that let warfighters rapidly access tactical 3D situational awareness data within a secure government owned framework built on a commercial technology base. New technologies to be developed include mapping algorithms, image processing algorithms, and interoperability software and hardware. This new technology will interface with commercial drones, Software Defined Radios (SDR), advanced sensors such as those found in self-driven cars (miniature radars and lidars), high-resolution imagers, and Internet of Things (IoT) devices.
OSD	0603133D8Z	RDT&E	Foreign Comparative Testing (Low Cost Innovative Projects)	In FY18, Gimballed Laser Target Designator (Navy): -Complete laser safety review and test planning during 1Q FY 2018. Receive test article during 2Q FY 2018. Conduct flight test during 3Q FY 2018. Complete final test and closeout report during 4Q FY 2018. If successful, payload will transition to Group 1 Unmanned Aerial System Program of Record. Completed in FY17: -Millimeter Wave Sensing for Autonomy

				(Navy): Tested technology that enables rapid and affordable evaluation of commercial automotive millimeter wave radar technology for defense applications including unmanned aerial systems. Completed flight test events in 4Q FY 2017. Complete final closeout report in 1Q FY 2018 with FY 2017 funding. If successful, the technology will transition into the Low-Cost Unmanned Aerial Vehicle Swarming Technology Innovative Naval Prototype Program. -Small Anti-Jam GPS Antenna for H-1 (Navy): Tested a small anti-jam Global Positioning Satellite (GPS) antenna system for helicopters, Group 3/4 Unmanned Aerial Vehicles, and ground vehicles to provide a counter GPS signal jamming capability to size, weight, and power constrained vehicles. Completed Phase I anechoic chamber testing 3Q FY 2017. Completed Phase II flight testing 3Q FY 2017. Complete final test and closeout report in 2Q FY 2018 with FY 2017 funding. If successful, the technology will transition to the Navy's H-1 Helicopters Program Office for fielding. -Underwater Wireless Power Transfer (Navy): Evaluates foreign wireless power transfer systems for potential use in Navy underwater systems and other defense applications. Wireless power transfer enables enhanced endurance of autonomous underwater vehicles and sensors, increased situational awareness, and new mission capabilities. Completed phase III pier-side testing in 4Q FY 2017. Conduct user demonstrations throughout FY 2018 with FY 2017 funding. If successful, transition potential exists for various Department of Defense programs. -High Efficiency Flexible Photovoltaics (Navy): Tests high efficiency, lightweight, flexible solar cells for cross-domain military applications that will increase power for Unmanned Aerial Vehicles, small satellites, man-portable and ground-based renewable energy systems. Complete solar backpack, Unmanned Aerial Vehicle, and simulated space testing in 1Q FY 2018 with FY 2017 funding. If successful, transition decision and final closeout report expected in 2Q FY 2018.
US Navy	0602131M	RDT&E	Marine Corps Lndg Force Tech (FORCE PROTECTION)	Autonomous vehicles for detection, neutralization, marking and reporting of explosive hazards; computer vision and machine learning approaches for automated target recognition using visual, thermal, RADAR, and LIDAR
USAF	1206857F	RDT&E	Operationally Responsive Space (Space Related Tactical Communications and Cyber Enhancements for SOF)	SOF Nano Synthetic Aperture Radar - Provides high-resolution ISR from stratospheric aircraft, Unmanned Aerial Systems (UAS), high-altitude balloons; Anti-Access Area Denial capability; immune to cloud cover, severe weather, and adversary counter-measures.
US Navy	0602131M	RDT&E	Marine Corps Lndg Force Tech (INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR))	Complete efforts to track entities of interest in a high clutter environment via geolocation of optical tags from a UAV platform (FY18)

Programs Supporting EW Sensors

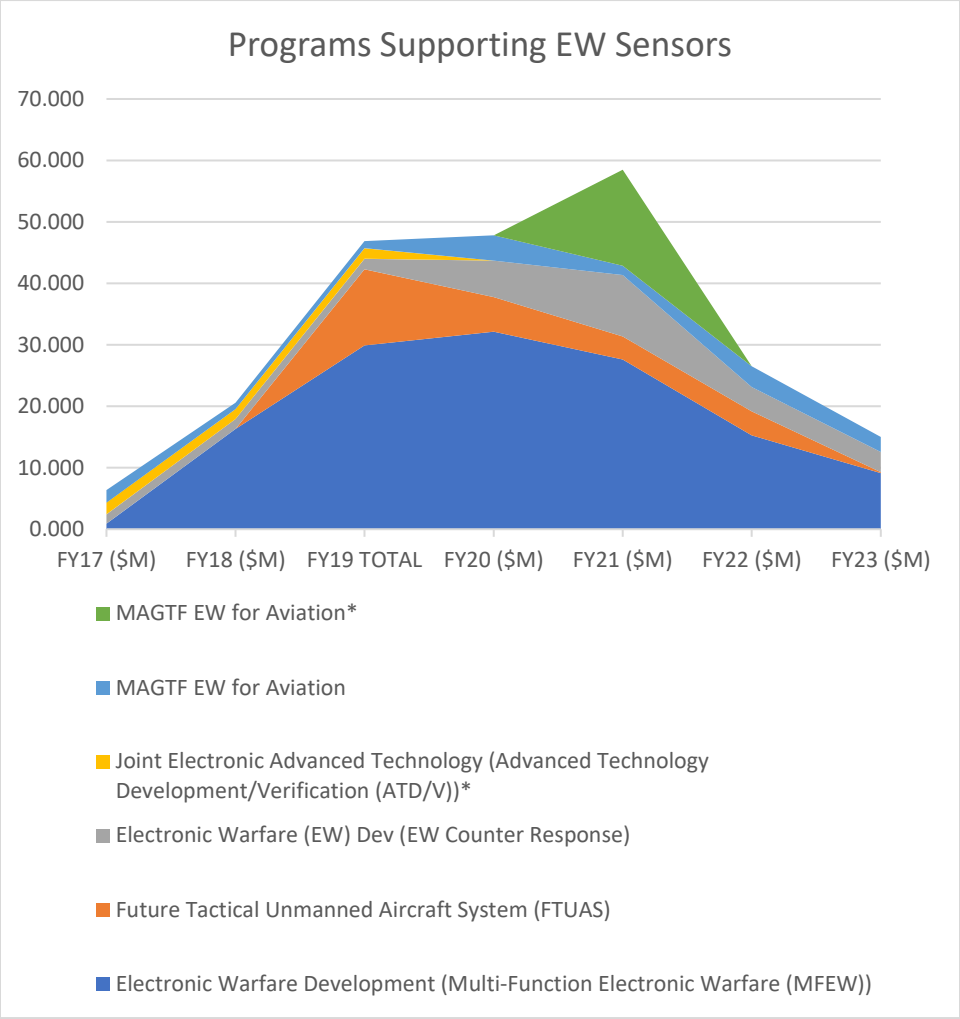


FIGURE 57: PROGRAMS SUPPORTING EW SENSORS INTEGRATED ON UNMANNED SYSTEMS

TABLE 47: LISTING OF PROGRAMS SUPPORTING EW SENSORS INTEGRATED ON UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
US Army	0604270A	RDT&E	Electronic Warfare Development (Multi-Function Electronic Warfare (MFEW))	The Multi-Function EW (MFEW) is a capability set that will provide the BCT Commander with an organic offensive Electronic Attack (EA), and Electronic Warfare Support (ES), and Defensive Electronic Attack (DEA) capability. Initially, an air large variant payload will be developed. MFEW will deliver scalable non-lethal effects to support Unified Land Operations and protect personnel, equipment and facilities. MFEW-Air is comprised of three variants: Air Large (Class IV Unmanned Aerial Vehicle), Air Small (Class III Unmanned Aerial Vehicle), and manned rotary wing payloads.
US Army	0604113A	RDT&E	Future Tactical Unmanned Aircraft System (FTUAS)	FTUAS will consist of an aircraft subsystem that will include the airframe, propulsion, avionics, communications, navigation, and software systems; aircraft-specific ground support equipment including take-off and landing systems, power

				generation, transportation, or unique command and control equipment; aircraft software; and required engineering, logistics, and programmatic support. Funding for USARPAC Multi-Domain Task Force (MDTF) Experimentation supports UAS aircraft, payload and Multi-Function Electronic Warfare (MFEW) experimentation which will inform FTUAS requirements and Analysis of Alternatives (AoA).
US Navy	0604270N	RDT&E	Electronic Warfare (EW) Dev (EW Counter Response)	Development of jamming techniques integrated as payloads on UAS
OSD	0603618D8Z	RDT&E	Joint Electronic Advanced Technology (Advanced Technology Development/Verification (ATD/V))*	Advanced Technology Development/Verification (ATD/V): ATD/V research efforts mature and assess emerging technologies to address compelling EW and converged EW-Cyber warfighting needs. The DEED Laboratory integrates promising technologies into unmanned aerial vehicles managed by the Naval Air Warfare Center, Weapons Division, for further exploration and assessment in venues like VH.
US Navy	0587	Procurement	MAGTF EW for Aviation	EW integration on UAS among other aircraft
US Navy	0587	Procurement	MAGTF EW for Aviation*	EW payloads for UAS (28 procured in FY21)

Programs Supporting Sensors & Payloads for CBRN, EOD, and Other Threats

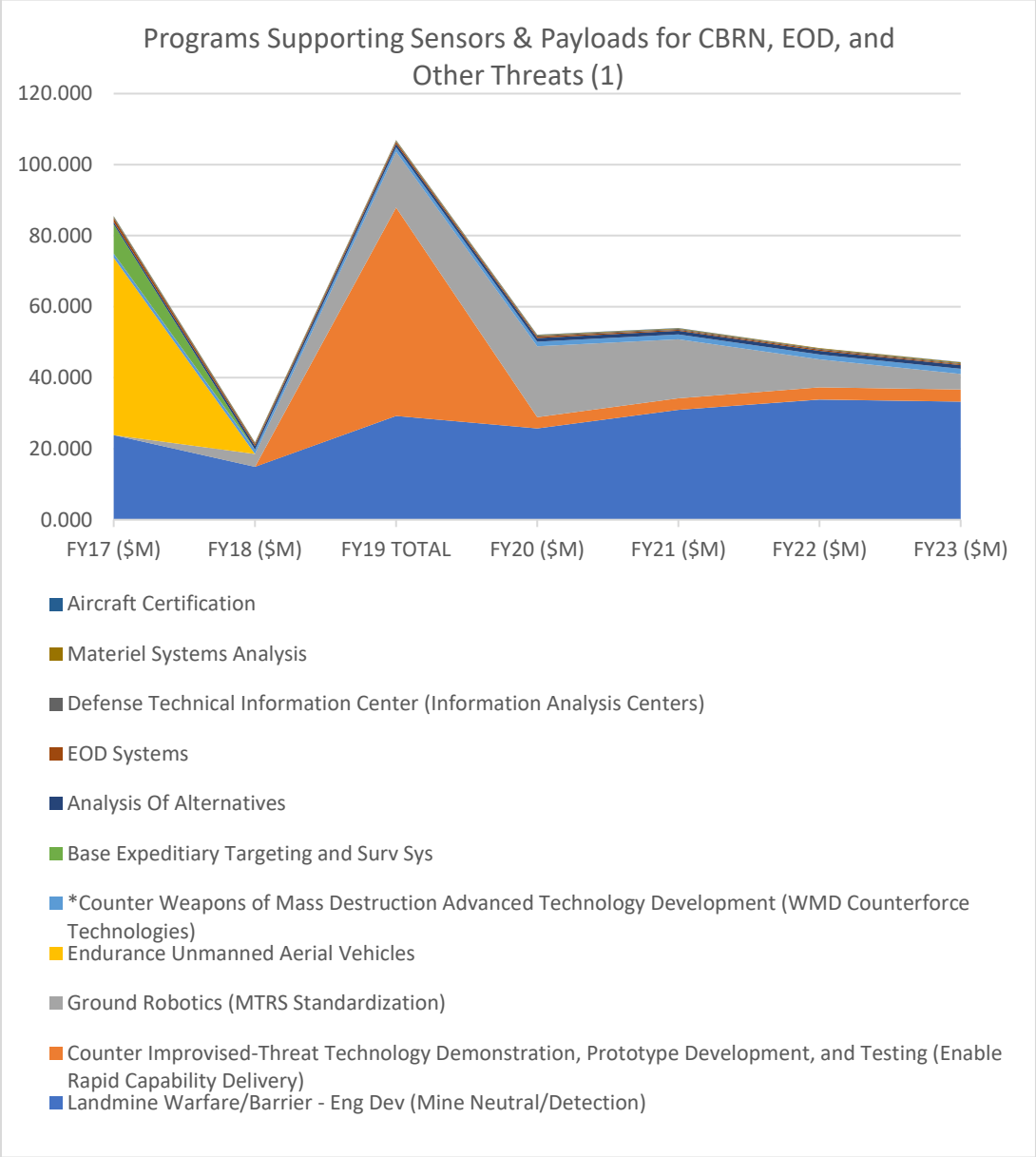


FIGURE 58: PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

TABLE 48: LISTING OF PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

Organization	PE Number	Funding Type	Title	Notes
US Army	0604808A	RDT&E	Landmine Warfare/Barrier - Eng Dev (Mine Neutral/Detection)	FY2019 Base funding of $38.945 million includes $27.681 million to support the continued development of the Husky Mounted Detection System (HMDS): a counter-explosive device capability that provides standoff detection and marking - HMDS is a mission equipment package mounted on the Husky

				route clearance vehicle; $9.350 million to support development and testing of Route Clearance & Interrogation System (RCIS) Type I & II: two semi-autonomous vehicles which provide a standoff capability to detect and neutralize the full spectrum of explosive hazards (integrates a semi-autonomous kit onto a High Mobility Engineering Excavator (HMEE) for remote control from a Buffalo Mine Protected Clearance Vehicle (MPCV)); $0.500 million to support continued Multifunction Video Display (MVD) development: provides view/control capability of systems like MTRS with future upgrades to include future UGVs, RCIS, and HMDS; $0.425 million to support RCV and Enabler improvements; and $0.989 million to support Standoff Robotic Explosive Hazard Detection System (SREHD) (formerly known as the Autonomous Mine Detection System (AMDS)) Developmental Testing (DT) corrective actions and Initial Operational Test and Evaluation (IOT&E) planning: consists of payload modules to be mounted on man-portable unmanned ground vehicles.
DTRA	0604134BR	RDT&E	Counter Improvised-Threat Technology Demonstration, Prototype Development, and Testing (Enable Rapid Capability Delivery)	FY19: Develop and test C-IED/C-sUAS systems for compatibility prior to systems deploying to operational theaters in support of the warfighter. FY19 OCO: Improve size, weight, power and integration of sensors to small unmanned systems; Improve on-board vs. off-board data processing to provide real time data in unmanned systems to support realtime improvised threat detection; Proof of concept for unmanned vehicle that can autonomously operate within confined spaces and provide necessary imagery to operator for BTS; Improve / develop threat Improvised Explosive Device/small Unmanned Aerial Systems (IED/sUAS) detect and defeat capabilities against future technology: acoustic detection at range, machine learning of constantly changing threat signatures (acoustic, RF signal, radar cross-section, optics, Unattended Radiated Emissions (URE), etc.) ($58.955 in FY19 OCO for UAS)
US Army	0605053A	RDT&E	Ground Robotics (MTRS Standardization)	Platform to Support Payload Development & Test: Testing of multi-shot disruptor and fire set for EOD robotics systems. Provide platforms to be used in the development and testing of the following payloads: High Dexterous Manipulation System (HDMS), Multi-Spectral Image Fusion System (MIFS), and Precision Aimed Multishot Disruptor (PAMD). (FY18) Other Transactional Authority: Funding will support the establishment of a library of robot parts which can be 3D printed via additive manufacturing. Funds will also test the operational capability of 3D printed parts with robot platforms. (FY18) Funds will test the operational capability of 3D printed parts with robot platforms. (FY19) CRS(H) / ERP: Funding will be used to award two contracts for CRS(H) prototype enhancements, delivery & testing of Production Qualification Test (PQT) articles, initiation of CRS(H) logistics development, and program management costs to include salaries, travel and miscellaneous expenses associated with the CRS(H) RDTE program. Funding will also be utilized to support Enhanced Robotic Payload (ERP) program initiation. The Common Robotic System, Heavy (CRS(H)) is a modular large-sized system that provides enhanced protection to the EOD Soldier in order to support the Joint Force Commander with the ability to identify, render safe and dispose of explosive ordnance (EO) and improvised explosive devices (IEDs) in support of the Range of

				Military Operations (ROMO) and Home Land Defense (HLD) operations.
USAF	0305205F	RDT&E	Endurance Unmanned Aerial Vehicles	Medium Altitude Global ISR and Communications (MAGIC) project: in FY17, Initiated efforts to develop a deployable Block 1 Orion air vehicle including: • Design and manufacture of Block 1 airframe structural certification test articles • Preliminary Design Review of the Block 1 air vehicle • Critical Design Review of the Block 1 airframe.
DTRA	0603160BR	RDT&E	*Counter Weapons of Mass Destruction Advanced Technology Development (WMD Counterforce Technologies)	The WMD battlespace awareness effort develops and integrates sensing technologies with multi-mission Unmanned Aerial System payloads that can find, characterize, and assess WMD threats.
US Army	0169BZ6501	Procurement	Base Expeditiary Targeting and Surv Sys	Targeting and surveillance system including the Rapid Aerostat Initial Deployment
US Army	0604100A	RDT&E	Analysis Of Alternatives	Funding will support new programs including Family of UAS / Future Tactical UAS
USMC	6520	Procurement	EOD Systems	Robotics for EOD
DTIC	0605801KA	RDT&E	Defense Technical Information Center (Information Analysis Centers)	Information Analysis Center (IAC) operations directly support the warfighter, and play an ongoing and critical role in solving key CCMD operational issues such as cyber security, unmanned aerial vehicle visual/audible signature reduction, and improvements to the ballistic resistance of body armor. (nothing specifically noted in FY18/FY19 plans)
US Army	0605706A	RDT&E	Materiel Systems Analysis	The US Army Materiel Systems Analysis Activity (AMSAA) will continue to support Army conceptual and developmental Acquisition Category programs, including Family of Unmanned Aircraft Systems and a range of other technologies (FY19)
US Army	0605606A	RDT&E	Aircraft Certification	The Airworthiness Certification PE also performs general research and development in support of aircraft qualification and overarching airworthiness projects that involve multiple aircraft models. Current ongoing programs requiring airworthiness qualification include Gray Eagle unmanned aircraft system (UAS), modified Shadow UAS, and a range of other manned aircraft.

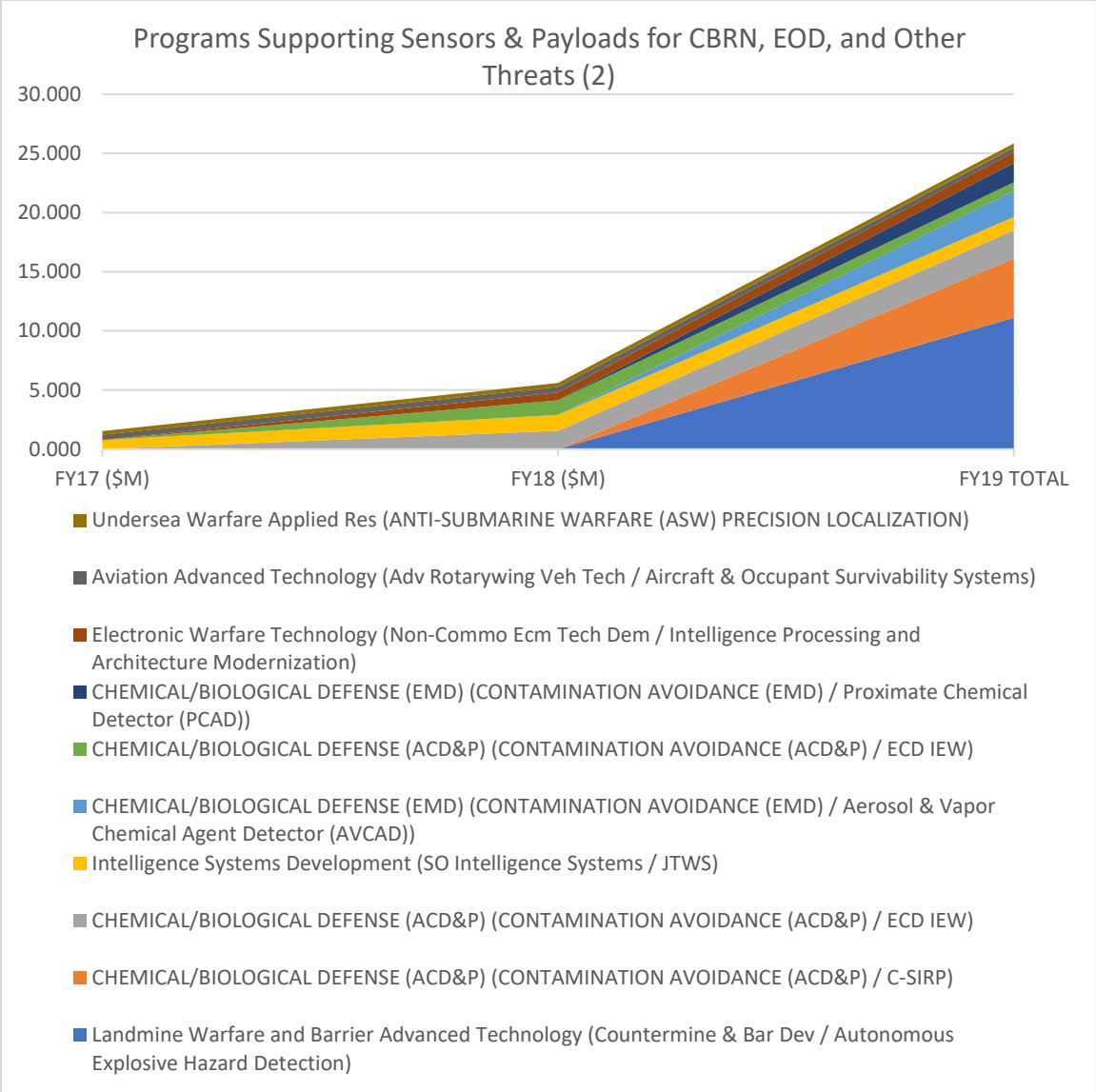


FIGURE 59: PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

TABLE 49: LISTING OF PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

Organization	PE Number	Funding Type	Title	Notes
US Army	0603606A	RDT&E	Landmine Warfare and Barrier Advanced Technology (Countermine & Bar Dev / Autonomous Explosive Hazard Detection)	Will mature sensors to detect wire components from standoff distances and sensor configurations for implementation on unmanned platforms; exploit novel sensor phenomenologies for optimization of explosive threat detection approaches; improve threat detection algorithms and signal processing techniques for the detection of buried explosive hazards using data collected in near-peer environments; mature low contrast target marking schemas and approaches; improve performance of close-in explosive threat confirmation sensors.

CBDP	0603884BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (ACD&P) (CONTAMINATION AVOIDANCE (ACD&P) / C-SIRP)	CBRN Sensor Integration on Robotics Platforms (C-SIRP): Initiate integration efforts for unmanned ground and air platforms, complete mission modeling efforts. Initiate size, weight, and power trade studies for sensor integration. Purchase developmental test articles. Complete unmanned technology demonstration. Provide support to test events requiring robotic platforms, support IEW remote sensing data requirements, and provide program management support. Program/project is new start effort in FY 2019.
CBDP	0603884BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (ACD&P) (CONTAMINATION AVOIDANCE (ACD&P) / ECD IEW)	Enhanced Capability Demonstration Integrated Early Warning (ECD IEW): in FY18/FY19, Continue Early Warning capability integration for remote CBRN and Non-CBRN sensors, robotic platforms, unattended sensors, and decision support.
SOCOM	1160405BB	RDT&E	Intelligence Systems Development (SO Intelligence Systems / JTWS)	Joint Threat Warning System (JTWS) enables the Special Operations Forces (SOF) Cryptologic Operator to collect, process, locate and exploit threat communications signals of interest. The JTWS SoS is assembled in four variants: Ground SIGINT Kit; Maritime; Air; and UAS. Decrease of $0.803 million is a realignment to higher command priorities.
CBDP	0604384BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (EMD) (CONTAMINATION AVOIDANCE (EMD) / Aerosol & Vapor Chemical Agent Detector (AVCAD))	Aerosol & Vapor Chemical Agent Detector (AVCAD) will provide the Joint Forces a man-portable system to detect and identify aerosol and vapor chemical threats and will also be employed on manned and unmanned platforms. (total funding for AVCAD across multiple sub-projects included in FY19)
CBDP	0603884BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (ACD&P) (CONTAMINATION AVOIDANCE (ACD&P) / ECD IEW)	Enhanced Capability Demonstration Integrated Early Warning (ECD IEW): in FY19, Continue Early Warning capability RDT&E test article procurement and assessment for remote CBRN and Non-CBRN sensors, robotic platforms, unattended sensors, and decision support.
CBDP	0604384BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (EMD) (CONTAMINATION AVOIDANCE (EMD) / Proximate Chemical Detector (PCAD))	Proximate Chemical Agent Detector (PCAD): Management Services (previously NGCD 2), a survey detector that is a portable system for the rapid location, detection and identification of liquid and solid chemical threats on surfaces, and may be handheld, tripod mounted, or mounted on unmanned platforms. (total funding for PCAD across multiple sub-projects included in FY19)
US Army	0603270A	RDT&E	Electronic Warfare Technology (Non-Commo Ecm Tech Dem / Intelligence Processing and Architecture Modernization)	Demonstrate mitigation techniques for noise within the HF frequency band from small unmanned air systems to facilitate deployment of HF applications on platforms
US Army	0603003A	RDT&E	Aviation Advanced Technology (Adv Rotarywing Veh Tech / Aircraft & Occupant Survivability Systems)	Mature rotorcraft threat protection capabilities including self-protection and engagement technologies. (FY18 - not specifically noted but possible relevance to unmanned rotorcraft) Will develop ownship and team based survivability behaviors and continue integration of rotorcraft threat protection technologies (FY19)
US Navy	0602747N	RDT&E	Undersea Warfare Applied Res (ANTI-SUBMARINE	Enable deployment of magnetic sensor on UAVs to localize submerged threats

			WARFARE (ASW) PRECISION LOCALIZATION)	

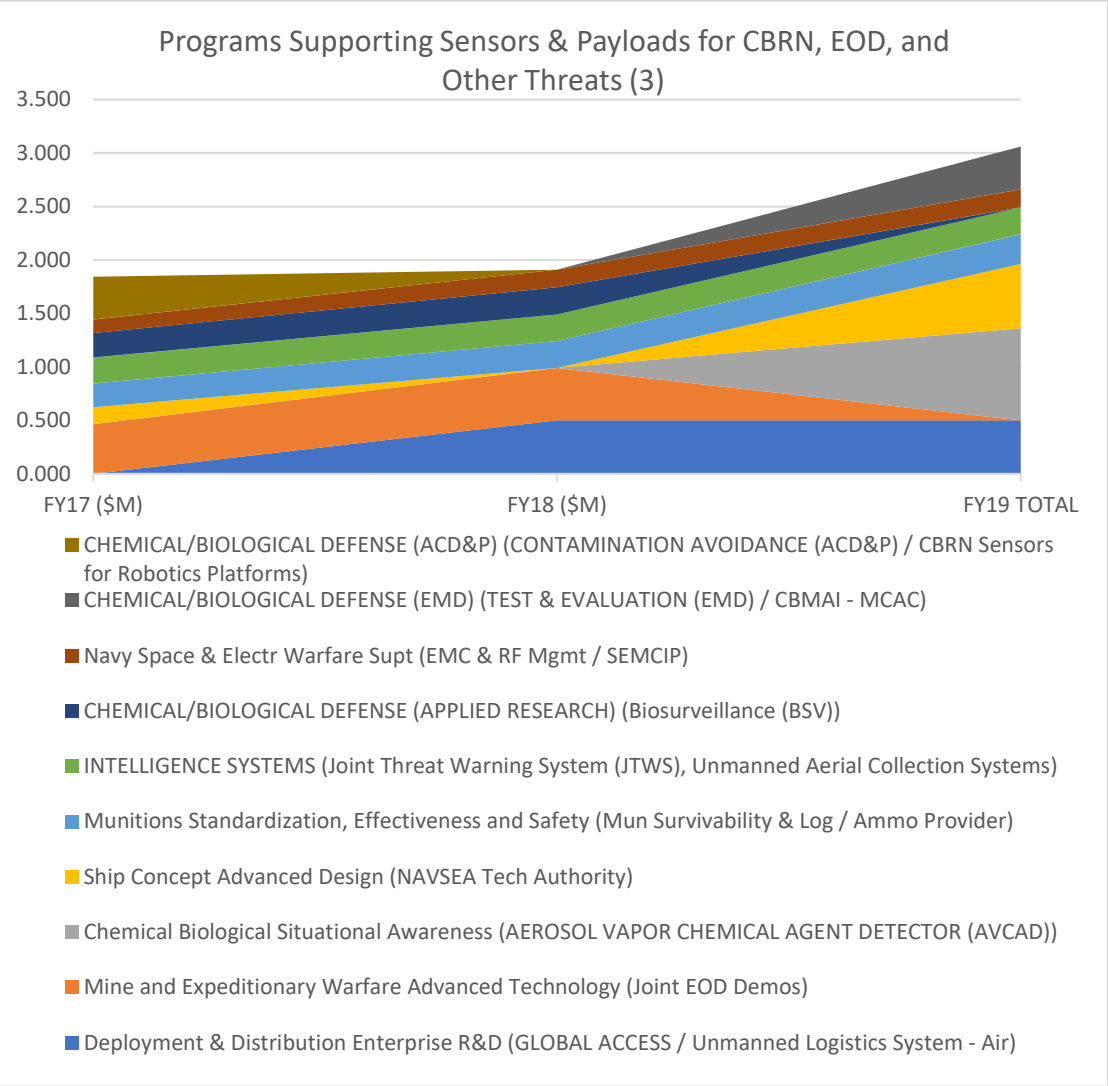


FIGURE 60: PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

TABLE 50: LISTING OF PROGRAMS SUPPORTING SENSORS AND PAYLOADS INTEGRATED ON UNMANNED SYSTEMS FOR CBRN, EOD, AND OTHER THREATS

Organization	PE Number	Funding Type	Title	Notes
USAF	0604776F	RDT&E	Deployment & Distribution Enterprise R&D (GLOBAL ACCESS / Unmanned Logistics System - Air)	Unmanned Logistics System - Air: in FY18, Competitive assessment of varying UAS capabilities. In FY19, Capabilities to support last tactical mile distribution.
US Navy	0603782N	RDT&E	Mine and Expeditionary Warfare Advanced	Development of highly dexterous dual manipulator systems (manipulators, controllers) for EOD robots for precision render

			Technology (Joint EOD Demos)	safe and neutralization missions; modular magnetic and acoustic influence sweeping systems for deployment from USV (>9.4 square nautical miles at 20 nautical miles per hour during a 4 hour mission)
CBDP	7001SA1000	Procurement	Chemical Biological Situational Awareness (AEROSOL VAPOR CHEMICAL AGENT DETECTOR (AVCAD))	Sensor that can detect aerosol and vapor chemical threats (mounted on manned and unmanned platforms)
US Navy	0603561N	RDT&E	Ship Concept Advanced Design (NAVSEA Tech Authority)	USV design and analysis (Platform Concept Advanced Development (CPSD 1.0) in FY17); development and advancement of NAVY unmanned systems across various platforms (Unmanned Systems (CPSD E) in FY19); development of rapid deployment and swarming technologies
US Army	0605805A	RDT&E	Munitions Standardization, Effectiveness and Safety (Mun Survivability & Log / Ammo Provider)	Conduct phase 1 demonstration of the enhanced speedbag with the Tactical Resupply Unmanned Aerial System ? Competitive (TRUC). Mature 5K forklift and Rough Terrain Container Handler (RTCH) automation kit prototypes to include integration of maintenance and troubleshooting aids and conduct validation testing. Integrate applique interface kit for manually operated Material Handling Equipment (MHE) into the 5K forklift and RTCH, implement software control subsystems, and perform subsystem testing. Complete the design of a multi-modal supply pallet that minimizes the requirement for handling and reconfiguration of cargo in transit. (FY18)
SOCOM	020400INTL	Procurement	INTELLIGENCE SYSTEMS (Joint Threat Warning System (JTWS), Unmanned Aerial Collection Systems)	Unmanned aerial collection systems (2 in FY19 @ $126,000 ea; 2 also acquired in FY17/18)
CBDP	0602384BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (APPLIED RESEARCH) (Biosurveillance (BSV))	Biosurveillance (BSV): in FY18, Complete biosurveillance capabilities aimed at analyzing and facilitating sharing of sequence data, predicting areas of disease reemergence, and visualizing pathogen dynamics in support of the Global Biosurveillance Portal. Initiate the development of analytic applications to acquire, synthesize and interrogate multiple sources of data (open source information, medical diagnostic devices, wearable technology, environmental sensors, unmanned platforms and genomic sequences) to provide high confidence in the prediction and early warning of chemical or biological events. Program/project funding transferred to another funding line.
US Navy	0605866N	RDT&E	Navy Space & Electr Warfare Supt (EMC & RF Mgmt / SEMCIP)	Mitigate EMI sources for Navy systems and platforms: focus on the evaluation of Commercial Off the Shelf (COTS) systems/radars and the integration of Unmanned Aircraft Systems (UAS)
CBDP	0604384BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (EMD) (TEST & EVALUATION (EMD) / CBMAI - MCAC)	Chem Bio Material Assessment Infrastructure (CBMAI) - Multi Commodity Agent Chamber (MCAC): in FY19, Modify chamber to support programs of records such as Chemical Sensor Integration on Robotic Platforms (C-SIRP) and Chemical Surface Detection (CSD).
CBDP	0603884BP	RDT&E	CHEMICAL/BIOLOGICAL DEFENSE (ACD&P) (CONTAMINATION	CBRN Sensors for Robotics Platforms - JCACS ECD

			AVOIDANCE (ACD&P) / CBRN Sensors for Robotics Platforms)	

Programs Focused on Testing and Evaluation Support for Unmanned Systems

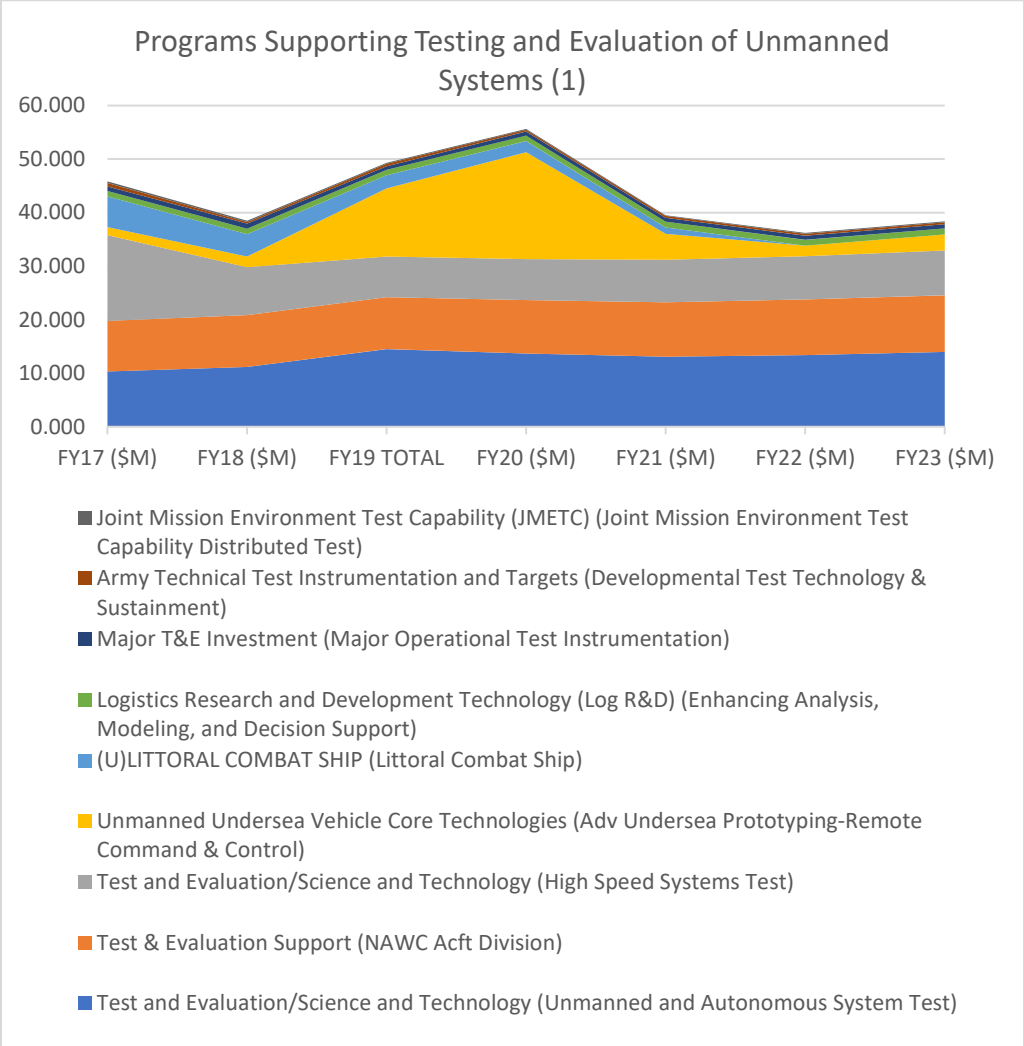


FIGURE 61: PROGRAMS SUPPORTING TESTING AND EVALUATION OF UNMANNED SYSTEMS AND ASSOCIATED TECHNOLOGIES

TABLE 51: LISTING OF PROGRAMS SUPPORTING TESTING AND EVALUATION OF UNMANNED SYSTEMS AND ASSOCIATED TECHNOLOGIES

Organization	PE Number	Funding Type	Title	Notes
OSD	0603941D8Z	RDT&E	Test and Evaluation/Science and Technology (Unmanned	FY 2019 Plans: The UAST project will continue to initiate and develop technologies to support autonomous system test planning, autonomous system test execution, and autonomous

			and Autonomous System Test)	system performance assessment. Efforts within test planning will include predicting autonomous behavior for testing and assuring thorough testing of autonomous systems. Investments in test execution will include: enhancing safety of autonomous system testing; creating test environments that are complex, immersive, and reactive; and adapting ranges to cognitive, autonomous system testing. Developments under performance assessment will include: testing and evaluating UAS-to-UAS and human-to-UAS interactions and measuring autonomous system reliability. The UAST project will complete development of technologies that automatically learn conditions for activating vulnerabilities deep within an autonomous system, using machine learning and backward chaining techniques to determine system level inputs that induce failure.
US Navy	0605864N	RDT&E	Test & Evaluation Support (NAWC Acft Division)	The Test and Evaluation Group, Patuxent River, performs development and operational test and evaluation of manned and unmanned air vehicle systems, including mission systems, equipment, subsystems, components, and support systems
OSD	0603941D8Z	RDT&E	Test and Evaluation/Science and Technology (High Speed Systems Test)	High Speed Systems Test: The fabrication, and installation of a telemetry capability integrated with a High Altitude, Long Endurance Uncrewed Aerial System (HALE UAS) for a technical demonstration continued in preparation for support of flight testing. In FY18, Efforts will continue to assess the technical performance and CONOPS for a HALE UAS configured to support flight T&E of hypersonic vehicles. A telemetry system onboard a UAS capable of collecting data from a hypersonic flight vehicle over broad open ocean areas will be demonstrated. Efforts will continue to develop atmospheric sensing and optical imaging systems on uncrewed platforms to support flight tests. FY 2019 Plans: Developments will continue to improve hypersonic ground and flight test capabilities to levels required for acquisition programs. Efforts will include investigation of new flight test techniques to include further development and demonstration of a UAS-based range concept, investigation of new ground test instrumentation, and continued improvement and validation of CFD codes. The high fidelity automated airborne reconfigurable tracking system will be completed and demonstrated on a UAS, providing a new capability to support flight T&E of hypersonic vehicles.
US Navy	0604029N	RDT&E	Unmanned Undersea Vehicle Core Technologies (Adv Undersea Prototyping-Remote Command & Control)	FY 2019 increase in funding is due to increased management needs for energy, autonomy modeling and simulation, test bed development, and increased Common Control System (CCS) efforts. Initial applicability to XLUUV; test advanced energy prototype in FY21; focus also on common control systems across multiple domains - integration with surrogate system in FY22; Previous funding in PE 0604536N (previous funding has been included in provided totals)
US Navy	0603581N	RDT&E	(U)LITTORAL COMBAT SHIP (Littoral Combat Ship)	Provide systems engineering support for VTUAV Initial Operational Test & Evaluation (IOT&E) on Independence Variant and complete VTUAV Dynamic Interface testing on the Freedom Variant (FY18 - nothing noted in FY19)
DLA	0603712S	RDT&E	Logistics Research and Development Technology (Log R&D) (Enhancing Analysis, Modeling, and Decision Support)	Strategic Distribution and Disposition (SDD) will continue to support the Distribution Modernization Program as necessary to identify, evaluate, and test disruptive technologies including drone technologies applicable to distribution and disposition.

US Army	0604759A	RDT&E	Major T&E Investment (Major Operational Test Instrumentation)	Will fund integration of improved representation of unmanned aerial system in operational test environments. (FY18/19)
US Army	0605602A	RDT&E	Army Technical Test Instrumentation and Targets (Developmental Test Technology & Sustainment)	Non-intrusive instrumentation to test Unmanned Ground Vehicles and sensors; The WSTC will continue updating, replacing, and modifying the obsolete ground stations and control infrastructure in support of the surrogate threat target capabilities (QF-4, QF-16, and subscale drones) at the test range (FY18)
OSD	0605100D8Z	RDT&E	Joint Mission Environment Test Capability (JMETC) (Joint Mission Environment Test Capability Distributed Test)	Joint Mission Environment Test Capability Distributed Test: supported 83 distinct customer distributed test and training events including MQ-4C Triton, SDB II, Joint Unmanned Air System – Mission Environment (JUAS-ME); provided planning support to SDB II, MQ-4C Triton, Unmanned Carrier Launched Airborne Surveillance & Strike (UCLASS)

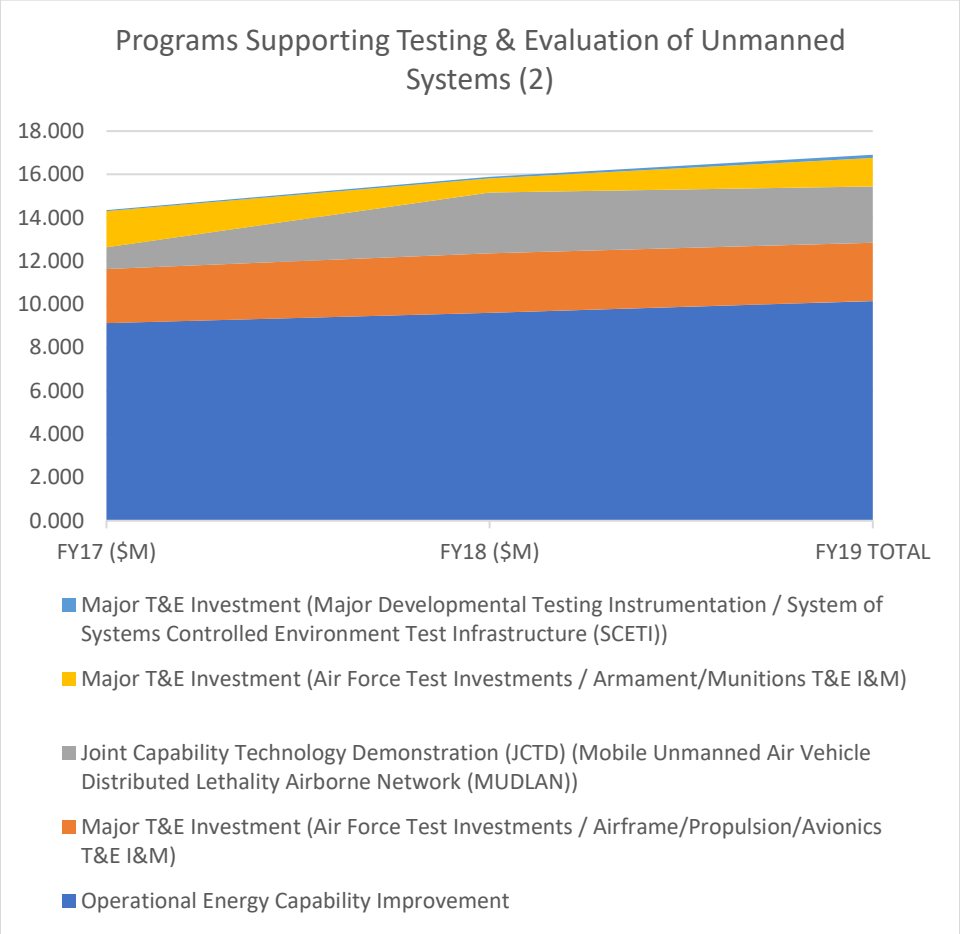


FIGURE 62: PROGRAMS SUPPORTING TESTING OF UNMANNED SYSTEMS AND ASSOCIATED TECHNOLOGIES

TABLE 52: LISTING OF PROGRAMS SUPPORTING TESTING OF UNMANNED SYSTEMS AND ASSOCIATED TECHNOLOGIES

Organization	PE Number	Funding Type	Title	Notes

OSD	0604055D8Z	RDT&E	Operational Energy Capability Improvement	In FY18, The FY16 unmanned vehicles programs will continue. The Reliable, Efficient, Tactical UAS Power System program will test the second generation engine for power output, specific fuel consumption, altitude, and product reliability. The Hybrid Tiger team will begin the flight testing phase validating the performance models and tuning flight controller gains, and refine software to emphasize optimal hybrid mode transitions and increased autonomy for soaring. The HTVE-UE program will continue base tasks related to component fabrication and breadboard assembly and testing, execute at-sea test planning, and perform initial system deployment; and continue studies and analyses related to FDECO interoperability, HTV characterization/environmental considerations, and CONOPS. The Aluminum Seawater Power program will go through the next round of component development and testing, and begin integration testing. The Small Turboprop Engine Range/Power Enhancement program will begin engine detailed design and acquire long lead materials for engine fabrication. The JP-8 Based Fuel Cell Power program will conduct physical integration of the JP-8 reformer and solid oxide fuel cell and all supporting hardware, and conduct the first two iterations of system level testing to determine weak parts of the system design. (The FY 2016 programs will reach their final year of OECIF funding in FY19) The FY 2017 programs will continue including The PTROL team will further build upon the technology to apply laser power beaming to power remotely a rotary wing unmanned air vehicle at greater range than in previous demonstrations as an interim step towards a broadly applicable and transition-able final capability to be delivered in FY 2021.
USAF	0604759F	RDT&E	Major T&E Investment (Air Force Test Investments / Airframe/Propulsion/Avionics T&E I&M)	Airframe/Propulsion/Avionics (APA) provides planning, improvements, and modernization needed for test capabilities to conduct and support DT&E and OT&E of aircraft and aircraft systems, aerospace research vehicles, unmanned aerial vehicles, cruise missiles, parachute delivery/recovery systems, cargo handling systems, and turbine engines.
OSD	0603648D8Z	RDT&E	Joint Capability Technology Demonstration (JCTD) (Mobile Unmanned Air Vehicle Distributed Lethality Airborne Network (MUDLAN))	Mobile Unmanned Air Vehicle Distributed Lethality Airborne Network (MUDLAN): In FY19, Perform flight testing on air, land, and sea platforms to demonstrate military utility of high data rate communications nodes. Incorporate test platforms in additional operational experiments to demonstrate over-the-horizon, distributed communications capabilities at scale. Transition the technologies to a U.S. Air Force Air Combat Command Program of Record.
USAF	0604759F	RDT&E	Major T&E Investment (Air Force Test Investments / Armament/Munitions T&E I&M)	In FY19 Gulf Range Enhancement (GRE) begins measured implementation to extend TSPI capabilities south into the Gulf Range for expanded use of the airspace for increased throughput of flight test efforts as well as to support future hypersonic, swarming autonomous vehicles, and LRSO test efforts.
US Army	0604759A	RDT&E	Major T&E Investment (Major Developmental Testing Instrumentation /	Will continue EMD phase contract activity for the SCETI program. This program will deliver the modular airborne sensor capability to test avionic sensors in degraded visual environments such as rain, dust, and snow for helicopters.

			System of Systems Controlled Environment Test Infrastructure (SCETI))	(it was also noted in the main project description that SCETI would provide for MUM-T but nothing is specifically noted in FY18/19 plans)

Other Platform Support

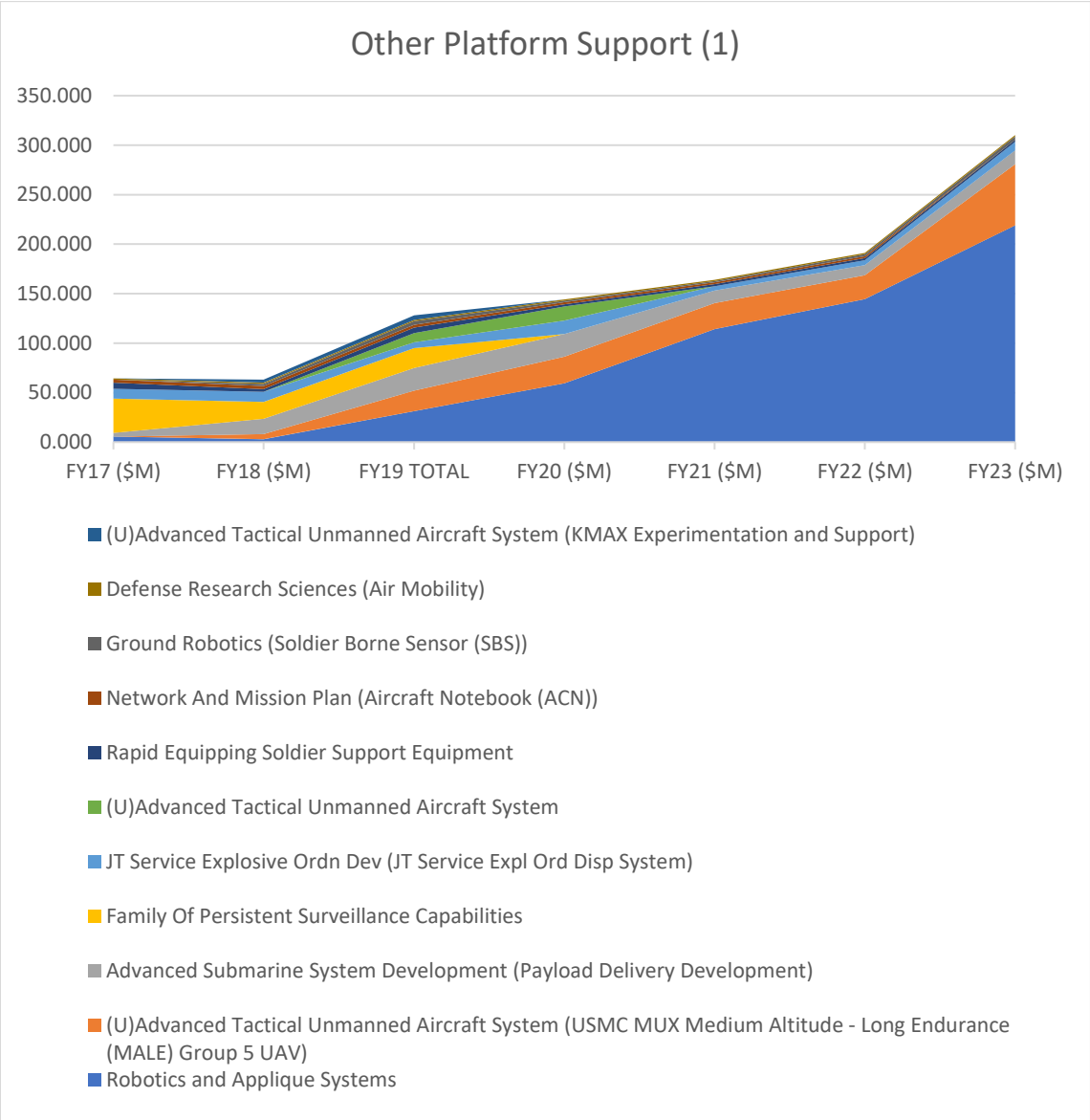


FIGURE 63: OTHER SUPPORT PROGRAMS FOR UNMANNED PLATFORMS

TABLE 53: LISTING OF OTHER SUPPORT PROGRAMS FOR UNMANNED PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Army	4868W12002	Procurement	Robotics and Applique Systems	Procurement of Common Robotics System (soldier back-packable UGV), Man-Transportable Robotics System (43 x Endeavor MTRS Inc II @ $120,000 ea), 2 x Talon 5a @

				$156,000 ea, and Soldier Borne Sensor (1,084 x SBS @ $20,000 ea)
US Navy	0304240M	RDT&E	(U)Advanced Tactical Unmanned Aircraft System (USMC MUX Medium Altitude - Long Endurance (MALE) Group 5 UAV)	Development of Marine Air Ground Task Force (MAGTF) Unmanned Aircraft System (UAS) Expeditionary (MUX) Concept of Operations and draft Capability Development Document (CDD). Provides funding for experimentation with advanced concept demonstrator UAVs such as USMC CQ-24A Cargo UAS and DARPA/ONR developed Tern Medium Altitude Long Endurance (MALE) UAS, along with other tactical UAV/payload/control station demonstrator efforts to help inform performance requirements, initial Key Performance Parameters (KPP), CONOPS, concepts, tactics, doctrine, and the future MUX program of record. FY 2018 to FY 2019 Increase/Decrease Statement: Increase from $3.650M to $18.274M results from additional industry capability RFIs and trade studies to support a future program of record.
US Navy	0603561N	RDT&E	Advanced Submarine System Development (Payload Delivery Development)	Payload handling systems integrated onto submarines for launch and recovery of US Navy UUV FoS in support of critical Undersea Warfare (USW); 3" Submarine Launched Unmanned "K" Aerial System (SL-UKAS)
US Army	9926BL5287	Procurement	Family Of Persistent Surveillance Capabilities	Aerostats used for persistent surveillance
US Navy	0603654N	RDT&E	JT Service Explosive Ordn Dev (JT Service Expl Ord Disp System)	Continue AEODRS Inc 2 Joint Service EOD Common Control Platform integration, testing and production readiness (FY18/19); Continue development and test AEODRS Increment 2 Prime System Integrator Production (FY18) / Prepare for AEODRS Increment 3 (Base and Infrastructure) Program Initiation (Milestone B) (FY18); Conduct Government Production First Article acceptance test and preparation for Full Rate Production. Milestone Authority approval for Advanced EOD Robotics System (AEODRS) Inc 3, Milestone B. Complete technical re-fresh plans and engineering improvements plans for AEODRS increments. (FY19)
US Navy	0304240N	RDT&E	(U)Advanced Tactical Unmanned Aircraft System	MALE UAV concept; The DARPA/ONR technology concept is a Tactically Exploited Reconnaissance Node (TERN) program
US Army	0017M80101	Procurement	Rapid Equipping Soldier Support Equipment	Procurement based on emerging rapid equipment requirements of technologies such as counter-UAS and persistent UAS
US Army	8658AA0712	Procurement	Network And Mission Plan (Aircraft Notebook (ACN))	Program to streamline aviation maintenance activities and airworthiness of Army aircraft including UAS
US Army	0605053A	RDT&E	Ground Robotics (Soldier Borne Sensor (SBS))	The SBS provides the small unit a "quick look" capability providing Situational Awareness (SA) of routes, building, tunnels, obstacles blocking line of sight, and similar concealed threat locations. This increase is due to maturing research and development of SBS Increment 1, 2 and 3 technology insertions in preparation for subsequent pre production activities.
US Army	0601102A	RDT&E	Defense Research Sciences (Air Mobility)	Improve rotary wing aerodynamics through experimental and computational approaches
US Navy	0304240M	RDT&E	(U)Advanced Tactical Unmanned Aircraft System (KMAX	CQ-24A Cargo UAS Experimentation and Support Services

			Experimentation and Support)	

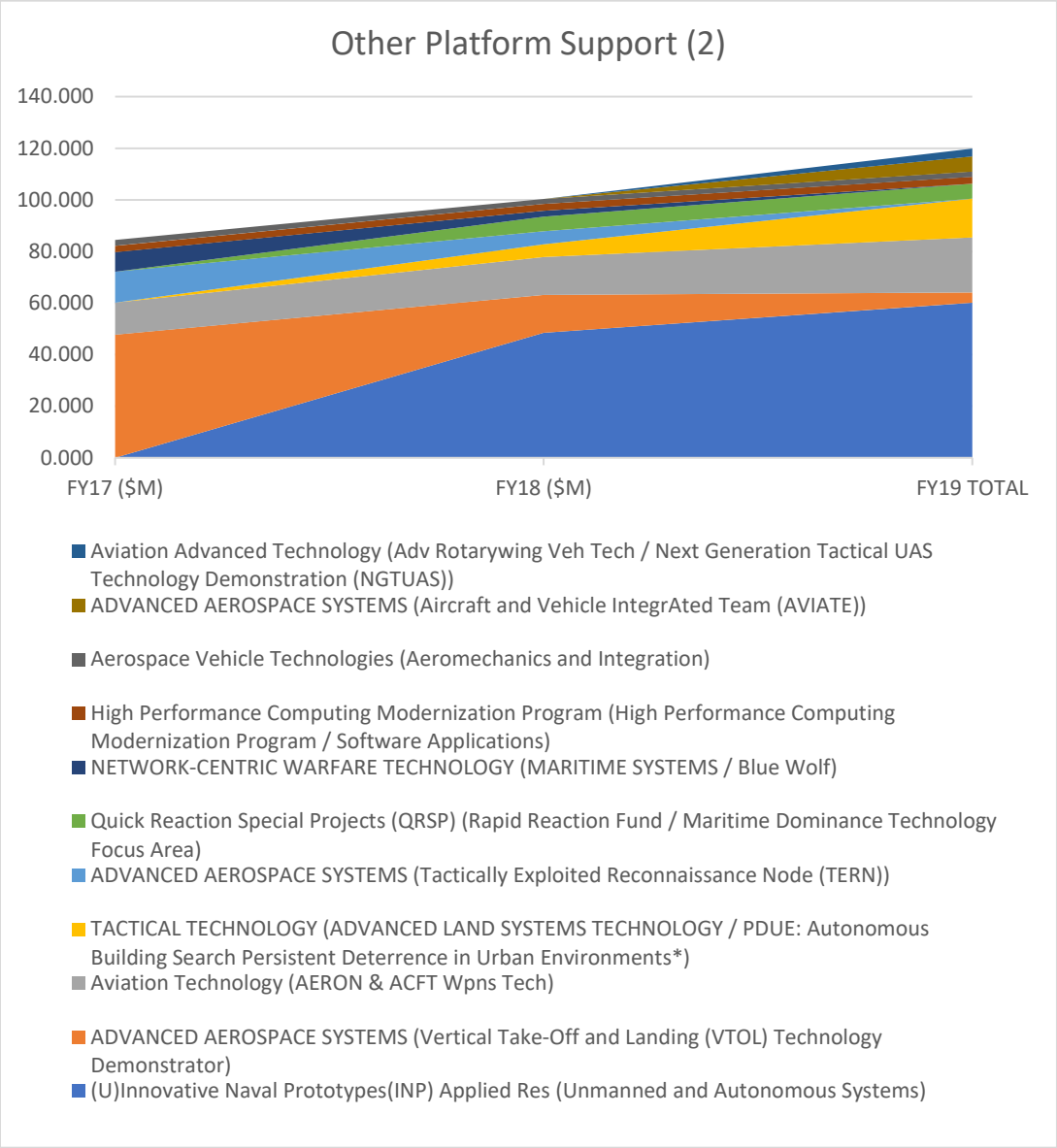


FIGURE 64: OTHER SUPPORT PROGRAMS FOR UNMANNED PLATFORMS

TABLE 54: LISTING OF OTHER SUPPORT PROGRAMS FOR UNMANNED PLATFORMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0602792N	RDT&E	(U)Innovative Naval Prototypes(INP) Applied Res (Unmanned and Autonomous Systems)	Autonomous Aerial Cargo/Utility System (AACUS); autonomy required to operate LDUUV / XLUUV; Complete LDUUV project enabling ISR missions of over 60 days endurance (autonomy / Aluminum Power System (ALPS) air-independent fuel cell system); Low-Cost UAV Swarming Technology (LOCUST) to counter threats in constrained urban environments, as well as large-scale anti-access area denial defenses; Medium Displacement Unmanned Surface Vehicle (MDUSV) for MCM,

				ASW, EW missions; complete Tern, a joint ONR and DARPA project, to enable launch and recovery of medium size, long endurance UAVs on short deck ships; complete maturation of technology for VTOL UAV capability; research into cooperative autonomy for USV swarms; FY 2018 to FY 2019 Increase/Decrease Statement: The overall FY18 to FY19 increase is due to the ramp up of funding in the second year of two FY18 new start INPs and an increase in funding for autonomy maturation efforts in support of unmanned surface craft operations, countered by a reduction of funding levels associated with the completion of three unmanned and autonomous systems technology development projects.
DARPA	0603286E	RDT&E	ADVANCED AEROSPACE SYSTEMS (Vertical Take-Off and Landing (VTOL) Technology Demonstrator)	Vertical Take-Off and Landing (VTOL) Technology Demonstrator: The Vertical Take-Off and Landing (VTOL) Technology Demonstrator program will demonstrate revolutionary improvements in (heavier than air) VTOL air vehicle capabilities and efficiencies through the development of subsystem and component technologies, aircraft configurations and system integration. The program will build and flight test an unmanned 10,000 - 12,000 lb. aircraft capable of sustained speeds in excess of 300 kt, demonstrate system level hover efficiency within 25 percent of the ideal power loading, and a lift-to-equivalent drag ratio no less than ten. FY 2018 Plans: - Complete testing of aircraft propulsion power generator system to verify electro-mechanical system functionality. - Complete electro-mechanical subsystem testing (Copper Bird) to validate design of fan motors and synchronization with generators. - Initiate hardware/software-in-the-loop testing. - Complete subsystem testing of power generation and distribution system (Iron Bird) to include the turboshaft engine, driveshaft, gearbox, generators, electric power distribution, and electric motor functionality. FY 2019 Plans: - Complete vehicle management system development and avionics requirements, as well as all elements of ground control and operator/pilot stations. - Select ground and flight test site location(s) and finalize ground and flight test plans. - Complete fabrication and assembly of the full, complete aircraft with integrated systems and subsystems. - Complete all air-worthiness considerations and required documentation. - Complete ground and tie-down testing. - Disassemble aircraft and ship to flight test location. - Initiate flight testing. The FY 2019 decrease reflects completion of flight testing and program completion.
US Army	0602211A	RDT&E	Aviation Technology (AERON & ACFT Wpns Tech)	Platform Design & Structures Technologies (FY18/19): research in support of Next Generation Tactical Unmanned Aircraft Systems (NGTUAS) and other manned and unmanned aircraft concepts); Rotors & Vehicle Management Technologies (Increase in funding from FY18 to FY19 to explore technologies that enable Unmanned Aerial System (UAS), FY19: explore technologies that enable high performance Unmanned Aerial Systems (UAS) rotors and propulsors, investigate an initial set of Unmanned Aerial Vehicle (UAV) handling qualities and UAV flight control design and test methods); Engine and Drives Technologies (FY19: investigation of alternative adaptable engine components in support of Future Vertical Lift/Future Tactical Unmanned Aerial Systems); Aircraft Weapon & Sensor Technologies (FY18: air-to-air targeting algorithms for Counter-UAS, realigned in FY19 to Mission Systems); Mission Systems

				(no specific note of C-UAS); Unmanned and Optionally Manned Technologies (increase of $12.4M FY18 to FY19 - funding has been increased to meet Army Future Vertical Lift Priority of Manned-Unmanned Teaming (MUM-T) , FY19: algorithms for increased air platform autonomy, human-machine interface (HMI) to reduce workloads, evaluate technologies to support the following capabilities; resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack) **THE TOTALS FOR FY17-19 REPRESENT ONLY THE SUB-PROJECTS RELEVANT TO UAS - SUB-PROJECTS LIKE 'AIRCRAFT AND OCCUPANT SURVIVABILITY TECHNOLOGIES HAVE BEEN EXCLUDED**
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (ADVANCED LAND SYSTEMS TECHNOLOGY / PDUE: Autonomous Building Search Persistent Deterrence in Urban Environments*)	Autonomous Building Search Persistent Deterrence in Urban Environments: program is to generate capabilities which would allow distributed forces to operate effectively in dense urban areas… this program seeks to create a system of autonomous ground and air platforms that monitor an area overtly to deter enemy operations in a designated area. FY 2019 Plans: - Conduct initial development of sensing and tracking capabilities integrated into an aerial platform. - Conduct initial development of lethal and non-lethal capabilities integrated into an aerial platform. - Perform initial evaluation of aerial vehicle flights coupled with sensor emplacement. - Demonstrate path planning and sensing focused on deterring enemy actions. - Continue development of lethal and non-lethal capabilities integrated into an aerial platform.
DARPA	0603286E	RDT&E	ADVANCED AEROSPACE SYSTEMS (Tactically Exploited Reconnaissance Node (TERN))	Tactically Exploited Reconnaissance Node (TERN) program, a joint effort with the Office of Naval Research, is to develop a systems approach for, and perform technical demonstration of, a Medium-Altitude, Long-Endurance Unmanned Aerial Vehicle (MALE UAV) capability from smaller ships. FY 2018 Plans: - Conduct integrated propulsion system testing. - Conduct demonstrator system ground checkout. - Conduct demonstrator system airworthiness assessment. - Conduct demonstrator system instrumentation calibration. - Conduct demonstrator system first flight. - Analyze demonstrator flight test data. - Refine demonstrator system flight control. - Conduct TERN objective system requirements review. - Conduct land-based demonstrator system flight testing. - Update TERN objective system performance models based on demonstrator system performance. - Conduct TERN objective system requirements review. - Conduct demonstrator system envelope expansion flight testing. - Conduct demonstrator transition to and from wing-borne flight testing. - Conduct relative navigation take-off and landing operations. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 decrease reflects program completion.
OSD	0603826D8Z	RDT&E	Quick Reaction Special Projects (QRSP) (Rapid Reaction Fund / Maritime Dominance Technology Focus Area)	Maritime Dominance Technology Focus Area: This focus area will develop the enabling capabilities and key technologies required to maintain maritime dominance, drawing the Chairman's Gap Assessment and strategic guidance from the new Under Secretary of Defense for Research and Engineering. Major drivers in the maritime domain include the development of extra-large, large, and small families of multi-mission unmanned undersea vehicles (UUVs), and the rapid growth of commercial undersea activity. The DoD is exploring emerging concepts for ubiquitous undersea communications, command and control, and large-scale UUV capabilities. To enable these

				concepts, RRF will focus on developing capabilities and technologies such as undersea power production, storage, and distribution; enhanced signal processing; autonomy; undersea situational awareness and navigation; sensors; undersea communications; and advanced materials development and production.
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Blue Wolf)	The Blue Wolf program seeks to provide a radically different solution to develop and demonstrate an undersea demonstrator vehicle with endurance and speed capabilities beyond conventional undersea systems within the weight and volume envelopes of current Navy undersea systems. FY 2018 Plans: - Complete battery module and system safety testing and analysis. - Complete test vehicle system integration and checkouts. - Complete demonstration vehicle system integration. - Conduct demonstration vehicle testing from barge in controlled area. - Complete system safety approval for at sea testing. - Transition to the Navy. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 decrease reflects program completion.
US Army	0603461A	RDT&E	High Performance Computing Modernization Program (High Performance Computing Modernization Program / Software Applications)	Implementation of foundational software improvements necessary to begin development of physics-based design analysis tools for future hypersonic weapon systems (High Speed Strike, Tactical Boost-Glide, and Manned/Unmanned Conventional Prompt Global Strike) (FY18/19); For fixed-wing aircraft, this will include, but will not be limited to, high-fidelity physics-based analysis capabilities for coupled aerodynamics, structural dynamics, propulsion, and flight controls in support of flight certifications (e.g., air worthiness, store carriage and release, etc.), mission planning for fielded and new systems and associated upgrades, and acquisition decisions associated with exploration and design analysis of future manned and unmanned aerial vehicle concepts. (FY19)
USAF	0602201F	RDT&E	Aerospace Vehicle Technologies (Aeromechanics and Integration)	Continue development and assessment of low cost attritable UAV concepts (FY18/FY19)
DARPA	0603286E	RDT&E	ADVANCED AEROSPACE SYSTEMS (Aircraft and Vehicle IntegrAted Team (AVIATE))	Aircraft and Vehicle IntegrAted Team (AVIATE): program will design, develop and demonstrate an advanced capability Unmanned Air System (UAS) that is an organic extension of tactical ground vehicles. FY 2019 Plans: Explore airframe design concepts of flight demonstration vehicle. The FY 2019 increase reflects program initiation.
US Army	0603003A	RDT&E	Aviation Advanced Technology (Adv Rotarywing Veh Tech / Next Generation Tactical UAS Technology Demonstration (NGTUAS))	Will refine air vehicle technologies maturation, integration and system level test and demonstration strategies. Will validate new design and assessment methodologies relevant to UAS-scaled platforms through demonstration. Will develop an informed Model Performance Specifications (MPS) and provide quantifiable metrics and key attributes for the NGTUAS. (New start in FY19)

Programs Supporting Autonomy (for Air- and Maritime-Specific Programs See Other Sections)

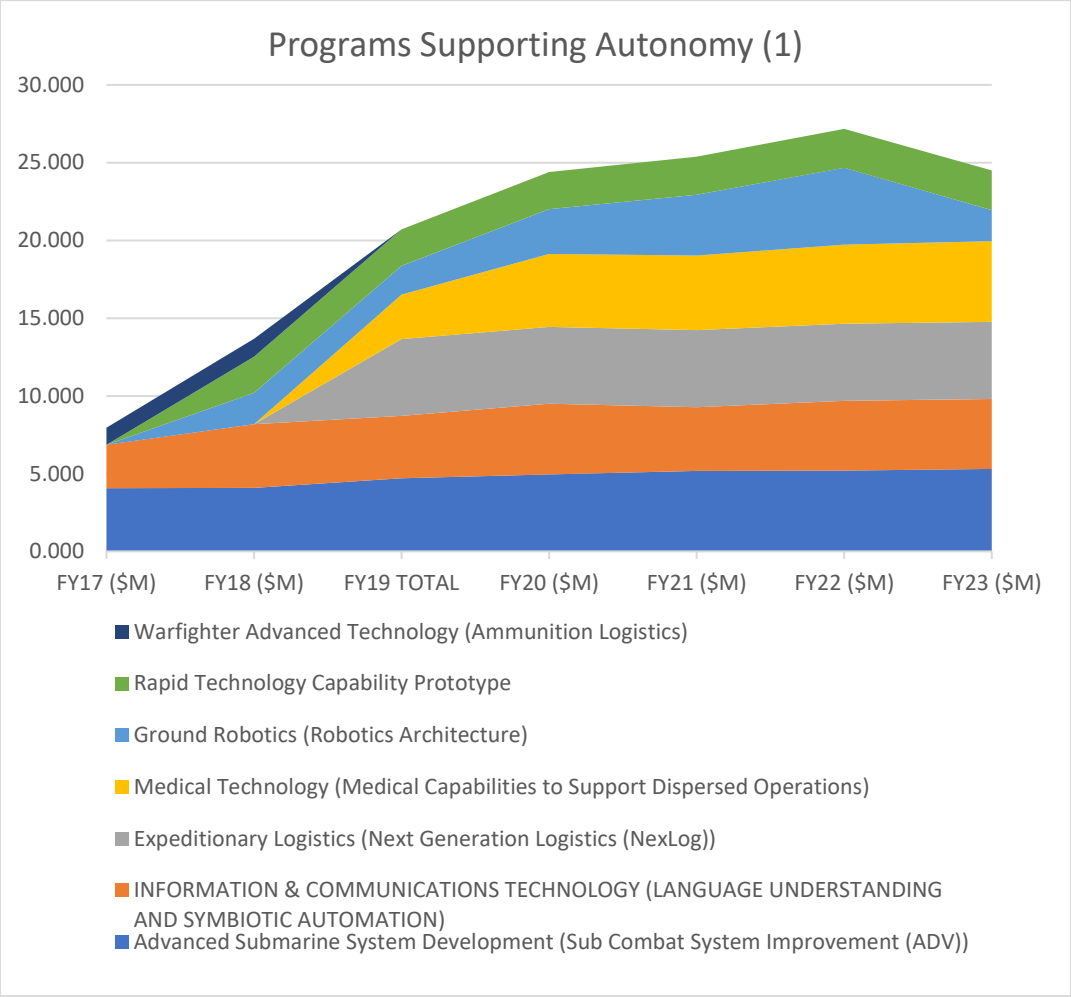


FIGURE 65: PROGRAMS SUPPORTING AUTONOMY (OTHER THAN AIR- AND MARITIME-SPECIFIC PROGRAMS)

TABLE 55: LISTING OF PROGRAMS SUPPORTING AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603561N	RDT&E	Advanced Submarine System Development (Sub Combat System Improvement (ADV))	Develop UAV / UUV / automated capabilities to address China, Russia, Iran, Korea and Terrorism (CRIKT) initiated in FY19
DARPA	0602303E	RDT&E	INFORMATION & COMMUNICATIONS TECHNOLOGY (LANGUAGE UNDERSTANDING AND SYMBIOTIC AUTOMATION)	Explainable Artificial Intelligence (XAI); Active Interpretation of Disparate Alternatives (AIDA); Low Resource Languages for Emergent Incidents (LORELEI); Assured Autonomy; Human-Machine Symbiosis (HMS)

US Navy	0604289M	RDT&E	Expeditionary Logistics (Next Generation Logistics (NexLog))	Testing of ground combat autonomy for a single vehicle or convoy operations; initiate development of autonomy technology for ship to shore connectors; development of machine learning-enhanced tactical logistics support tools
US Army	0602787A	RDT&E	Medical Technology (Medical Capabilities to Support Dispersed Operations)	Autonomous and Unmanned Medical Capability: Will explore feasibility of integrating medical capabilities and information systems with Army unmanned systems (UMS) Programs of Record in order to leverage multipurpose robotic platforms for medical capabilities. Will research standardization of medical device interfaces for use in an autonomous platform. Will research feasibility of Unmanned Aerial Systems (UAS) to support remote patient monitoring research prototypes, closed-loop patient support systems, and prototype automated diagnostic and therapeutic en route care capabilities. Medical Aspects of Man-Machine Teaming/Medical Robotics: Will research the design of robotic systems, including physical interfaces and hardware configurations, to effectively implement and control resuscitation and critical care procedures driven by algorithms defined by complementary research described in the Autonomous and Unmanned Medical Capability Task Area. Will research and design a proof of concept field robotic fold-up litter to show the feasibility of deploying soft robotics sensors and also show the capability to apply pressure using a soft robotics manipulator. Will model and characterize the problems caused by signal latency and constrained bandwidth on complex telerobotic surgical tasks. Will research and prioritize procedures amenable to full automation of tele-robotic operations. Will research and explore the feasibility of using robotic perception systems to detect casualties from a standoff distance and at closer ranges using both conventional computer vision approaches and recent advancements in deep learning techniques.
US Army	0605053A	RDT&E	Ground Robotics (Robotics Architecture)	Robotic Architecture (RA) provides the engineering and development resources to manage the overarching architecture for robotic systems that are both modular and interoperable across the Joint Force in order to facilitate future modernization efforts. Fiscal Year 2019 RDTE supports the continued development, finalization, and publishing of the Robotics and Autonomous Systems, Ground (RAS-G) Interoperability Profile (IOP) Version 4.0. IOP V4.0 will provide the required modular open interfaces and compliance test tools for new programs including Robotic Combat Vehicle (RCV) and Enhanced Robotics Payloads (ERP). Additionally, FY19 RDTE supports the robotics portfolio wide analysis of software interfaces between active programs including Universal Controller, MTRS Inc. II, CRS(I), RCIS, SMET and Leader Follower.
US Navy	0604320M	RDT&E	Rapid Technology Capability Prototype	Initiate product development of unmanned aerial, surface, and underwater vehicles (UAV, USV, and UUV) swarm capability (FY18); FY19 Product Development Autonomous Vehicles: Initiate efforts to identify, prototype, and assess the use in a variety of combat and supporting use employments, vehicles capable of sensing their environment, while navigating and functioning independently without human conduction to take evasive or defensive action and avoid detection, tracking, targeting or attack, provide an alternative reconnoiter capability in non-permissive settings for the purpose of

				mapping and patrolling for the purpose of intensifying combat power and reducing risk to the force.
US Army	0603001A	RDT&E	Warfighter Advanced Technology (Ammunition Logistics)	Complete development of Automated Supply Point-Scalable software prototype technology demonstrator to support basic automation of ammunition supply point (ASP) warehouse management operations at the pallet and sub-pallet levels, with a focus on demonstrating the basic concept of automated control of operations, manned and unmanned teaming, situational monitoring, interfacing and control of robotic movement resource devices, and supply configuration tracking; demonstrate ammunition resupply technologies. (Effort was realigned to higher priority Army Modernization efforts.)

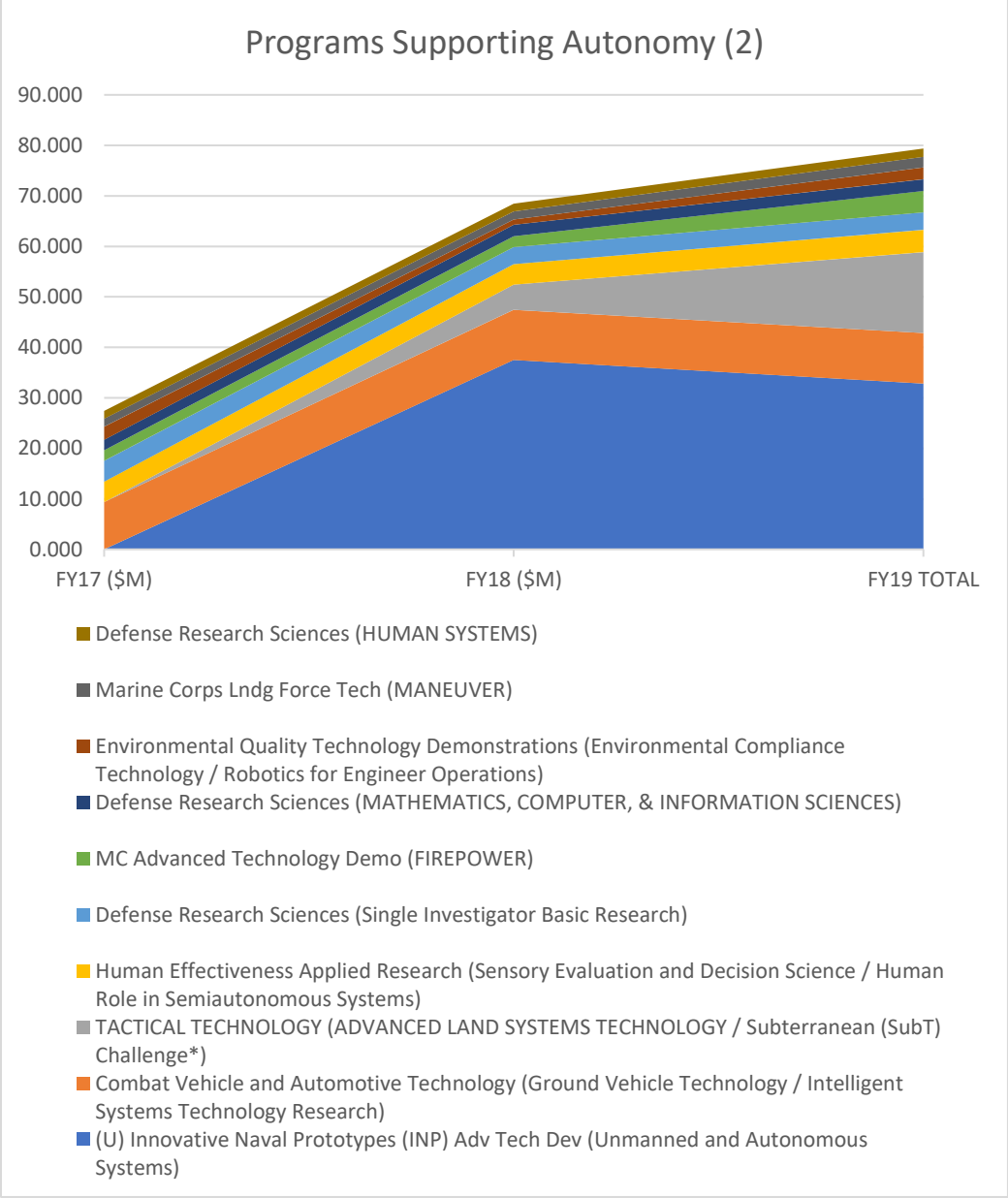


FIGURE 66: PROGRAMS SUPPORTING AUTONOMY (OTHER THAN AIR- AND MARITIME-SPECIFIC PROGRAMS)

TABLE 56: LISTING OF PROGRAMS SUPPORTING AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603801N	RDT&E	(U) Innovative Naval Prototypes (INP) Adv Tech Dev (Unmanned and Autonomous Systems)	Autonomous Aerial Cargo/Utility System (AACUS): sensors/software required for optional autonomous flight on an existing USMC rotary wing; Claws: autonomy required to operate LDUUV / XLUUV; Complete LDUUV project enabling ISR missions of over 60 days endurance (autonomy / Aluminum Power System (ALPS) air-independent fuel cell system); Low-Cost UAV Swarming Technology (LOCUST) to counter threats in constrained urban environments, as well as large-scale anti-access area denial defenses; Medium Displacement Unmanned Surface Vehicle (MDUSV) for MCM, ASW, EW missions; complete Tern, a joint ONR and DARPA project, to enable launch and recovery of medium size, long endurance UAVs on short deck ships; complete maturation of technology for VTOL UAV capability; FY 2018 to FY 2019 Increase/Decrease Statement: The overall FY18 to FY19 decrease is due to a significant reduction of funding levels associated with the completion of three unmanned and autonomous systems technology development projects, countered by an increase in funding in the second year of two FY18 new start INPs.
US Army	0602601A	RDT&E	Combat Vehicle and Automotive Technology (Ground Vehicle Technology / Intelligent Systems Technology Research)	Mature the increased reliability of robotic technologies to produce trust and confidence of autonomous vehicles; Improve standardized data collection tools and methodologies to mature Department of Defense (DoD) ground robotic requirements, development, technology investments and procurement decisions; conduct experiments to validate that these tools and technologies are increasing our capabilities of protecting the force, reducing burden on soldiers, and mission command & tactical intelligence. (FY18) Develop advanced vehicle behaviors to transition to autonomy-enabling kits for tactical wheeled vehicles in leader-follower convoy operations; advance capabilities to enable operations in increasingly challenging environments like off-road terrain and reduced communication areas. (FY19)
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (ADVANCED LAND SYSTEMS TECHNOLOGY / Subterranean (SubT) Challenge*)	Subterranean (SubT) Challenge will develop novel integrated solutions capable of mapping and navigating complex and dynamic terrains (tunnel systems, urban underground and cave networks); sensors and computation for perception in austere conditions; distributed information sharing in degraded communications environments; and collaborative autonomy enabling extended operations with minimal human interventions. FY 2019 Plans: - Conduct baseline design, development, integration, of proposed solutions in the sub-domain of tunnel systems. - Conduct circuit competition in the sub-domain of tunnel systems. - Assess technology maturity and predicted technology trends to identify research and development needs and gaps. - Continue development and refinement of the virtual test bed.
USAF	0602202F	RDT&E	Human Effectiveness Applied Research (Sensory Evaluation and Decision Science / Human Role in	Human Trust and Interaction: in FY18, Evaluate trust for robotics and automated systems in degraded visual environments and develop trust guidelines for Line In-The-Sky Auto Ground Collision Avoidance System. In FY19, Develop initial transparency and trust guidelines for application to semiautonomous vehicles and autonomous agents for analysts.

			Semiautonomous Systems)	
US Army	0601102A	RDT&E	Defense Research Sciences (Single Investigator Basic Research)	The particular workloads of interest are emerging safety-critical embedded Army systems where autonomous functionality is required such as in unmanned airplanes and helicopters, battlefield robots, unmanned ground vehicles, and various autonomous weapon systems. (FY19)
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (FIREPOWER)	Systems engineering of supervised-autonomous weapon system control will continue, implementing engagement logic, to develop and demonstrate the key enabling technologies and command and control methods for weaponized unmanned ground vehicles (FY19)
US Navy	0601153N	RDT&E	Defense Research Sciences (MATHEMATICS, COMPUTER, & INFORMATION SCIENCES)	Develop machine intelligence to support autonomous operations with minimal human supervision; autonomous sensing for UAV platforms; robotic systems that take advantage of emerging neuromorphic processors
US Army	0603728A	RDT&E	Environmental Quality Technology Demonstrations (Environmental Compliance Technology / Robotics for Engineer Operations)	Will mature risk mitigation frameworks associated with contingency autonomous construction methods and activities. Mature algorithms and decision making software for control processes (bandwidth needs, response time lag, and override response times) developed to facilitate autonomous methods necessary for expedient point of need construction. (FY19)
US Navy	0602131M	RDT&E	Marine Corps Lndg Force Tech (MANEUVER)	Enable UGVs as autonomous logistic connector vehicles; autonomous vehicle operation in GPS-denied environments; human machine interface (HMI) enabling gesture and natural language control of a UGV; manned-unmanned teaming (MUMT) with high levels of autonomy; physics based simulation of unmanned amphibious craft transition from sea to land; FY 2018 to FY 2019 Increase/Decrease Statement: The funding increase form FY 2018 to FY 2019 supports accelerated development of novel approaches to swarming small, low cost autonomous amphibians across open water, surf zone, and land environments.
US Navy	0601153N	RDT&E	Defense Research Sciences (HUMAN SYSTEMS)	Human-robot interaction; hybrid teaming with autonomous systems; neuro-control of bio-inspired UUV; active vision and cognitive navigation skills in mobile robots; cyber vulnerabilities of UxVs based on human performance sources

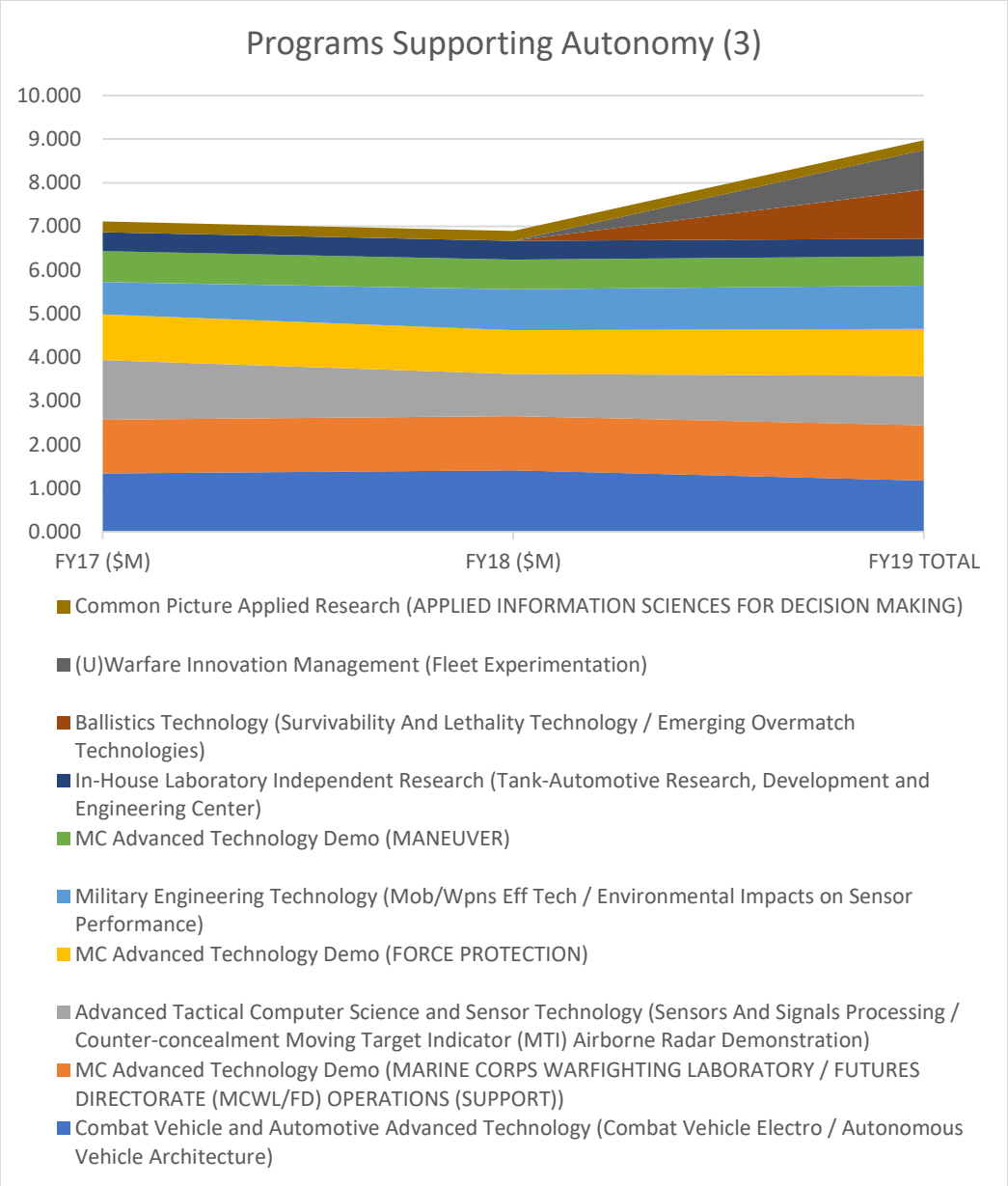


FIGURE 67: PROGRAMS SUPPORTING AUTONOMY (OTHER THAN AIR- AND MARITIME-SPECIFIC PROGRAMS)

TABLE 57: LISTING OF PROGRAMS SUPPORTING AUTONOMY

Organization	PE Number	Funding Type	Title	Notes
US Army	0603005A	RDT&E	Combat Vehicle and Automotive Advanced Technology (Combat Vehicle Electro / Autonomous Vehicle Architecture)	Will continue to mature and validate the common system architecture for autonomous vehicles by demonstrating autonomous vehicle architecture, algorithm software modules, a common interface and hardware and software integration across the full spectrum of operational and tactical supply movement operations. (FY19)

US Navy	0603640M	RDT&E	MC Advanced Technology Demo (MARINE CORPS WARFIGHTING LABORATORY / FUTURES DIRECTORATE (MCWL/FD) OPERATIONS (SUPPORT))	Continue technical, strategic, and managerial support for operations with advanced technology utilizing autonomy, robotics, and cyber capabilities.
US Army	0603772A	RDT&E	Advanced Tactical Computer Science and Sensor Technology (Sensors And Signals Processing / Counter-concealment Moving Target Indicator (MTI) Airborne Radar Demonstration)	Mature software and algorithms to integrate Robotics and Autonomous Systems (RAS) with MC information systems to better allow Commanders the ability to plan, monitor and incorporate RAS into unit formations and missions and assist the development of doctrine. (FY19)
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (FORCE PROTECTION)	Advanced technology demonstration for autonomous vehicles in the detection, neutralization, marking and reporting of explosive hazards using multiple, existing vehicles in movement to contact and amphibious raid scenarios
US Army	0602784A	RDT&E	Military Engineering Technology (Mob/Wpns Eff Tech / Environmental Impacts on Sensor Performance)	Enable autonomous navigation and tactical behaviors in unmanned ground systems (nothing specifically noted in FY18/19)
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (MANEUVER)	Inclusion of an autonomous vehicle capability that will provide support to the dismounted Marine during Enhanced Company Operations (ECO); development of autonomy technologies and system concepts that will enable unmanned ground vehicles (UGVs) to be used as autonomous logistic connector vehicles.
US Army	0601101A	RDT&E	In-House Laboratory Independent Research (Tank-Automotive Research, Development and Engineering Center)	Ground vehicle technologies including unmanned systems (autonomy-enabled systems, teleoperation, etc.)
US Army	0602618A	RDT&E	Ballistics Technology (Survivability And Lethality Technology / Emerging Overmatch Technologies)	Will explore advanced protection and lethal mechanisms to enable the next generation combat vehicle and small autonomous systems
US Navy	0606355N	RDT&E	(U)Warfare Innovation Management (Fleet Experimentation)	Unmanned Systems Autonomy
US Navy	0602235N	RDT&E	Common Picture Applied Research (APPLIED INFORMATION SCIENCES FOR DECISION MAKING)	Nano-scale logic/memory devices for autonomous vehicles and individual fighters

Programs Supporting Communications & Data Management

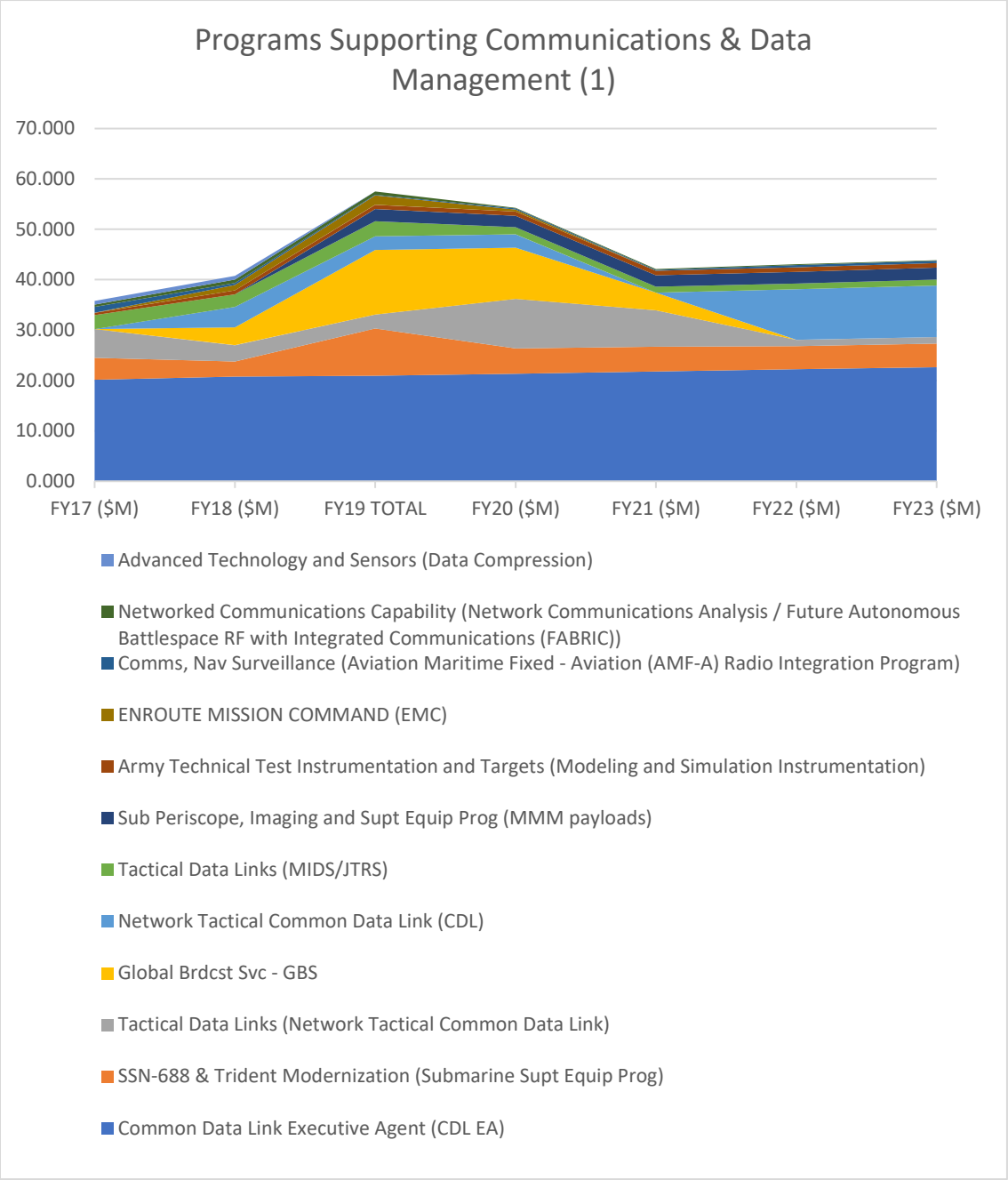


FIGURE 68: PROGRAMS SUPPORTING COMMUNICATION AND DATA MANAGEMENT OF UNMANNED SYSTEMS

TABLE 58: LISTING OF PROGRAMS SUPPORTING COMMUNICATIONS AND DATA MANAGEMENT OF UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
USAF	0305236F	RDT&E	Common Data Link Executive Agent (CDL EA)	Common Data Link Executive Agent (CDL EA) provides the DoD standard for interoperable, multi-service, multi-agency, Intelligence, Surveillance, and Reconnaissance (ISR) datalinks for 10,000+ DoD manned/unmanned airborne and ground

				platforms. (Marine CDL for Tactical UAS - $7.75M FY17; SUAS SWAP Constrained Rev B Terminals (scheduled through 4QFY18)
US Navy	0604503N	RDT&E	SSN-688 & Trident Modernization (Submarine Supt Equip Prog)	Multifunction Module Mast (MMM) payloads for improved communications between UAS and submarines
US Navy	0205604N	RDT&E	Tactical Data Links (Network Tactical Common Data Link)	Network Tactical Common Data Link (NTCDL) supports the transmission of ISR data from manned and unmanned sources (MQ-4C Triton, MQ-25 Stingray, MQ-8B/C Fire Scout)
US Army	9915BC4120	Procurement	Global Brdcst Svc - GBS	High speed broadcast service of data from UAS and other sources
US Navy	2950	Procurement	Network Tactical Common Data Link (CDL)	Common Data Link (CDL) for MQ-4 Triton, MQ-8B/C Fire Scout, MQ-25 Stingray and other manned aircraft
US Navy	0205604N	RDT&E	Tactical Data Links (MIDS/JTRS)	Multifunctional Information Distribution System (MIDS) Joint Tactical Radio System (JTRS): TTNT waveform is the next waveform to be added to the MIDS JTRS terminal with the capability to support data exchange between fast-moving tactical aircraft, weapons, and unmanned aircraft, in addition to air, land, and sea-based command and control nodes, in a variety of air-to-air and air-to-ground missions including time sensitive targeting, air warfare, close air support, non-traditional ISR, and anti-surface warfare.
US Navy	0840	Procurement	Sub Periscope, Imaging and Supt Equip Prog (MMM payloads)	Multifunction Module Mast (MMM) payloads for improved UAS communications
US Army	0605602A	RDT&E	Army Technical Test Instrumentation and Targets (Modeling and Simulation Instrumentation)	Will improve our RTCA secure network and tactical engagement capabilities to support Gray Eagle, Shadow (RQ-7BVN) TUAS, Joint Tactical Radio System (JTRS), and other platforms
US Army	9922B08400	Procurement	ENROUTE MISSION COMMAND (EMC)	Ka Fixed Satellite Antenna which provides a fast, reliable, robust network enabling mission command and data-intensive services (for example UAV video)
US Army	8659AA0723	Procurement	Comms, Nav Surveillance (Aviation Maritime Fixed - Aviation (AMF-A) Radio Integration Program)	Radio hardware for Army aircraft including UAS
OSD	0603662D8Z	RDT&E	Networked Communications Capability (Network Communications Analysis / Future Autonomous Battlespace RF with Integrated Communications (FABRIC))	Future Autonomous Battlespace RF with Integrated Communications (FABRIC): FY19 Prototyping, Lab, and Field Testing - Plan for a system field testing of the network supporting links to unmanned aerial vehicle platforms and nearby units operating in an urban/dense environment.
USAF	0604257F	RDT&E	Advanced Technology and Sensors (Data Compression)	Reduction of Data Using Compression Enhancements (RDUCE): Will support integration of compression capabilities into operational sensors including, but not limited to, the

				U2/ASARS, Global Hawk MP-RTIP/EISS, and Reaper/LynxSAR. (FY18)

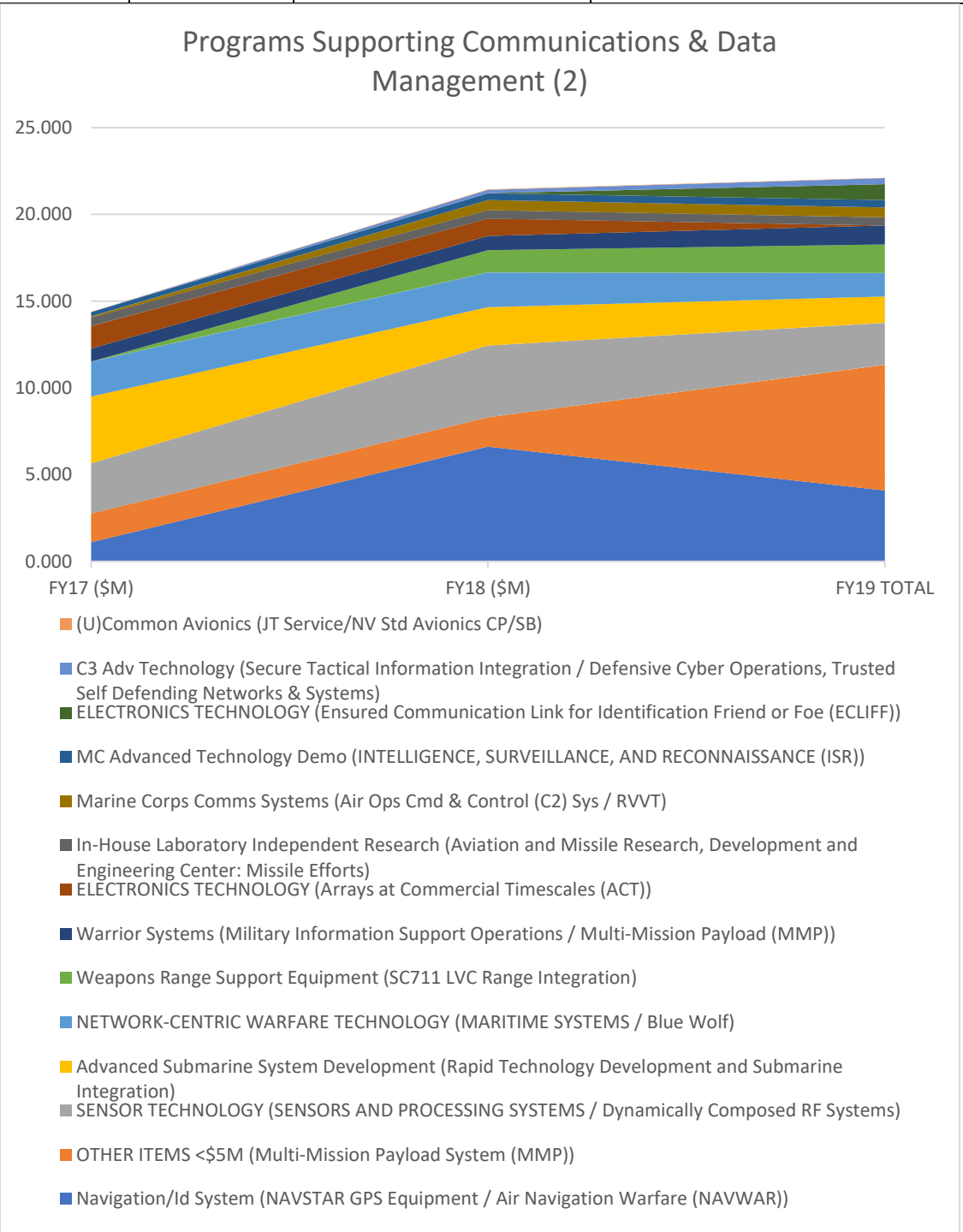


FIGURE 69: PROGRAMS SUPPORTING COMMUNICATION AND DATA MANAGEMENT OF UNMANNED SYSTEMS

TABLE 59: LISTING OF PROGRAMS SUPPORTING COMMUNICATIONS AND DATA MANAGEMENT OF UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0604777N	RDT&E	Navigation/Id System (NAVSTAR GPS Equipment / Air Navigation Warfare (NAVWAR))	The $11M increase in funding is to integrate Anti-Jam (AJ) antennas into select aviation platforms and to fund development and integration of miniaturized anti-jam antennas in AH-1Z, UH-1Y helicopters, MQ-4C, and MQ-8B/C air platforms. (continued in FY19)
SOCOM	0204OTHER	Procurement	OTHER ITEMS <$5M (Multi-Mission Payload System (MMP))	Broadcast system integrated into unmanned and manned aircraft
DARPA	0603767E	RDT&E	SENSOR TECHNOLOGY (SENSORS AND PROCESSING SYSTEMS / Dynamically Composed RF Systems)	Dominance of the Radio Frequency (RF) spectrum is critical to successful U.S. military operations. Radar systems, Electronic Warfare (EW) systems, and communication systems require custom software and hardware that is costly and time consuming to build and integrate onto platforms. The Dynamically Composed RF Systems program addresses these challenges by developing adaptive, converged RF array systems. In FY18, Design converged RF front end and apertures to address bandwidth, field of view, and sensitivity goals commensurate with the prototype system architecture and the limitations of compact platforms / unmanned aerial vehicles (UAV). In FY19, Develop integration plan describing how the converged RF payload will be installed into the target platform.
US Navy	0603561N	RDT&E	Advanced Submarine System Development (Rapid Technology Development and Submarine Integration)	Demo of common communications for UAS; Demo Li-ion SAFECAP Fleet Modular AUV (FMAUV) design (decrease largely accounted for in the planned transition of UAS COMMs project)
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (MARITIME SYSTEMS / Blue Wolf)	Tactical Undersea Network Architectures program will develop the technologies necessary for autonomous, reliable, and secure undersea data transfers; true plug, play, and operating standards; and rapid, cost effective deployment technologies. This connectivity is important for synchronizing forces, establishing and maintaining situation awareness, and control of remotely operated vehicles and systems. The program will develop and demonstrate novel technology options and designs to temporarily restore connectivity for existing tactical data networks in contested environments using small diameter optical fiber and buoy relay nodes.
US Navy	4204	Procurement	Weapons Range Support Equipment (SC711 LVC Range Integration)	Real-time telemetry for UAS training and other assets
SOCOM	1160431BB	RDT&E	Warrior Systems (Military Information Support Operations / Multi-Mission Payload (MMP))	The Multi-Mission Payload (MMP) is a family of broadcast systems intended to be integrated into multiple manned and unmanned, long-loiter aerial systems with the capability of broadcasting in AM, FM, SW, TV, Very High Frequency (VHF), TV Ultra High Frequency (UHF) and cellular (Short Message Service, Multi-Media Messaging Service, and Voice). This system provides the capability of broadcasting MISO messages via multiple mediums into permissive, semi-permissive, and denied foreign areas. FY18/FY19 Plans: FY 2019 Base Plans: Continues with primary development, systems engineering, and test and evaluation of pod-based cellular and television

				broadcast, power, and antenna technologies. Increase of $0.584 million is due to expanded development testing.
DARPA	0602716E	RDT&E	ELECTRONICS TECHNOLOGY (Arrays at Commercial Timescales (ACT))	Arrays at Commercial Timescales (ACT): program will develop standardized, fully digital phased array system components to enable rapid upgrades to DoD communications, electronic warfare, and radar systems. Phased arrays, which control and steer radio signals, have helped the DoD maintain technological superiority in nearly every theater of conflict. The ongoing cost reductions and performance improvements typical in the commercial sector could enable the DoD to place phased arrays on inexpensive platforms such as Unmanned Aerial Vehicles where they have previously proven prohibitively expensive to develop or maintain.
US Army	0601101A	RDT&E	In-House Laboratory Independent Research (Aviation and Missile Research, Development and Engineering Center: Missile Efforts)	Nano-antennas, wireless datalinks, radar, acoustic sensors, GPS & inertial navigation
US Navy	0206313M	RDT&E	Marine Corps Comms Systems (Air Ops Cmd & Control (C2) Sys / RVVT)	RVVT - The RVVT acquisition strategy is to continually improve the Video Down-Link (VDL) products by enhancing the encryption, range, and reducing the power and weight requirements through competition. Efforts to integrate Full Motion Video (FMV) to support Joint Fires Observers (JFOs) and Joint Terminal Attack Controllers (JTACs) began in FY 2017.
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR))	Continue technology development required to enable tactical UAS on-board processing of terabytes of data in real time; Increased focus will be put on investments in technology to enable all sensors, weapons, platforms to be smarter and more capable of knowing why, when and how to collaborate.
DARPA	0602716E	RDT&E	ELECTRONICS TECHNOLOGY (Ensured Communication Link for Identification Friend or Foe (ECLIFF))	Ensured Communication Link for Identification Friend or Foe (ECLIFF) program aims to provide communication links for Identification Friend or Foe (IFF) capabilities with a reduced radio frequency (RF) signature, improved performance against jamming and interference, and a compact form factor. The miniaturization realized with the ECLIFF platform should make the capability useful for both large platforms and portable applications such as unmanned air vehicle, man-portable, and even hand-held devices.
US Army	0603794A	RDT&E	C3 Adv Technology (Secure Tactical Information Integration / Defensive Cyber Operations, Trusted Self Defending Networks & Systems)	Mature an enhanced reprogrammable miniaturized encryption module for tactical handhelds and Internet of Things (IoT) sensors/devices optimized for low power and low cost requirements to enable integration into smaller footprint platforms such as unmanned aerial vehicles and dismount Soldier systems (FY19)
US Navy	0605217N	RDT&E	(U)Common Avionics (JT Service/NV Std Avionics CP/SB)	Assist with insertion of communication, navigation, surveillance, and supporting technologies and conduct capability certification on developmental platforms (CH-53K is currently the primary platform - nothing noted in FY18/19)

Programs Supporting Energy & Propulsion

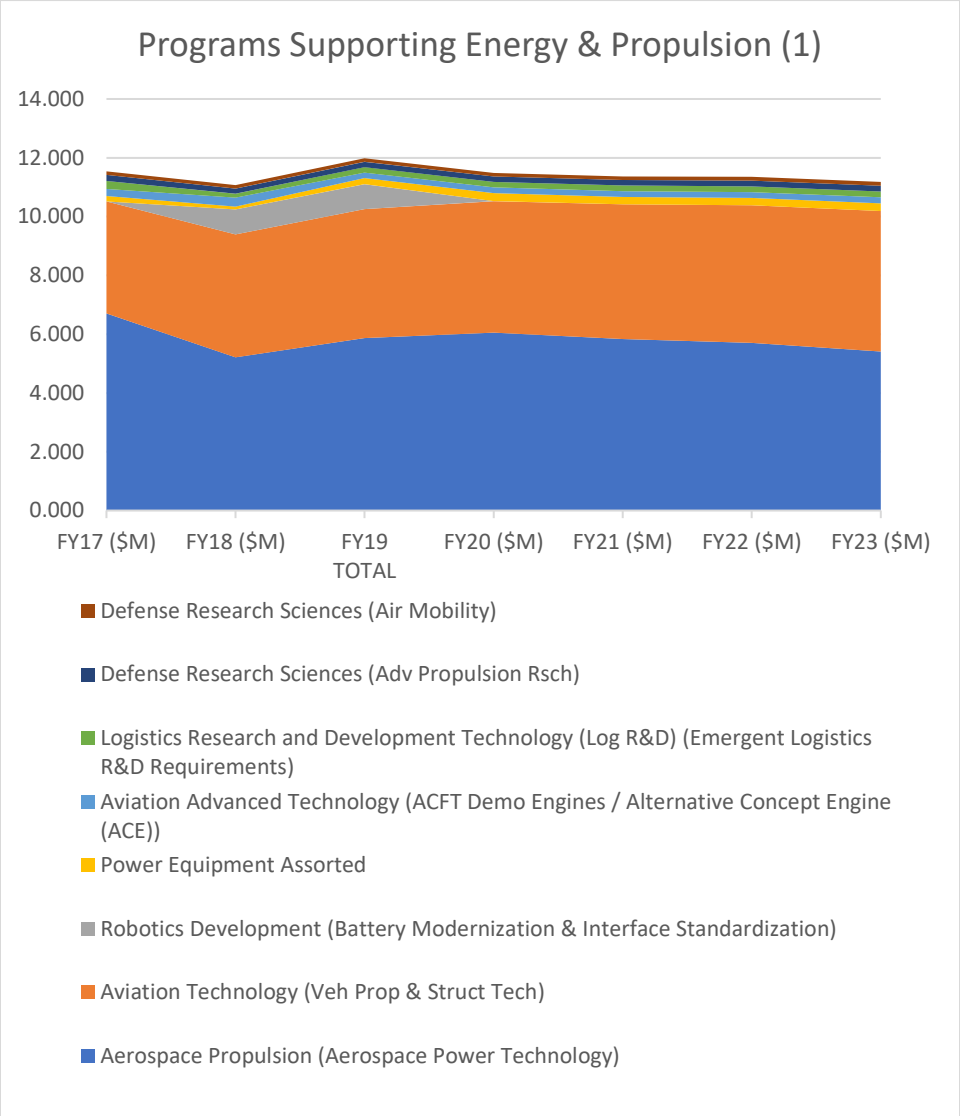


FIGURE 70: PROGRAMS SUPPORTING ENERGY AND PROPULSION SYSTEMS INTEGRATED ON UNMANNED SYSTEMS

TABLE 60: LISTING OF PROGRAMS SUPPORTING ENERGY AND PROPULSION SYSTEMS INTEGRATED ON UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
USAF	0602203F	RDT&E	Aerospace Propulsion (Aerospace Power Technology)	High Power System Technologies: Develop integrated system architecture, controls, and component technologies to provide for the large amounts of electrical power needed, and concurrent thermal mitigation required, by current and future manned and unmanned systems. In FY19 Continue the development of advanced power options for small unmanned aircraft.
US Army	0602211A	RDT&E	Aviation Technology (Veh Prop & Struct Tech)	Air Vehicle Propulsion and Power Technology (Increase to support additional efforts in small engines for Unmanned Air Systems); Micro/Small Scale Unmanned Aerial Systems (FY19:

				enable small Unmanned Aircraft System (UAS) to perform aggressive maneuver through complex environments, enable advanced speed, endurance, payload capability, and on-demand design and fabrication of small-mission based UAS); High Speed & Efficient Vertical Take-off and Landing (no specific note of UAS)
US Army	0604017A	RDT&E	Robotics Development (Battery Modernization & Interface Standardization)	FY19 funding to finalize the C-E Battery technology assessment and determine a solid and integrated core Standard Family of Batteries to include batteries for generators and hybrids, robotics, vehicles, and low density/usage systems increased slightly over FY18.
USMC	6366	Procurement	Power Equipment Assorted	Batteries and associated components to support robots among other systems
US Army	0603003A	RDT&E	Aviation Advanced Technology (ACFT Demo Engines / Alternative Concept Engine (ACE))	Complete detailed design and initiate fabrication of innovative/adaptive engine component technologies such as variable speed power turbine. (FY18) Will continue component design integration efforts and perform fabrication of hardware for full system demonstration to enable greater aircraft performance and engine durability in support of Future Vertical Lift. (FY19) - NO SPECIFIC DEVELOPMENTS FOR UAS NOTED
DLA	0603712S	RDT&E	Logistics Research and Development Technology (Log R&D) (Emergent Logistics R&D Requirements)	Energy Readiness Program (ERP) ERP will focus on determining R&D solutions for ongoing issues affecting fuel and fuel additive quality and operational requirements (e.g. thermal stability, storage stability, ignition capability). The program will continue to assist the military services in the qualification and certification of alternative fuels to meet military specification requirements; this will be parallel to the availability of military resources necessary to complete these efforts. The ERP program will investigate and prototype, as appropriate, drone technologies applied to the energy operations.
US Army	0601102A	RDT&E	Defense Research Sciences (Adv Propulsion Rsch)	Engine and drivetrain technologies for manned and unmanned vehicles
US Army	0601102A	RDT&E	Defense Research Sciences (Air Mobility)	Conduct experimental research in acoustics and interactional aerodynamics of multi-rotor and rotor-propeller configurations

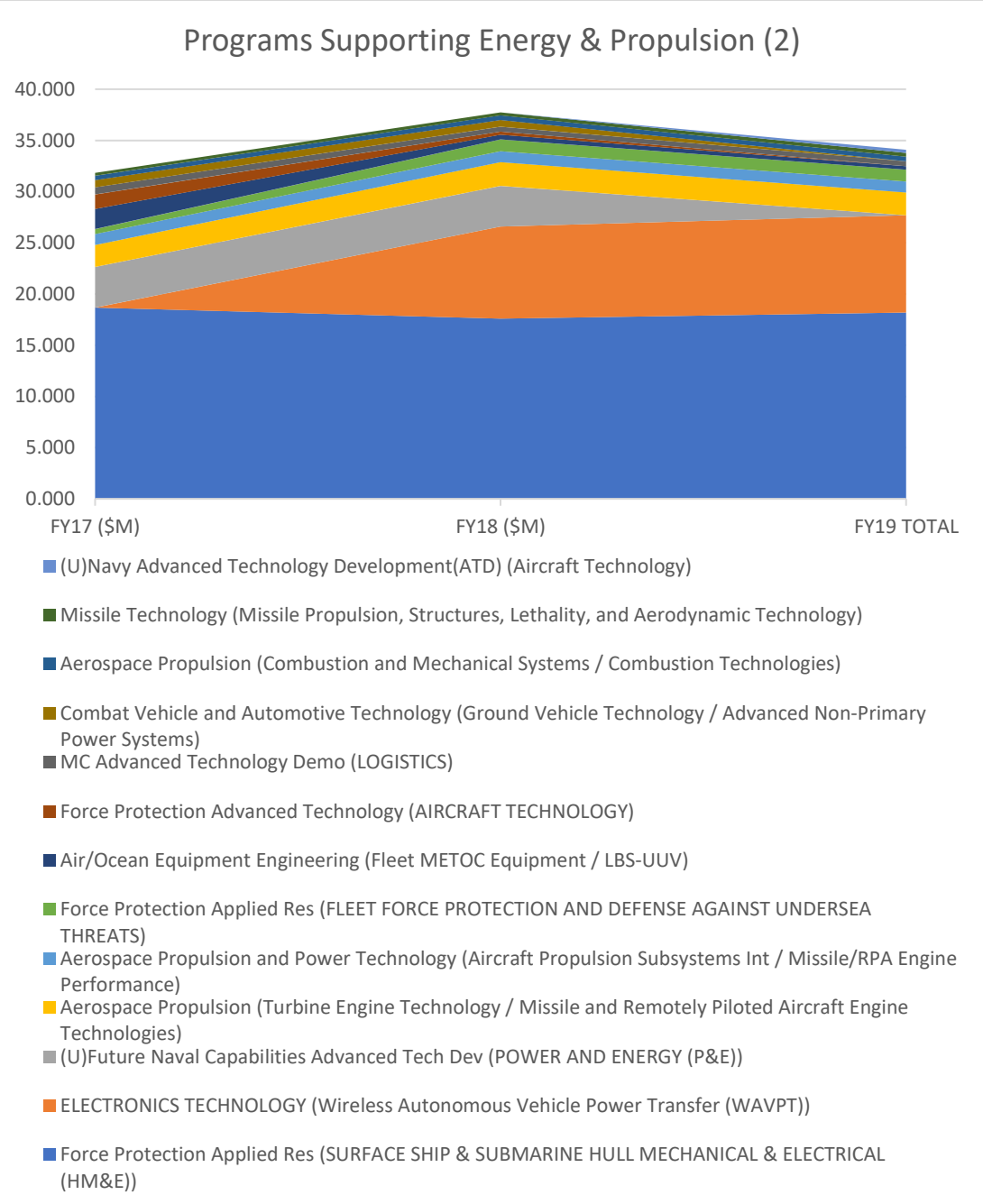


FIGURE 71: PROGRAMS SUPPORTING ENERGY AND PROPULSION SYSTEMS INTEGRATED ON UNMANNED SYSTEMS

TABLE 61: LISTING OF PROGRAMS SUPPORTING ENERGY AND PROPULSION SYSTEMS INTEGRATED ON UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0602123N	RDT&E	Force Protection Applied Res (SURFACE SHIP & SUBMARINE HULL	UAV Fuel cell development; Medium Displacement USV (MDUSV) development; USV swarm development; autonomy for UUV missions / understand counter-UUV autonomy options

			MECHANICAL & ELECTRICAL (HM&E))	
DARPA	0602716E	RDT&E	ELECTRONICS TECHNOLOGY (Wireless Autonomous Vehicle Power Transfer (WAVPT))	Wireless Autonomous Vehicle Power Transfer (WAVPT) program will develop small footprint, efficient receivers to enable power beaming from a ground-based transmitter to a remote unmanned aerial vehicle (UAV). FY 2019 Plans: - Design a custom high-power, high-efficiency, receiver architecture for mission-required beam transmission. - Complete designs and begin component development for a custom integrated wireless power system integrated with a Group 2/3 UAV.
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (POWER AND ENERGY (P&E))	Complete integration of fuel cell on UUV and conduct land-based testing and transition planning (The decrease from FY18 to FY19 was due to the Navy's restructuring of the FNC Program)
USAF	0602203F	RDT&E	Aerospace Propulsion (Turbine Engine Technology / Missile and Remotely Piloted Aircraft Engine Technologies)	Missile and Remotely Piloted Aircraft Engine Technologies (including long-range supersonic and hypersonic vehicles)
USAF	0603216F	RDT&E	Aerospace Propulsion and Power Technology (Aircraft Propulsion Subsystems Int / Missile/RPA Engine Performance)	Missile/Remotely Piloted Aircraft Engine Performance: FY18/FY19 plans include supersonic turbojet engine altitude testing (FY18); Initiate design of advanced turbine based accelerator with reusable hypersonics applications (FY18/19); Continue the development of derivative supersonic turbojet engines for missile and high speed accelerators (FY18/FY19). **Most efforts seem to relate to missiles rather than RPA
US Navy	0602123N	RDT&E	Force Protection Applied Res (FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS)	Hydrogen storage technology to power autonomous undersea vehicles; acoustic technology for detection of small UAVs
US Navy	0604218N	RDT&E	Air/Ocean Equipment Engineering (Fleet METOC Equipment / LBS-UUV)	Conduct LBS-G, LBS-AUV, and LBS-AUV(S) (Razorback) engineering design studies (FY19): Continue investigating next generation propulsion technologies such as Hybrid Thruster, battery chemistry, thermal engines, and universal buoyancy engines for potential system upgrades. Also, investigating battery technology, bio-fouling solutions, afterbody solutions, and open architecture approaches. FY 2018 to FY 2019 Increase/Decrease Statement: Reduction in funding from FY18 to FY19 will reduce the amount of investigating into next generation propulsion technologies such as Hybrid Thruster, battery chemistry, thermal engines, and universal buoyancy engines for potential system upgrades.
US Navy	0603123N	RDT&E	Force Protection Advanced Technology (AIRCRAFT TECHNOLOGY)	Propulsion systems including variable/adaptive cycle engine components, for next generation carrier based TACAIR ISR systems (UAS not specifically mentioned)
US Navy	0603640M	RDT&E	MC Advanced Technology Demo (LOGISTICS)	High specific power solar cells for MC applications including unmanned robotic vehicles
US Army	0602601A	RDT&E	Combat Vehicle and Automotive Technology (Ground Vehicle Technology / Advanced	Auxiliary Power Units (APUs) for military ground vehicle and unmanned ground systems (verify performance, control strategy and advanced noise control); ending work in FY18

			Non-Primary Power Systems)	
USAF	0602203F	RDT&E	Aerospace Propulsion (Combustion and Mechanical Systems / Combustion Technologies)	Develop, test, and evaluate revolutionary combustion and propulsion concepts for gas turbine, pulse detonation, and combined cycle engines for missiles, manned and unmanned systems
US Army	0602303A	RDT&E	Missile Technology (Missile Propulsion, Structures, Lethality, and Aerodynamic Technology)	Develop advanced hardware and subsystem technology to enable mission flexibility via dual pulse motor for future small guided missiles from rotary wing and UAS platforms (FY19)
US Navy	0603671N	RDT&E	(U)Navy Advanced Technology Development(ATD) (Aircraft Technology)	Propulsion systems including variable/adaptive cycle engine components, for next generation carrier based TACAIR ISR systems (UAS not specifically mentioned); FY 2018 to FY 2019 Increase/Decrease Statement: The funding increase from FY18 to FY19 reflects the realignment of funding for Aircraft Technology from PE 0603123N Force Protection Advanced Technology

Programs Supporting Training for Unmanned Systems

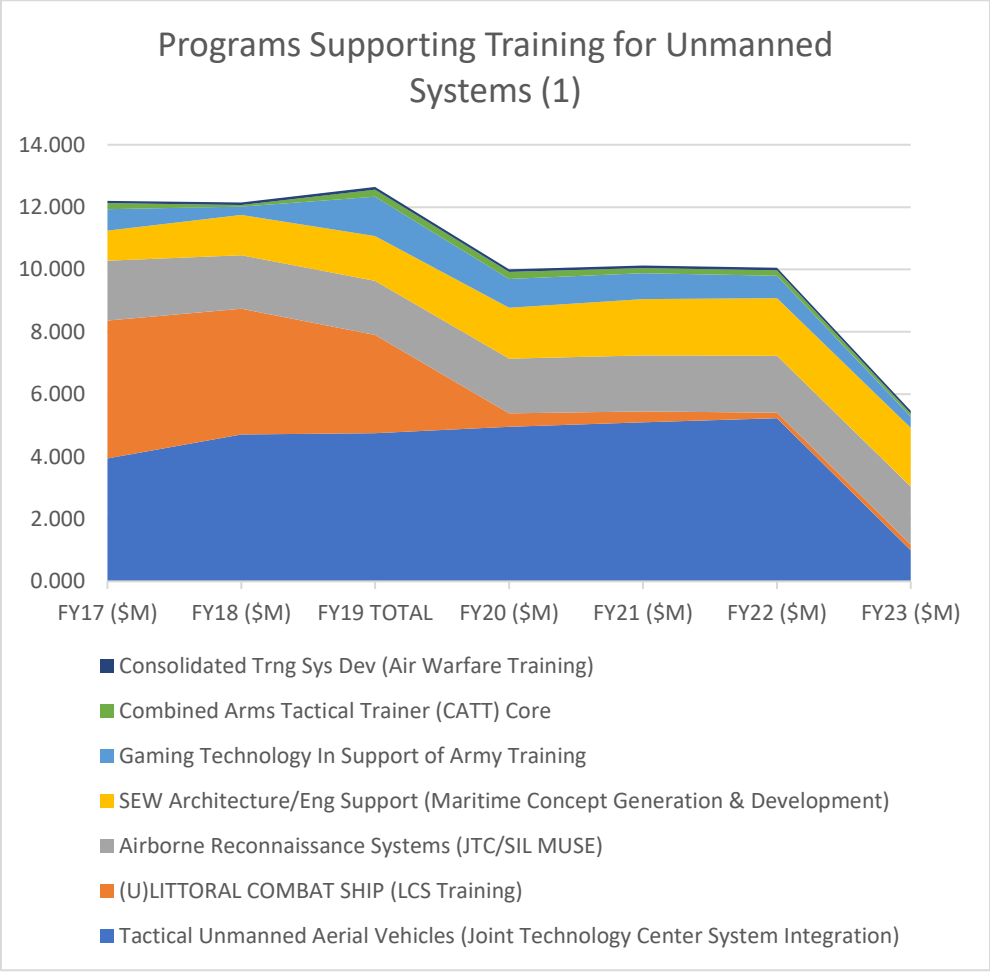


FIGURE 72: PROGRAMS SUPPORTING TRAINING FOR UNMANNED SYSTEMS

TABLE 62: LISTING OF PROGRAMS SUPPORTING TRAINING FOR UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
US Army	0305204A	RDT&E	Tactical Unmanned Aerial Vehicles (Joint Technology Center System Integration)	FY19: Continued movement towards standards based solutions, e.g. Common Image Generator Interface (CIGI), which will facilitate optimal interoperability and an IG agnostic framework with which to integrate with various IGs. Continued specific integration of Night Vision Image Generator (NVIG) and Virtual Reality Scene Generator (VRSG) into the Modeling & Simulation domain as it pertains to UAS simulation, terrain and model development. Continued support of annual/bi-annual theater level Exercises (Ulchi Freedom Guardian (UFG), Yama Sakura (YS) and Key Resolve (KR), Talisman Saber (TS), Pacific Sentry -2 & -3, as well as 5 other Exercises coming online, Integration Events (IEs) and Validation Events (VEs). Continued improvement of mapping capability for mission planning. Continued redesign of Windows Entity Server (WES) and NetLink to improve network routing and large PDU data feeds (i.e. 7 million+), thus lessening bandwidth consumption. Continued development of a Heads Up Display (HUD) designer application that will allow for the creation and modification of HUDs without having to touch the software baseline thereby reducing costs and increasing fidelity and speed of solution in theater. Continued implementation of generic 6 Degree of Freedom (DoF) application that will allow for creation of new platforms without modifying code; again a reduction in costs and increased solution delivery velocity. Continued architecture optimization, to facilitate extensibility and scalability, to maintain readiness for growth of M&S requirements coming from the Services.
US Navy	0603581N	RDT&E	(U)LITTORAL COMBAT SHIP (LCS Training)	NAWC will start the development of the VTUAV visual display trainer, oversee performance of the development effort, while providing additional support efforts to the LCS Fleet Introduction Program Office (PMS 505) (FY19)
USAF	0305206F	RDT&E	Airborne Reconnaissance Systems (JTC/SIL MUSE)	The Multiple Unified Simulation Environment (MUSE) is the DoD simulation/training system of choice for many Unmanned Aircraft Systems (UAS), RPA, and ISR systems. MUSE is also known as the Air Force Synthetic Environment for Reconnaissance and Surveillance (AFSERS) in its Air Force Application. MUSE/AFSERS is currently in use within all Services and most unified commands simulating MQ-1, MQ-9, RQ-4, MQ-1C, M/RQ-5, RQ-7, national and commercial satellite collectors, P-3, E-8, and the U-2.
US Navy	0604707N	RDT&E	SEW Architecture/Eng Support (Maritime Concept Generation & Development)	STRIKE GROUP-ORGANIC, LONG ENDURANCE UNMANNED AERIAL VEHICLE (UAV) experiment - This experiment effort will examine the employment of long endurance UAVs organic to a Carrier or Expeditionary Strike Group - a capability that will provide unit level ships with the ability to transport Intelligence, Surveillance, and Reconnaissance (ISR) and strike payloads long distances from the host platform. OFFICE OF NAVAL RESEARCH (ONR) TECHNOLOGY INNOVATION GAMES (TIGS). This series of workshops executed in conjunction with ONR will give Fleet operators the opportunity to examine emerging capabilities and determine potential concepts of employment to effectively incorporate innovative capabilities into Fleet warfighting missions and tasks. Potential technology being examined includes: MDUSV, Unmanned Systems (UxS)

				Defensive Actions. COUNTER-UNMANNED SYSTEMS EXPERIMENT SERIES - This effort will build upon the 2017 counter-UAV experiment by examining emerging TTPs and technologies to counter the proliferation of unmanned undersea, surface, and air vehicles. MINE WARFARE (MIW) EXPERIMENTATION: Through workshops, war simulation and at-sea events, the FY 18 efforts will continue to examine TTP and Command and Control (C2) construct for our future Mine Counter-Measures (MCM) force as new programs of record and unmanned systems come on line, and legacy systems begin to decommission. MCM WAR SIMULATION AND/OR AT SEA EXPERIMENT - This effort will examine current and planned Navy MCM equipment (manned and unmanned) and evaluate concepts of employment with an overall goal of developing a product that merges overall Navy requirements. (FY18)
US Army	6860NA0176	Procurement	Gaming Technology In Support of Army Training	Training using gaming technology for a range of operations including UAV integration and IED defeat training (possible using UGVs)
US Army	0604780A	RDT&E	Combined Arms Tactical Trainer (CATT) Core	Gaming Technology provides an application to train and rehearse a range of capabilities including UAV integration
US Navy	0204571N	RDT&E	Consolidated Trng Sys Dev (Air Warfare Training)	Naval Aviation training technologies for UAS; common architecture components for UAS, manned aircraft, and a range of other technologies

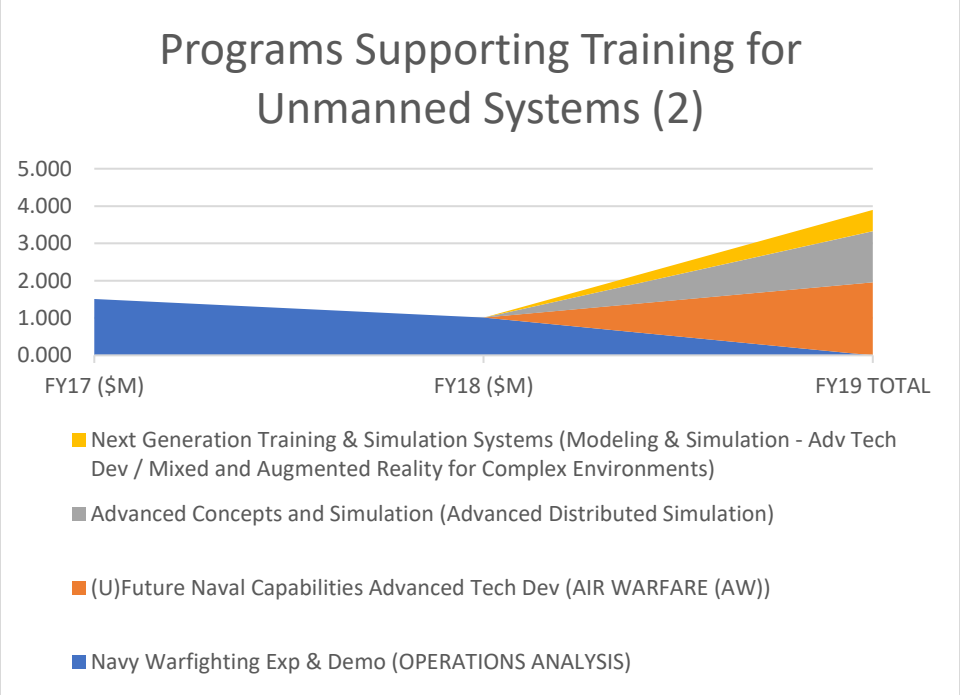


FIGURE 73: PROGRAMS SUPPORTING TRAINING FOR UNMANNED SYSTEMS

TABLE 63: LISTING OF PROGRAMS SUPPORTING TRAINING FOR UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes

US Navy	0603758N	RDT&E	Navy Warfighting Exp & Demo (OPERATIONS ANALYSIS)	Conduct wargame to identify capability needs of MDUSV
US Navy	0603673N	RDT&E	(U)Future Naval Capabilities Advanced Tech Dev (AIR WARFARE (AW))	Develop dynamic adaptive and modular training for unmanned aerial systems
US Army	0602308A	RDT&E	Advanced Concepts and Simulation (Advanced Distributed Simulation)	Investigate and design the synthetic framework, architecture, and technologies to enable a manned/unmanned teaming training and rehearsal simulation environment. (FY19)
US Army	0603015A	RDT&E	Next Generation Training & Simulation Systems (Modeling & Simulation - Adv Tech Dev / Mixed and Augmented Reality for Complex Environments)	Will mature modeling and simulations for megacities environments that will be used for urban interactive immersive training capability, components will include the simulated terrain environment representing complex and dense urban environments as well as manned/unmanned teaming models; mature the components of the dismounted soldier augmented reality visual system and occlusion algorithms for manned/unmanned teaming training operations. (FY19)

Other Air-Related Programs

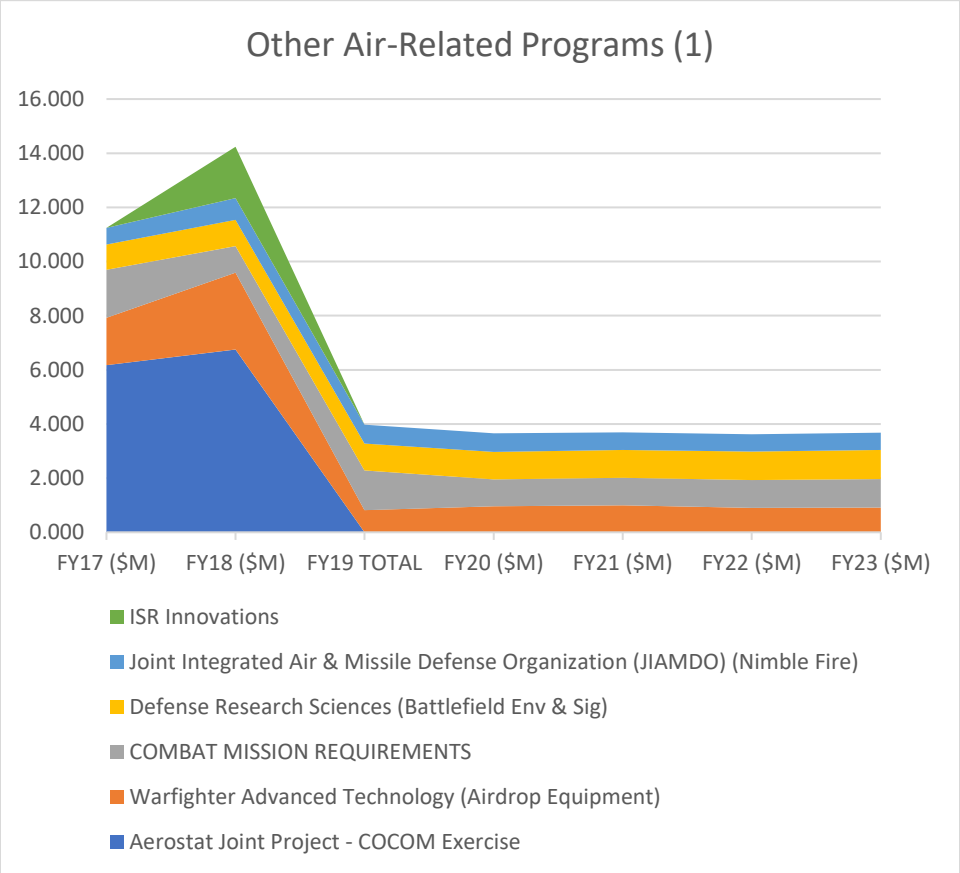


FIGURE 74: SUPPORT FOR OTHER AIR-RELATED PROGRAMS

TABLE 64: LISTING OF OTHER AIR-RELATED PROGRAMS

Organization	PE Number	Funding Type	Title	Notes
US Army	0202429A	RDT&E	Aerostat Joint Project - COCOM Exercise	Perform program shutdown activities. FY 2019 remaining activity is disposal of unclassified material.
US Army	0603001A	RDT&E	Warfighter Advanced Technology (Airdrop Equipment)	Will demonstrate precision aerial delivery software and hardware components in a GPS denied/degraded environment as well as in Dense, Urban, Complex Terrain. (FY19)
SOCOM	0206CMR	Procurement	COMBAT MISSION REQUIREMENTS	Equipment to support combat missions including UAVs
US Army	0601102A	RDT&E	Defense Research Sciences (Battlefield Env & Sig)	Improve survivability and situational awareness of unmanned systems in adverse weather conditions
TJS	0605126J	RDT&E	Joint Integrated Air & Missile Defense Organization (JIAMDO) (Nimble Fire)	Project 5/5 in FY18/FY19: Non-program of record experimentation of innovative uses of existing sensors and weapons across traditional IAMD assets. Examples include: ground-based sensors providing fire-control quality tracking to tactical air assets; contributions of unmanned assets to the air picture; and joint engagement sequences.
USAF	0207277F	RDT&E	ISR Innovations	Atmospheric Sensing and Prediction System (ASAPS) is a platform-integrated sensor for detecting adverse weather conditions such as clouds and icing. While initially envisioned to improve environmental awareness for Remotely Piloted Aircraft--which are particularly susceptible to lightning damage due to their composite structure--the technology could expand to contribute to the distributed, collaborative, and self-organizing sensor systems providing environmental threat detection for autonomous swarming aircraft. (in FY18 Develop ASAPS lightning sensing ability)

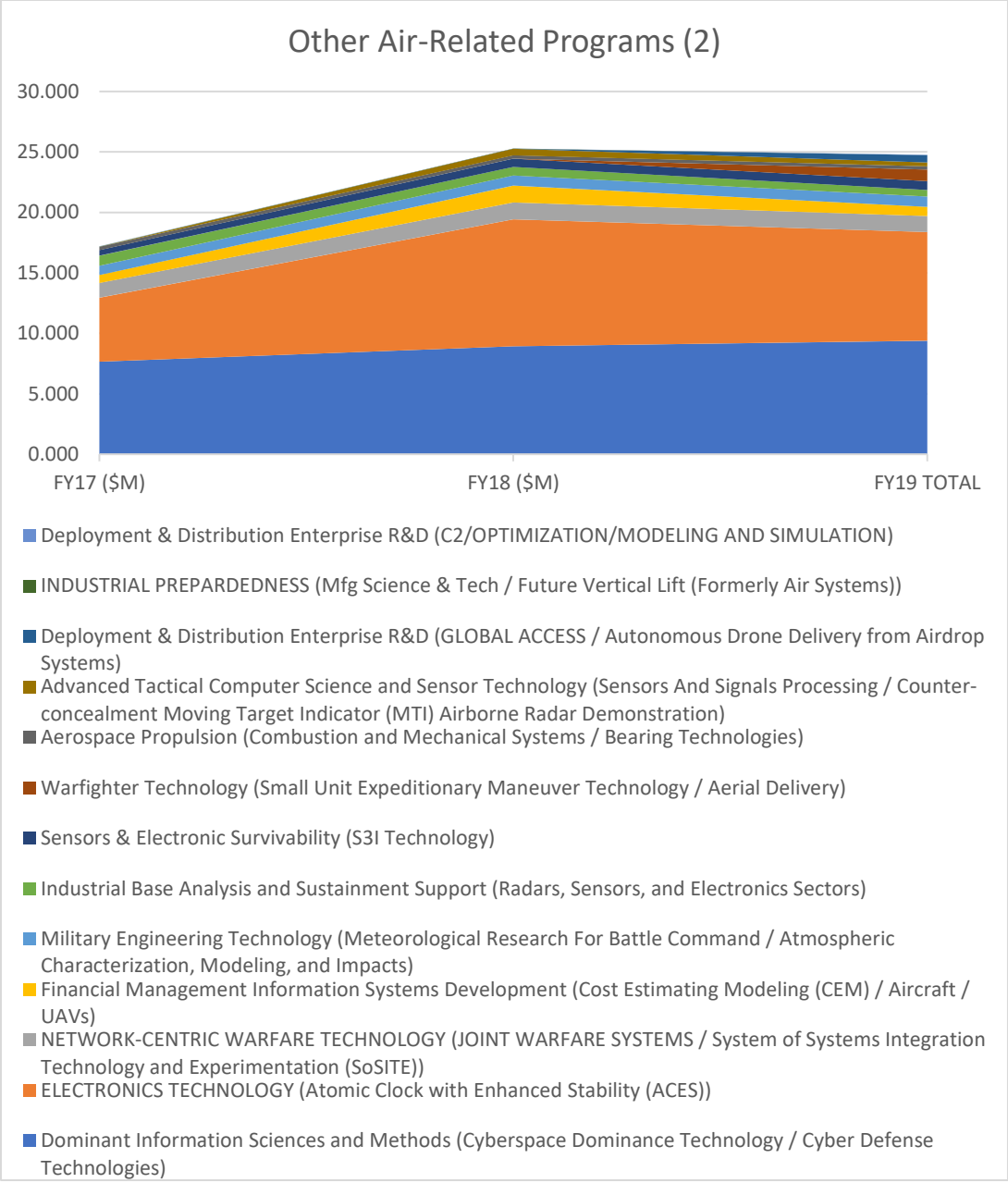


FIGURE 75: SUPPORT FOR OTHER AIR-RELATED PROGRAMS

TABLE 65: LISTING OF OTHER AIR-RELATED PROGRAMS

Organization	PE Number	Funding Type	Title	Notes
USAF	0602788F	RDT&E	Dominant Information Sciences and Methods (Cyberspace Dominance Technology / Cyber Defense Technologies)	Initiate applied research in the area of biologically resilient cyber technologies, mission-specific blockchain capabilities, and the alignment of cyber resilient services and dynamic management tailored towards unmanned aerial systems. (FY19)

DARPA	0602716E	RDT&E	ELECTRONICS TECHNOLOGY (Atomic Clock with Enhanced Stability (ACES))	Atomic Clock with Enhanced Stability (ACES) program aims to develop extremely stable chip-scale atomic clocks for unmanned aerial vehicles and other low size, weight, and power (SWaP) platforms with extended mission durations.
DARPA	0603766E	RDT&E	NETWORK-CENTRIC WARFARE TECHNOLOGY (JOINT WARFARE SYSTEMS / System of Systems Integration Technology and Experimentation (SoSITE))	System of Systems Integration Technology and Experimentation (SoSITE) program seeks to implement an architecture framework capable of assessing and demonstrating potential operational benefits of integrating various system capabilities to improve mission success in contested environments. FY 2019 Plans: - Secure test articles for flight test experiments for distributed opposed strike and suppression of enemy air defenses on manned and unmanned platforms, and experimental mission systems.
USAF	0901538F	RDT&E	Financial Management Information Systems Development (Cost Estimating Modeling (CEM) / Aircraft / UAVs)	Develop data collection requirements documents/tables and data collection process improvements, collect and analyze data to develop new estimating methods (e.g. statistical tools, cost estimating relationships (CERs)), and perform other gap filling studies for aircraft, UAVs, ballistic and tactical missiles, munitions, electronics and aircraft modifications, ground stations and automated information systems, space, launch vehicles, and cross-cutting areas.
US Army	0602784A	RDT&E	Military Engineering Technology (Meteorological Research For Battle Command / Atmospheric Characterization, Modeling, and Impacts)	Demonstrate capability of incorporating unmanned aerial systems (UAS) and other local data sources into a networked- constrained Nowcast model (FY19 Slight increase to advance modeling capability)
OSD	0607210D8Z	RDT&E	Industrial Base Analysis and Sustainment Support (Radars, Sensors, and Electronics Sectors)	In FY18/FY19, Unmanned Systems & Technologies: Wide spread adoption of unmanned systems and their supporting technologies are experiencing industry shortfalls in developing/delivering/servicing unmanned systems. This effort will identify and address material, manufacturing, and supply chain vulnerabilities from micro/man portable systems up to the large platforms – across all domains of air, surface, sub surface, land, blue water, and space. FY2018 focuses on assisting with the Navy Triton program, PMA-262, associated industrial base and production facilities. Technologies of focus include radar, sensors/apertures, power management, avionics equipment, and large scale complex composites manufacturing.
US Army	0602120A	RDT&E	Sensors & Electronic Survivability (S3I Technology)	RF sensing for UAS detection; obstacle avoidance for autonomous navigation; develop a lightweight UAS-compatible RF sensor with equivalent sensitivity to a vehicle-mounted stepped frequency radar in order to increase standoff protection beyond the blast radius
US Army	0602786A	RDT&E	Warfighter Technology (Small Unit Expeditionary Maneuver Technology / Aerial Delivery)	Will study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance precision aerial delivery capabilities and assure re-supply via manned and unmanned systems in A2/AD environments
USAF	0602203F	RDT&E	Aerospace Propulsion (Combustion and Mechanical	Continue work on small magnetic bearings & oil-free bearings for small & medium scale UAS, hi-Mach cruise missile and low-cost engines (FY19)

			Systems / Bearing Technologies)	
US Army	0603772A	RDT&E	Advanced Tactical Computer Science and Sensor Technology (Sensors And Signals Processing / Counter-concealment Moving Target Indicator (MTI) Airborne Radar Demonstration)	Develop scalable apertures and processing suitable for both airborne manned and unmanned platforms addressing open architecture, modularity, and scalability of the payloads. (FY19)
USAF	0604776F	RDT&E	Deployment & Distribution Enterprise R&D (GLOBAL ACCESS / Autonomous Drone Delivery from Airdrop Systems)	Autonomous Drone Delivery from Airdrop Systems: Drone hardware development and integration (FY19 new start)
US Army	0708045A	RDT&E	INDUSTRIAL PREPARDEDNESS (Mfg Science & Tech / Future Vertical Lift (Formerly Air Systems))	This effort funds manufacturing technology advances needed for more affordable manned and unmanned aircraft components and subsystems. (nothing specifically noted in FY18/FY19 plans relating to UAS)
USAF	0604776F	RDT&E	Deployment & Distribution Enterprise R&D (C2/OPTIMIZATION/MODELING AND SIMULATION)	Modeling & Simulation Innovation: Select student research/faculty-assisted projects (including the Remotely Piloted Aircraft Performing Airdrop Mission): in FY18/FY19, TRL 4-6: Collaborative partnership with Air Force Institute of Technology for graduate research addressing Joint Deployment and Distribution challenges.

Other Programs Providing Planning & Support for Unmanned Systems

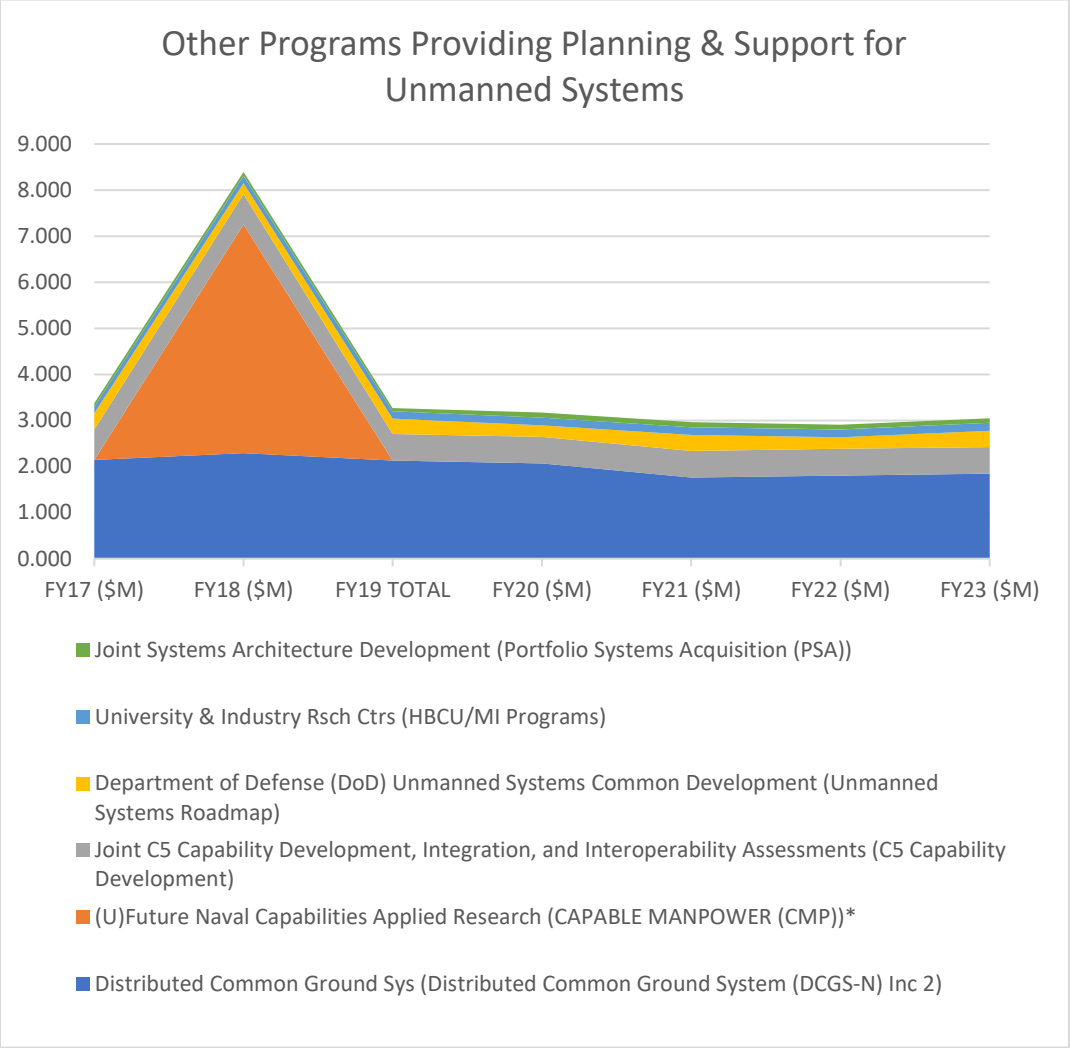


FIGURE 76: FUNDING FOR PROGRAMS PROVIDING PLANNING AND SUPPORT OF UNMANNED SYSTEMS

TABLE 66: LISTING OF PROGRAMS FUNDING PLANNING AND SUPPORT FOR UNMANNED SYSTEMS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0305208N	RDT&E	Distributed Common Ground Sys (Distributed Common Ground System (DCGS-N) Inc 2)	Support operational, tactical planning, and execution across the full range of joint military operations using among other things new and evolving unmanned systems sensor data
US Navy	0602750N	RDT&E	(U)Future Naval Capabilities Applied Research (CAPABLE MANPOWER (CMP))*	Initiate Manned and Unmanned Common Planning Picture (FY18)
TJS	0604826J	RDT&E	Joint C5 Capability Development, Integration, and Interoperability	In FY19, Data and Services – develop, promote, and integrate warfighter data and services requirements, standards, technical specifications, and policy to improve warfighter interoperability and information sharing with joint, mission

			Assessments (C5 Capability Development)	partners, and other U.S. government departments and agencies. Perform and lead proof of concept activities of the North Atlantic Treaty Organization (NATO) core data framework and the National Information Exchange Model (NIEM) with selected communities of interest, such as robotics and autonomous systems, to achieve coalition interoperability and demonstrate operational effectiveness for the mission partner environment and for the federated mission networking domain...
OSD	0604400D8Z	RDT&E	Department of Defense (DoD) Unmanned Systems Common Development (Unmanned Systems Roadmap)	Unmanned Systems Roadmap: Develops, Drafts, and Produces the Department's Unmanned Systems Integrated Roadmap. In FY19, Release the FY19 Unmanned Systems Integrated Roadmap Update the Department's Unmanned Systems Integrated Roadmap and perform related studies supporting the Department's vision for unmanned systems. Integrate feedback, responses and new technology into the FY19 Roadmap. Investigate changes to concept of operations with guidance provided by Department's vision for unmanned systems. The Unmanned systems roadmap is Developed and published every other year to provide the Department's vision for unmanned systems based on the rapid change in technology.
US Army	0601104A	RDT&E	University & Industry Rsch Ctrs (HBCU/MI Programs)	Unspecified research including multiscale modeling of robotics
OSD	0604875D8Z	RDT&E	Joint Systems Architecture Development (Portfolio Systems Acquisition (PSA))	In FY18/FY19, Update roadmaps and where appropriate generate new roadmaps to guide investments in critical areas (e.g., future vertical lift, unmanned systems, ground vehicles, weapons/munitions and Integrated Air and Missile Defense (IAMD))

Deployment of Unmanned Maritime Systems

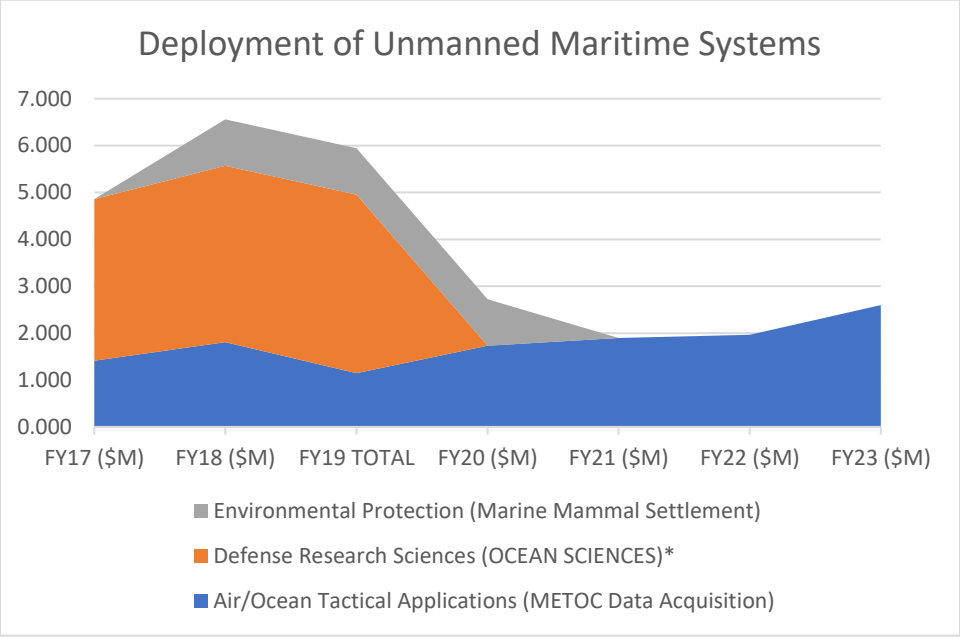


FIGURE 77: PROGRAMS FUNDING DEPLOYMENT OF UNMANNED MARITIME SYSTEMS

TABLE 67: LISTING OF PROGRAMS DEPLOYING UNMANNED MARITIME SYSTEMS FOR SAMPLING AND MONITORING

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603207N	RDT&E	Air/Ocean Tactical Applications (METOC Data Acquisition)	Use of unmanned vehicles and other new sensor technologies for acquisition of meteorological and oceanographic data; variable and dynamic littoral environmental conditions or in denied, remote or inaccessible areas over extended periods of time (no specific mention of how unmanned systems are being use in FY18/19 plans)
US Navy	0601153N	RDT&E	Defense Research Sciences (OCEAN SCIENCES)*	Use of autonomous unmanned sampling systems to study the Northern Arabian Sea circulation; initiate studies of coastal/riverine environments using unmanned vehicles; detection/classification of marine mammals using autonomous hardware; remote sensing of Arctic sea-ice
US Navy	0603721N	RDT&E	Environmental Protection (Marine Mammal Settlement)	Work in FY2019 under topic area 1 will be focused on conducting soundscape monitoring and fieldwork within National Marine Sanctuaries on the East Coast, West Coast, and Hawaii. This will include deployment and maintenance of passive acoustic monitoring equipment, gliders, telemetry stations; organization and communication regarding analysis techniques; and potentially some initial analysis of data collected.

Space Robotics

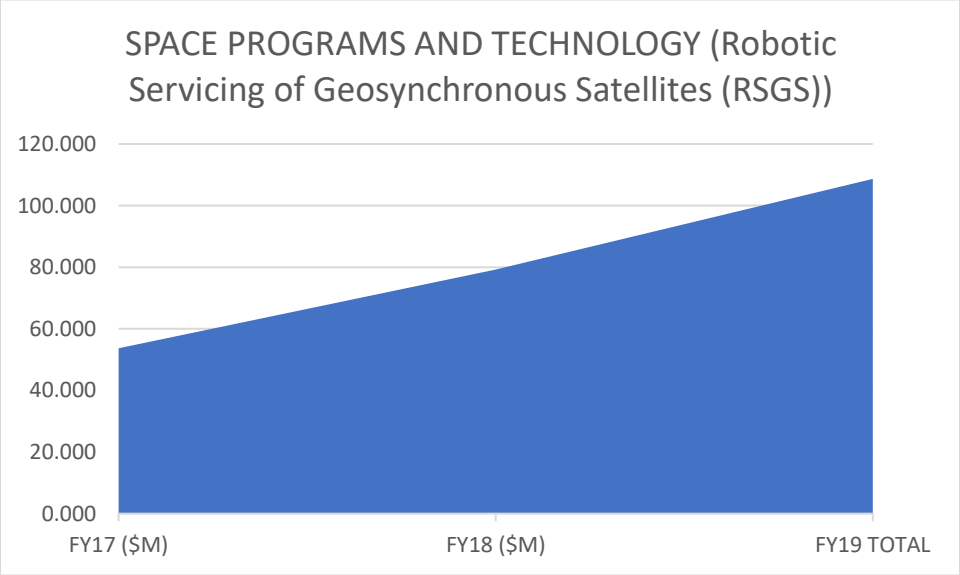


FIGURE 78: SPACE PROGRAM TO SERVICE SATELLITES USING ROBOTICS

TABLE 68: SPACE PROGRAM TO SERVICE SATELLITES USING ROBOTICS

Organization	PE Number	Funding Type	Title	Notes
DARPA	0603287E	RDT&E	SPACE PROGRAMS AND TECHNOLOGY (Robotic Servicing of	Robotic Servicing of Geosynchronous Satellites (RSGS) program seeks to establish the capability to acquire robotic services in GEO suitable for a variety of potential servicing tasks, in full

			Geosynchronous Satellites (RSGS))	collaboration and cooperation with existing satellite owners and national security space operators, and with sufficient propellant for several years of follow-on capability. FY 2019 Plans: - Begin integration of robotic payload. - Complete build and test of second robotic arm and tool changer. - Fabricate robotic operations test bed. - Complete build of flight units of robotic tools and tool holders. - Begin preparations for launch with Air Force Space Test Program. - Complete build of rendezvous and proximity operations sensors. - Complete payload structures fabrication. - Test final build of flight software. - Convene CONFERS second general assembly and open forum. - Publish revised on-orbit safety standards inclusive of lessons learned from on-going commercial and government activity. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 increase reflects integration of robotic payload and fabrication of multiple items including robotic arm and tool changer, testbed, flight ready tools and tool holders, sensors, payload structures, and flight software.

All Other Programs

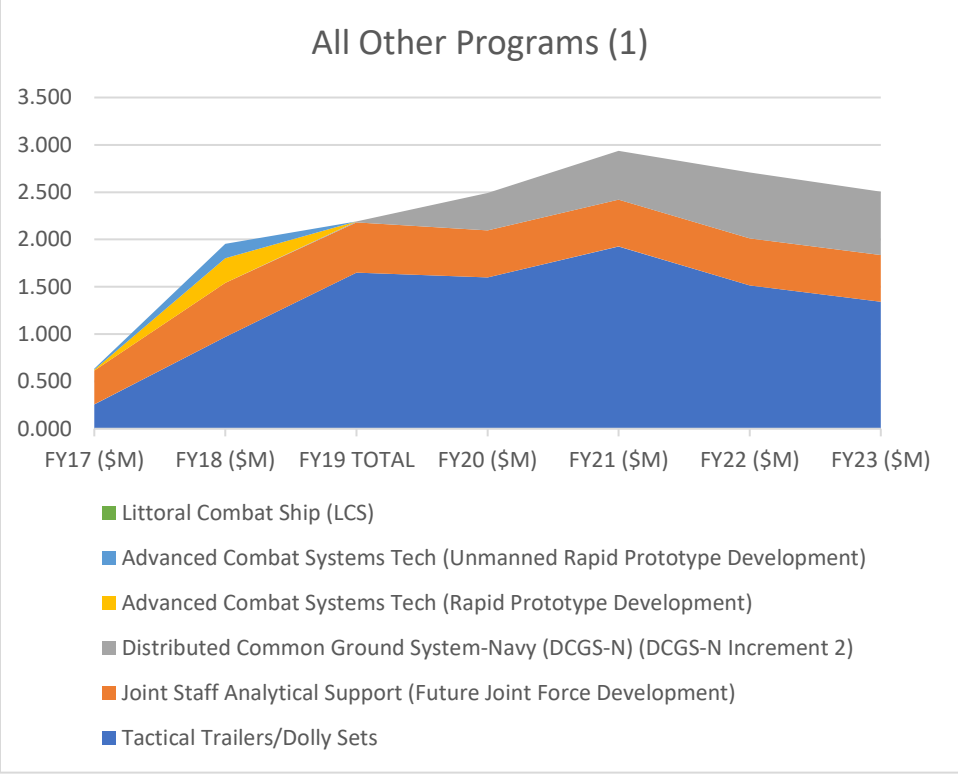


FIGURE 79: ALL OTHER PROGRAMS (NOT RELATED TO C-UXS)

TABLE 69: LISTING OF ALL OTHER PROGRAMS (NOT RELATED TO C-UXS)

Organization	PE Number	Funding Type	Title	Notes
US Army	0254DA0100	Procurement	Tactical Trailers/Dolly Sets	Trailer to transport M160 Robotic Mine Flail
TJS	0204571J	RDT&E	Joint Staff Analytical Support (Future Joint Force Development)	Future Joint Force Development: Concept implementation is underway for the Joint Concepts for rapid aggregation, robotic and autonomous systems, human aspects of military operations, access and maneuver in the global commons, preventing the transfer and use of weapons of mass Destruction, and operational contract support.
US Navy	2914	Procurement	Distributed Common Ground System-Navy (DCGS-N) (DCGS-N Increment 2)	Supports operational, tactical planning, and execution for the full range of military operations by improving the use and analysis of sensor/platform data (from new and evolving unmanned systems among others)
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (Rapid Prototype Development)	Development of new technologies that provide advanced warfighting capabilities including unmanned systems (the majority of funding seems to be focused towards the SURTASS-E towed sensor for large ships providing wide-area surveillance (program re-aligned to PE0604030N)
US Navy	0603382N	RDT&E	Advanced Combat Systems Tech (Unmanned Rapid Prototype Development)	Development of new technologies that provide advanced warfighting capabilities including unmanned systems (program re-aligned to PE0604030N)
US Navy	2127	Procurement	Littoral Combat Ship (LCS)	The LCS deploys unmanned vehicle mission packages for ASW, SUW, MCM, etc.

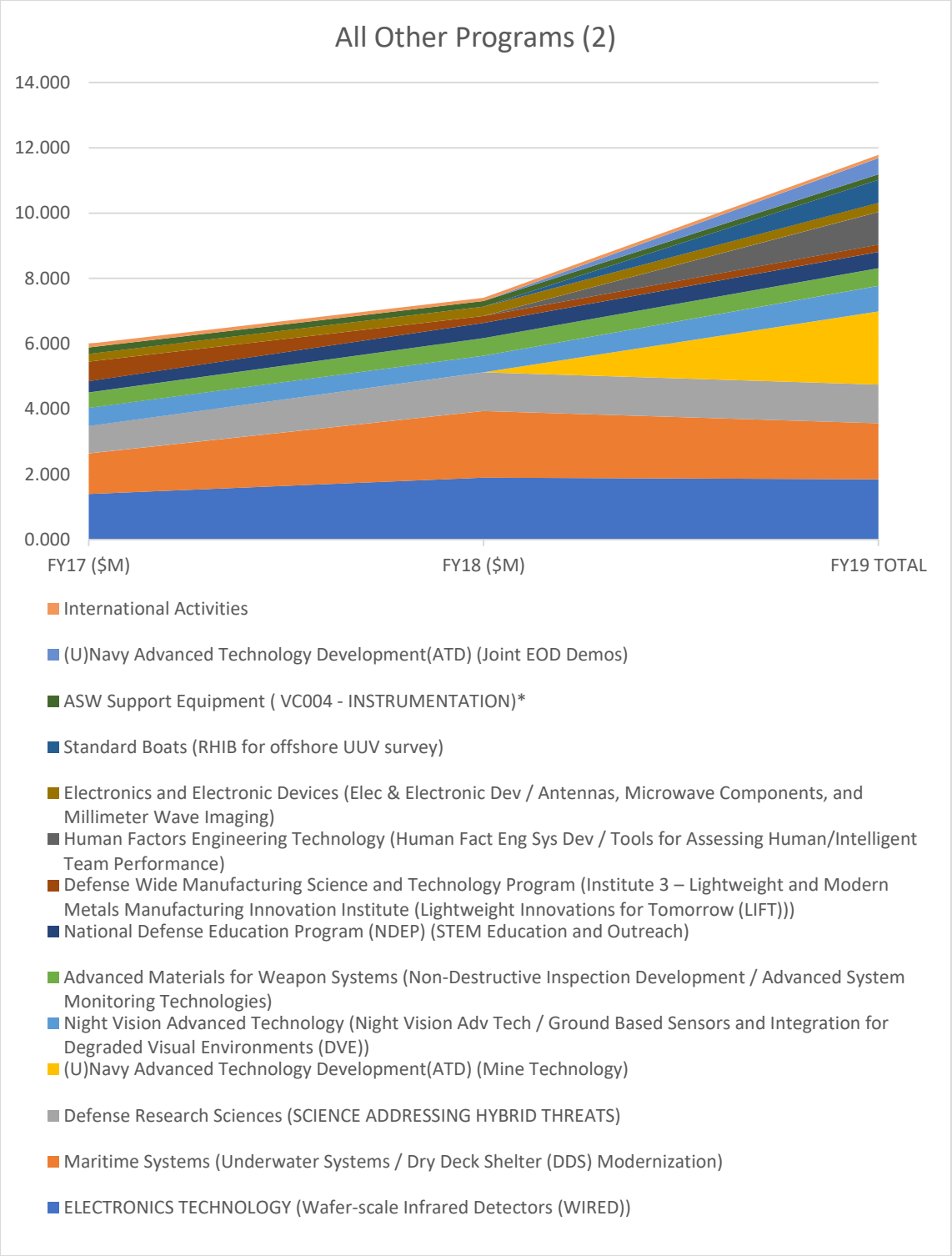


FIGURE 80: ALL OTHER PROGRAMS (NOT RELATED TO C-UXS)

TABLE 70: LISTING OF ALL OTHER PROGRAMS (NOT RELATED TO C-UXS)

Organization	PE Number	Funding Type	Title	Notes
DARPA	0602716E	RDT&E	ELECTRONICS TECHNOLOGY (Wafer-scale Infrared Detectors (WIRED))	Wafer-scale Infrared Detectors (WIRED): These sensors will provide increased standoff distances for small unmanned aerial vehicles, low-cost missiles, handheld weapon sights and surveillance systems, helmet-mounted systems, and ground-vehicle-mounted threat warning systems.
SOCOM	1160483BB	RDT&E	Maritime Systems (Underwater Systems / Dry Deck Shelter (DDS) Modernization)	Dry Deck Shelter (DDS) Modernization: Funding supports product improvements to the current DDS, as well as associated diver equipment for in-service submarine support systems, unmanned underwater vehicles, and follow on development efforts for future SOF payloads.
US Navy	0601153N	RDT&E	Defense Research Sciences (SCIENCE ADDRESSING HYBRID THREATS)	Counter-IED solutions against hybrid threats and adversaries
US Navy	0603671N	RDT&E	(U)Navy Advanced Technology Development(ATD) (Mine Technology)	Advanced mining concepts including remote control, advanced sensing, command & control (C2), and more discriminative targeting solutions
US Army	0603710A	RDT&E	Night Vision Advanced Technology (Night Vision Adv Tech / Ground Based Sensors and Integration for Degraded Visual Environments (DVE))	Incorporate advanced UCIR sensors and image processing into unmanned systems to enhance target detection performance of convoy operations under degraded environments. (FY19)
USAF	0603112F	RDT&E	Advanced Materials for Weapon Systems (Non-Destructive Inspection Development / Advanced System Monitoring Technologies)	Advanced System Monitoring Technologies: in FY18/FY19, Continue to transition robotic nondestructive inspection methods to minimize disassembly and reduced maintenance burden to perform inspections of aircraft structures.
OSD	0601120D8Z	RDT&E	National Defense Education Program (NDEP) (STEM Education and Outreach)	STEM Education and Outreach including FIRST Robotics.
OSD	0603680D8Z	RDT&E	Defense Wide Manufacturing Science and Technology Program (Institute 3 – Lightweight and Modern Metals Manufacturing Innovation Institute (Lightweight Innovations for Tomorrow (LIFT)))	Institute 3 – Lightweight and Modern Metals Manufacturing Innovation Institute (Lightweight Innovations for Tomorrow (LIFT)): The goal is to catalyze the development of an advanced lightweight metal U.S. supplier base and to enable DoD to realize greater speed and agility of manned, unmanned, and Warfighter systems as well as benefits for commercial applications.
US Army	0602716A	RDT&E	Human Factors Engineering Technology	Develop portable, "plug and play" analysis toolkit that enables individualized assessment of a single human interacting with an intelligent agent in pseudo-controlled environments.

			(Human Fact Eng Sys Dev / Tools for Assessing Human/Intelligent Team Performance)	
US Army	0602705A	RDT&E	Electronics and Electronic Devices (Elec & Electronic Dev / Antennas, Microwave Components, and Millimeter Wave Imaging)	Investigate small, low-power sensors and control systems for use by Soldiers and in unmanned applications (FY18)
US Navy	1210	Procurement	Standard Boats (RHIB for offshore UUV survey)	Rigid Hull Inflatable Boats (RHIBs) (x2) for global UUV offshore survey request
US Navy	5429	Procurement	ASW Support Equipment (VC004 - INSTRUMENTATION)*	Support for target drone operations
US Navy	0603671N	RDT&E	(U)Navy Advanced Technology Development(ATD) (Joint EOD Demos)	Conduct advanced technology development and demonstration of robotic manipulation for ordnance exploitation & neutralization, standoff detection and classification for ordnance, and identification of explosives (highly dexterous dual manipulator systems (manipulators, controllers) for EOD robots for precision render safe and neutralization missions)
USAF	1001004F	RDT&E	International Activities	International Armaments Cooperation (IAC) Agreement Activities: IAC activities will meet warfighter needs and enhance interoperability by exploring cooperation with our partners in the areas of robotics, autonomous control, remotely piloted aircraft, and a range of other technologies.

Counter-Unmanned Systems (C-UxS) Equipment

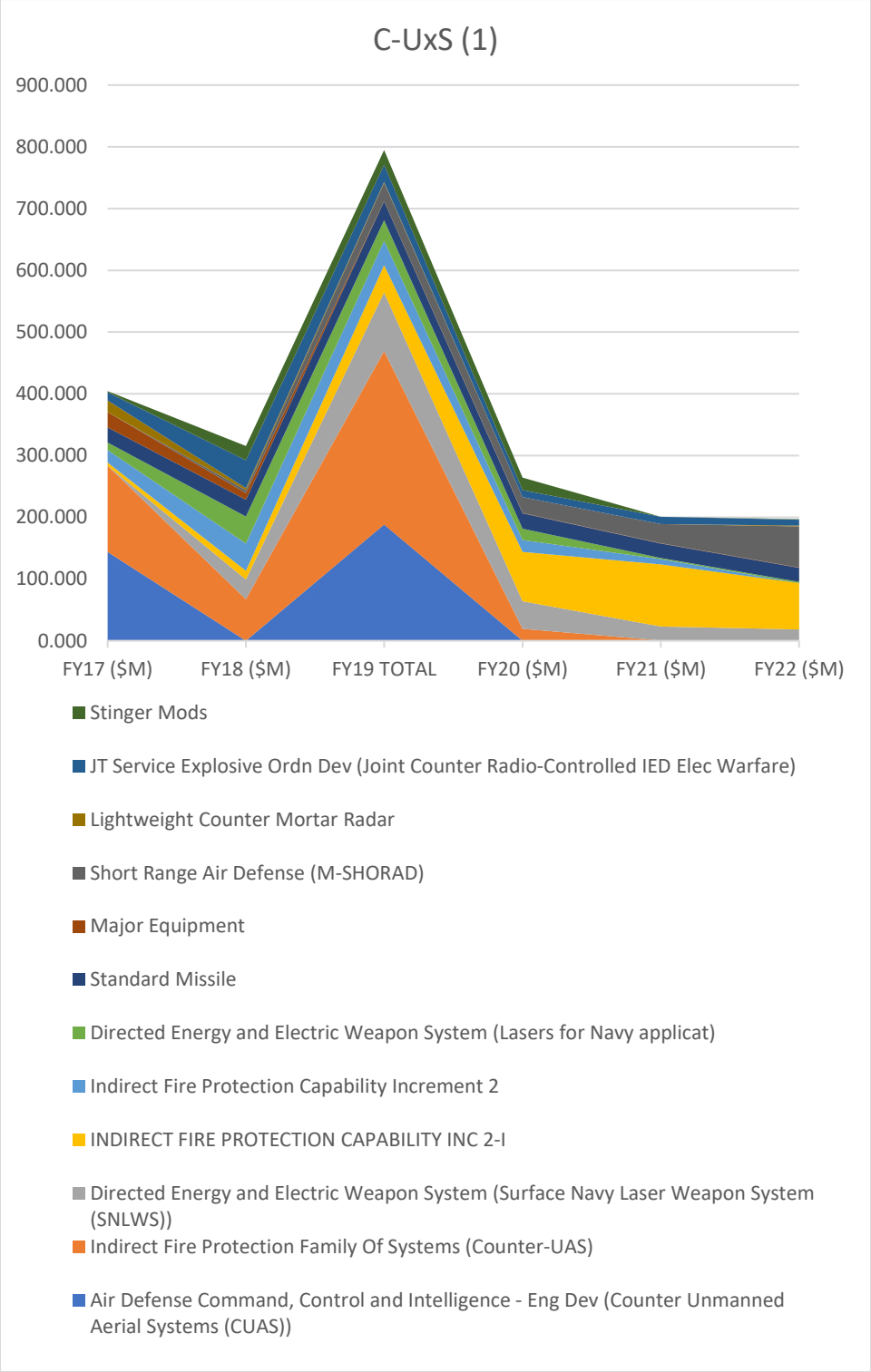


FIGURE 81: PROGRAMS SUPPORTING C-UXS

TABLE 71: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
US Army	0604741A	RDT&E	Air Defense Command, Control and Intelligence - Eng Dev (Counter Unmanned Aerial Systems (CUAS))	Develop, integrate, and test kinetic, or hard kill, defeat solutions into the Low-slow-small UAS Integrated Defeat System (LIDS): 1) develop Coyote medium range seeker; 2) develop lightweight flat panel radar; 3) increase range of mobile gun weapon; and 4) develop and integrate multi-function Electronic Warfare (EW) with full On The Move (OTM) capability. (FY19 / FY19 OCO)
US Army	0173BZ0501	Procurement	Indirect Fire Protection Family Of Systems (Counter-UAS)	Counter-UAS technology support
US Navy	0603925N	RDT&E	Directed Energy and Electric Weapon System (Surface Navy Laser Weapon System (SNLWS))	Development of advanced prototype laser weapon systems in the 60 kW or higher class - Solid State Laser (SSL); FY19: continue fabrication of two units, each consisting of a High Energy Laser Weapon System combined with a CISR capability for countering UAS-mounted sensors (main reason provided for funding increase from FY18)
US Army	8930C61001	Procurement	INDIRECT FIRE PROTECTION CAPABILITY INC 2-I	Defense against cruise missiles and UAS
US Army	0605052A	RDT&E	Indirect Fire Protection Capability Increment 2	Supports a ground-based weapon system that is designed to acquire, track, engage, and defeat the UAS, CM, and RAM threats.
US Navy	0603925N	RDT&E	Directed Energy and Electric Weapon System (Lasers for Navy applicat)	Counter-UAS capabilities using Lower Power Lasers combined with sensors for ISR and tracking; Beginning in FY 2018, Low Power Module (LPM) development efforts are being renamed Optical Dazzling Interdictor, Navy (ODIN); FY 2018 to FY 2019 Increase/Decrease Statement: Funding decreased in FY19 as the majority of the engineering development and initiation of material procurement for production of the initial five (5) systems is accomplished in FY18.
US Navy	2234	Procurement	Standard Missile	Small missile for protection against UAS
WHS	31	Procurement	Major Equipment	Counter-UAS equipment
US Army	0604117A	RDT&E	Short Range Air Defense (M-SHORAD)	Improved air defense identification and defeat capabilities to counter UAS and other threats; As part of the objective solution, the 50-kilowatt laser will be assessed for possible transition from Science Technology to an objective M-SHORAD program in FY2022
US Army	8387B05201	Procurement	Lightweight Counter Mortar Radar	Radars used for counter-mortar that have also been transitioned for counter-UAS
US Navy	0603654N	RDT&E	JT Service Explosive Ordn Dev (Joint Counter Radio-Controlled IED Elec Warfare)	Joint Counter RCIED (Radio-Controlled Improvised Explosive Devices) EW (JCREW) development of equipment for Counter-Unmanned Aerial System (C-UAS) operations; Thirty C-UAS systems have been fielded to date to provide a rapid response initial capability, with additional systems planned per the JUON.
US Army	2684C20000	Procurement	Stinger Mods	Defense against cruise missiles, fixed/rotary wing aircraft and UAS

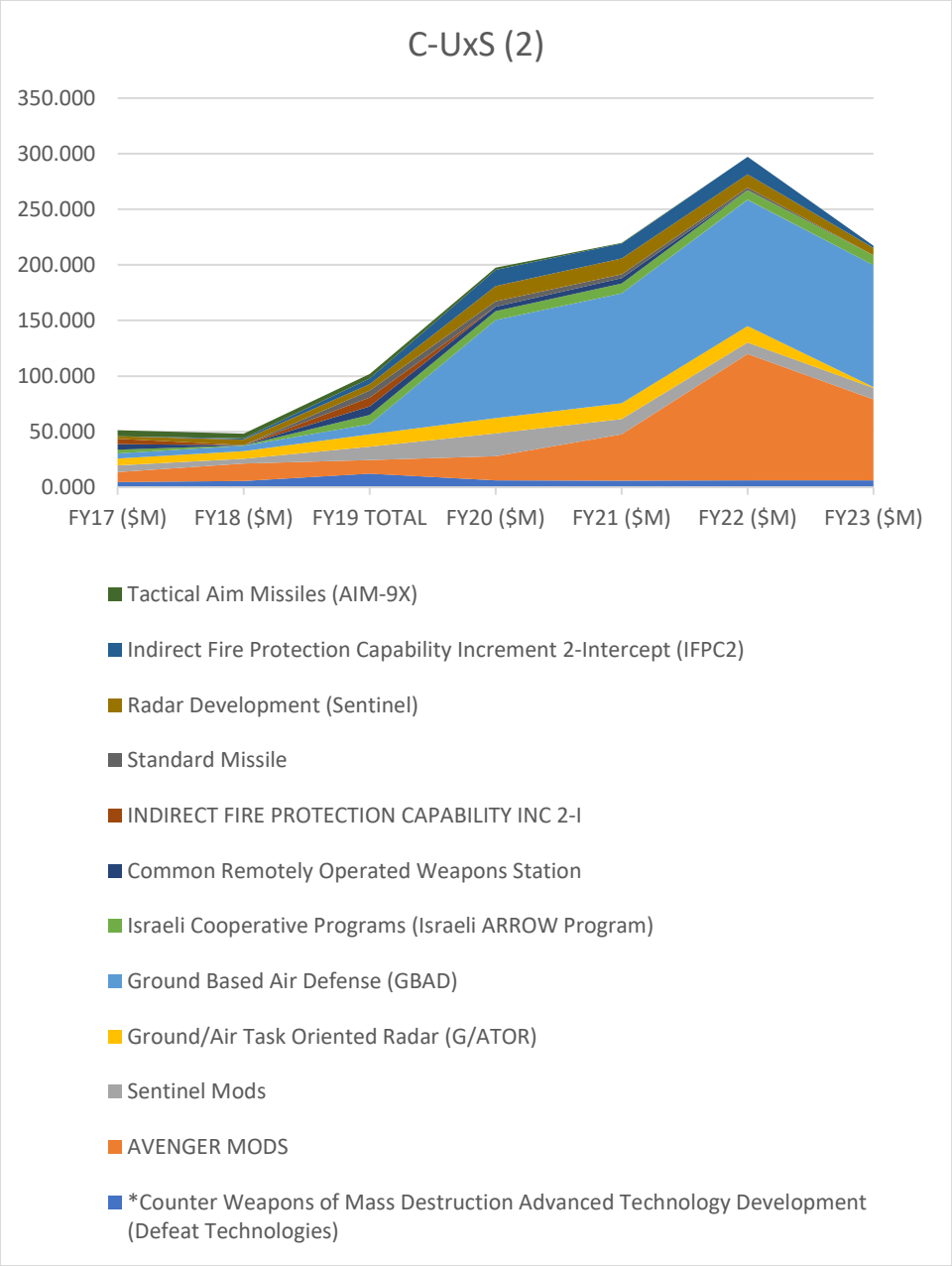


FIGURE 82: PROGRAMS SUPPORTING C-UXS

TABLE 72: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
DTRA	0603160BR	RDT&E	*Counter Weapons of Mass Destruction Advanced Technology Development (Defeat Technologies)	In FY19, Collect signatures on IED/sUAS in a predictive environments using modeling & simulation; Provide advanced infrastructure to improve collection of signatures including sensors, lab and field equipment, collection software, and collection tools; Provide advanced IED/sUAS library analytics to improve database management (including entry, creation of information and vetting of information), search

				functionality, and 3rd party database queries; Provide curation, dissemination, and access to collected data; Develop and establish standardized data collection protocols; Build, procure, and validate advanced and improvised threats to assist in threat risk analysis; Develop IED/sUAS Identify Friend or Foe (IFF) low cost solutions to support U.S. forces and improve sensor detection while decreasing false alarm rates and reporting; Identify and develop passive threat detections for IED/sUAS systems as the technology continues to develop in private industry; Develop counter-measures to detect and defeat multi-agent enemy IED/sUAS; Develop acoustic disrupters to defeat enemy IED/sUAS; Improve sensor integration of C-IED/C-sUAS systems to improve detection and defeat capabilities and reduce the human in the loop; Develop capability for manned aircraft to detect IED/sUAS in order to protect manned aircraft from potential threat IED/sUAS effects. The increase from FY 2018 to FY 2019 is due to the net effect of the realignment of funds to support experimental activities in Project RM and requirements in Project RE and increased investment to counter small Unmanned Aerial Systems (UAS), (i.e., Tier 1 and 2 UAS), including rotary and fixed winged systems.
US Army	2690CE8710	Procurement	AVENGER MODS	Defense against cruise missiles, fixed/rotary wing aircraft and UAS
US Army	0125WK5057	Procurement	Sentinel Mods	Radar used to automatically detect, classify, identify and report targets including UAS
USMC	4655	Procurement	Ground/Air Task Oriented Radar (G/ATOR)	Radar to detect UAS and cue air defense weapons
USMC	3006	Procurement	Ground Based Air Defense (GBAD)	Counter-UAS equipment (C-UAS capability installed every year starting FY20)
MDA	0603913C	RDT&E	Israeli Cooperative Programs (Israeli ARROW Program)	Arrow Block 5 development will also incorporate a Long Range Detection Suite that consists of an unmanned aerial vehicle Airborne Early Warning System (ABEWS) and Sharp Eye Radar for increased sensor range, early detection and enhanced raid size capacity.
US Army	8310G04700	Procurement	Common Remotely Operated Weapons Station	Remote weapon station procurement capable of countering UAS
US Army	8930C61001	Procurement	INDIRECT FIRE PROTECTION CAPABILITY INC 2-I	Defense against cruise missiles and UAS
US Navy	2234	Procurement	Standard Missile	Small missile for protection against UAS
US Army	0604820A	RDT&E	Radar Development (Sentinel)	Sentinel contributes to the digital battlefield by automatically detecting, classifying, identifying and reporting targets such as UAS
US Army	0604319A	RDT&E	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	Develop a kinetic interceptor to counter UAS and Cruise Missiles
US Navy	0207161N	RDT&E	Tactical Aim Missiles (AIM-9X)	Missile system essential to countering threats such as UAVs, cruise missiles and electronic attack

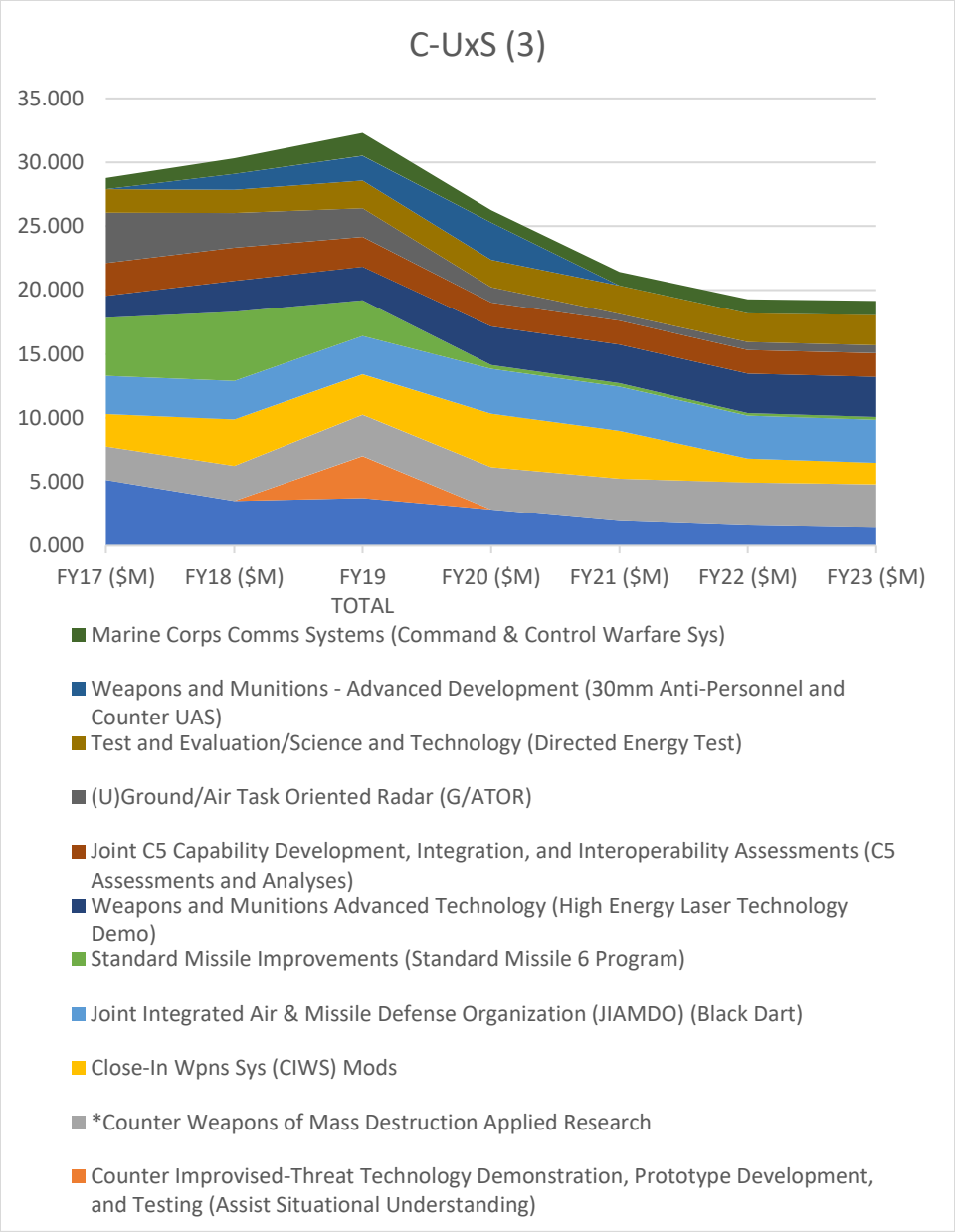


FIGURE 83: PROGRAMS SUPPORTING C-UXS

TABLE 73: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
USAF	0207161F	RDT&E	Tactical AIM Missiles (AIM-9 Product Improvement)	The AIM-9X short range air-to-air missile modification program provides a launch and leave, air combat munition that uses passive Infra-Red (IR) energy for acquisition and tracking of enemy aircraft and complements the Advanced Medium Range Air-to-Air Missile (AMRAAM). The missile is essential to Pacific Command plans to counter threats employed by advanced Digital Radio Frequency Memory (DRFM) electronic attack, cruise missiles, and Unmanned Aerial Vehicles.

DTRA	0604134BR	RDT&E	Counter Improvised-Threat Technology Demonstration, Prototype Development, and Testing (Assist Situational Understanding)	In FY19: Effort to consolidate Web Visualizations for DTRA IED/sUAS data. This will include the Common Intelligence Picture/Common Operational Picture and technical data and will serve as the platform for creation of C-IED/CsUAS analytics. Build a data science enabled module that will crawl through Catapult reporting and identify reports related to IED/sUAS events. Through machine learning techniques and application of training data, the team will train this module to identify reports that normal queries may miss. These reports will serve as the base data set for the CIED/C-sUAS event table. Prepare a list of vetted IED/sUAS events pulled from Catapult reporting. Events will be broken down into relevant categories with associated attributes. Stand up a database of technical data associated with known IED/sUAS. Library will be available for direct query and incorporated into other C-IED/C-sUAS capabilities.
DTRA	0602718BR	RDT&E	*Counter Weapons of Mass Destruction Applied Research	In FY19, Collect signatures on threat-improvised rotary winged and fixed winged IED/sUAS in a lab and field environment; Provide infrastructure to collect signatures including sensors, lab, and field equipment, collection software and collection tools; Provide a consolidated C-IED/C-sUAS library including database(s), database access, and database/library management including entry, creation and vetting of information; Analyze C-IED/C-sUAS equipment data, and create/sustain algorithms, databases and tables to monitor the creation and vetting of information; Monitor exploitation of rotary winged, fixed winged IED/C-sUAS to manage the capability gap (from a technology and database standpoint). The increase from FY 2018 to FY 2019 is due to the net effect of the realignment of funds to support experimental activities in Project RM in program element 0603160BR and increased investment to counter IED/C-sUAS.
US Navy	4205	Procurement	Close-In Wpns Sys (CIWS) Mods	Autonomous combat system that engages threats including UAS through integration of FLIR sensor
TJS	0605126J	RDT&E	Joint Integrated Air & Missile Defense Organization (JIAMDO) (Black Dart)	Black Dart is a unique joint, interagency demonstration focusing on rapid development and implementation of Counter - Unmanned Aircraft Systems (C-UAS) technology from readily-available commercial and governmental products. In FY19: Continue stakeholder participation utilizing scenarios which are integrating systems across land, littoral, and maritime domains at venues to include Urban and sea-based scenarios. Analyze and present results of Black Dart 18 to Joint Staff, Joint Requirements Oversight Council and stakeholders.
US Navy	0604366N	RDT&E	Standard Missile Improvements (Standard Missile 6 Program)	Develop missile technology for defense against UAS and other threats
US Army	0603004A	RDT&E	Weapons and Munitions Advanced Technology (High Energy Laser Technology Demo)	Mobile high power solid state laser (SSL) technology demonstrations (capable of defeating a range of threats including UAVs)
TJS	0604826J	RDT&E	Joint C5 Capability Development, Integration, and Interoperability Assessments (C5	Command, control, communications, computers, and cyber (C5) Assessments and Analyses: in FY19, Bold Quest (BQ) 2019 coalition interoperability demonstrations – support the design, plan, and execution of the BQ events which address close air support, counter UAS, IFF testing, and cyber effects on operations for U.S. forces and coalition partners. Support

			Assessments and Analyses)	includes accredited exercise networks, associated C2 systems, and data collection and analysis capabilities. USCENTCOM counter-UAS (C-UAS) support – Conduct analysis activities both at CONUS C-UAS events and in active operational theaters to evaluate effectiveness of rapidly fielded C-UAS systems. Results will inform follow-on fielding and rapid procurement decisions.
US Navy	0204460M	RDT&E	(U)Ground/Air Task Oriented Radar (G/ATOR)	Radar to detect UAS and cue air defense weapons; Funding increases $6.199M from FY18 to FY19 to initiate software development supporting a Composite Tracking Network (CTN) interface for the GB2 mission profile that will reduce Warfighter Air Surveillance gaps on the battlefield by providing tracks for both enemy aircraft and unmanned aerial vehicles.
OSD	0603941D8Z	RDT&E	Test and Evaluation/Science and Technology (Directed Energy Test)	Directed Energy Test: Investments in high energy lasers (HEL) test technologies will be initiated to assess the changes in HEL effects due to the shift of HELs to shorter wavelengths near one micron. These technology developments will include efforts to characterize the performance of HEL systems as they engage small targets such as enemy rockets, missiles, artillery, and unmanned aerial vehicles.
US Army	0603639A	RDT&E	Weapons and Munitions - Advanced Development (30mm Anti-Personnel and Counter UAS)	Development of the Lightweight 30mm (LW30, 30mmx113mm) Airburst cartridge which can be used for Counter-UAS and anti-personnel (new start in FY19)
US Navy	0206313M	RDT&E	Marine Corps Comms Systems (Command & Control Warfare Sys)	Counter-UAS efforts: FY19 plan reflects test and evaluation for CREW development efforts to include software load-set development and capability testing of the CREW System and market research and development efforts for the Multi-Function Electronic Warfare, which would do both CREW and Counter Unmanned Aerial Systems (C-UAS).

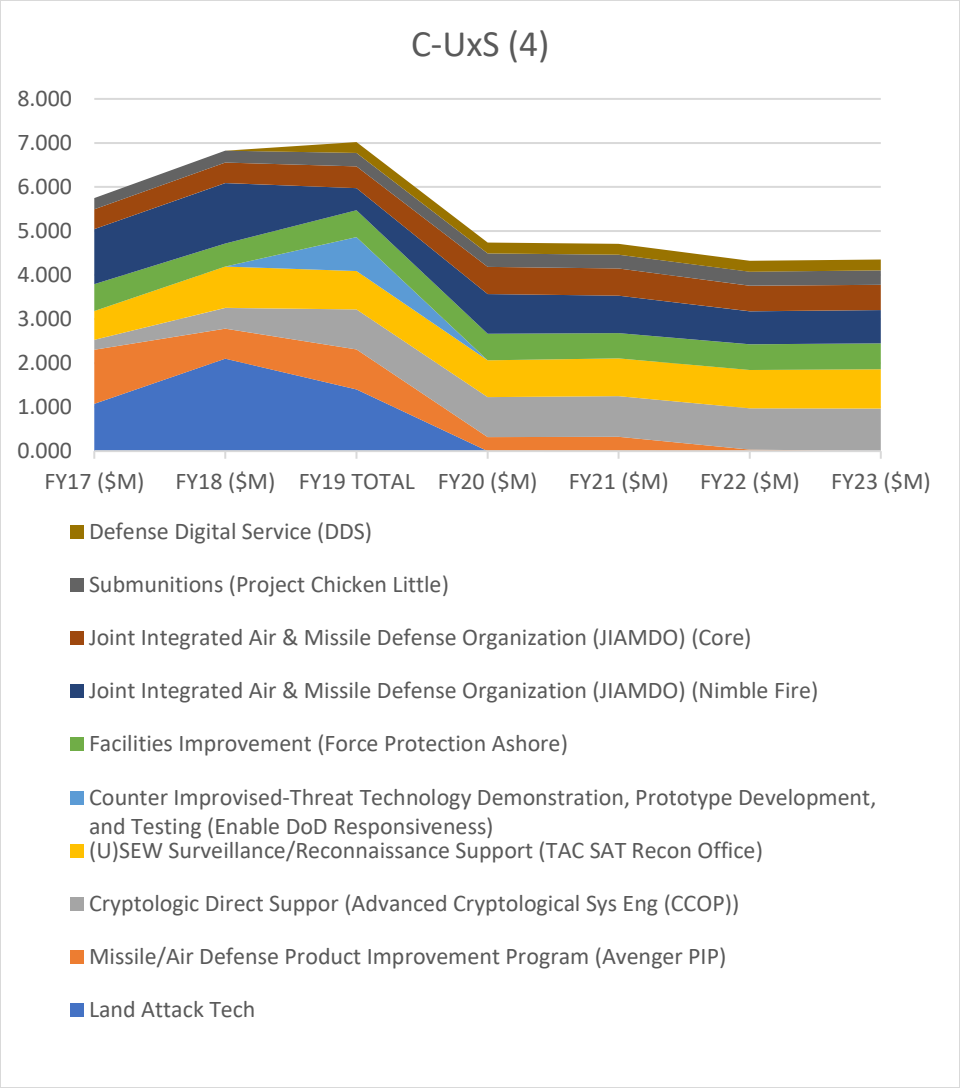


FIGURE 84: PROGRAMS SUPPORTING C-UXS

TABLE 74: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603795N	RDT&E	Land Attack Tech	Begin development and incremental testing of Counter-Unmanned Aerial System (C-UAS) software upgrade (MK 38 MOD 2, a minor caliber gun weapon system); Delivery of final Counter-UAS capability software release in FY19 OCO; FY 2018 to FY 2019 Increase/Decrease Statement: Decrease from FY 2018 to FY2019 due to nearing completion of efforts supporting Joint Urgent Operational Need (CC-0558) for Counter Unmanned Aerial Systems (CUAS).
US Army	0203801A	RDT&E	Missile/Air Defense Product Improvement Program (Avenger PIP)	The Avenger Air Defense System is a lightweight, ground-to-air missile and gun weapon system mounted on a High Mobility Multi-purpose Wheeled Vehicle. The Avenger's mission is to protect fixed critical assets and Corps/Echelons above Corps Maneuver forces from Unmanned Aircraft Systems (UAS), Cruise Missiles (CM),

				and Fixed Wing and Rotary Wing aircraft. The Avenger Modification - Service Life Extension Program (MOD-SLEP) addresses obsolescence of key Line Replaceable Units (LRUs) and ensures that Avenger is viable and sustainable through FY31, filling a capability gap to counter Unmanned Aircraft Systems (UAS), Cruise Missiles (CM), and Fixed Wing and Rotary Wing aircraft.
US Navy	0204574N	RDT&E	Cryptologic Direct Suppor (Advanced Cryptological Sys Eng (CCOP))	Counter-UAS efforts (FY18 OCO and continued in FY19): Funding will support development and integration efforts to fuse data produced and distributed by Shipboard IW / Information Operations (IO) systems with other intelligence data at multiple classification levels and provided to shipboard combat systems to support kinetic (bombs, mortars, missiles, bullets) and non-kinetic fires (electronic attack, lasers, cyber-attack) and can also be used to enable a more complete understanding and more agile and effective exploitation of the electromagnetic spectrum.
US Navy	1206867N	RDT&E	(U)SEW Surveillance/Reconnaissance Support (TAC SAT Recon Office)	Efforts include advanced sensors, platform and ground processing, and integrated national-to-tactical information fusion capabilities (to counter UAS among other capabilities) (previously funded under PE 0605867N - cell shaded blue represents this previous funding)
DTRA	0604134BR	RDT&E	Counter Improvised-Threat Technology Demonstration, Prototype Development, and Testing (Enable DoD Responsiveness)	Efforts in support of rapid development and prototyping to counter improvised threats such as UAS
US Navy	0603725N	RDT&E	Facilities Improvement (Force Protection Ashore)	Continue Installation Protection Capability Development - Airborne Threat project to detect, assess and classify for the defense against full-scale and man-deployable airborne threats (e.g., UAV, drones, remote-control [R/C] platforms.- Testing of three Counter UAS systems at NAWC China Lake.
TJS	0605126J	RDT&E	Joint Integrated Air & Missile Defense Organization (JIAMDO) (Nimble Fire)	Joint Distributed Engineering Plant (JDEP): Fund multiple, distributed test events to assess the interoperability of joint IAMD weapons systems with a focus on C-UAS capabilities to counter the emerging threat of Group 1 and 2 UAS. Continue to leverage live-fly data of the Black Dart technology demonstrations to develop scenarios that replicate the future operational environments.
TJS	0605126J	RDT&E	Joint Integrated Air & Missile Defense Organization (JIAMDO) (Core)	Efforts include Counter-UAS capabilities
USAF	0604604F	RDT&E	Submunitions (Project Chicken Little)	Exploit the signatures of ISR targets; capture and catalog multi-spectral signatures on asymmetric threat Unmanned Aerial Systems (UAS). (FY19)
WHS	0606589D8W	RDT&E	Defense Digital Service (DDS)	An example project provided in FY19 increase/decrease statement: devise a hard and software solution to counter Unmanned Aircraft Systems that attack warfighters in theater

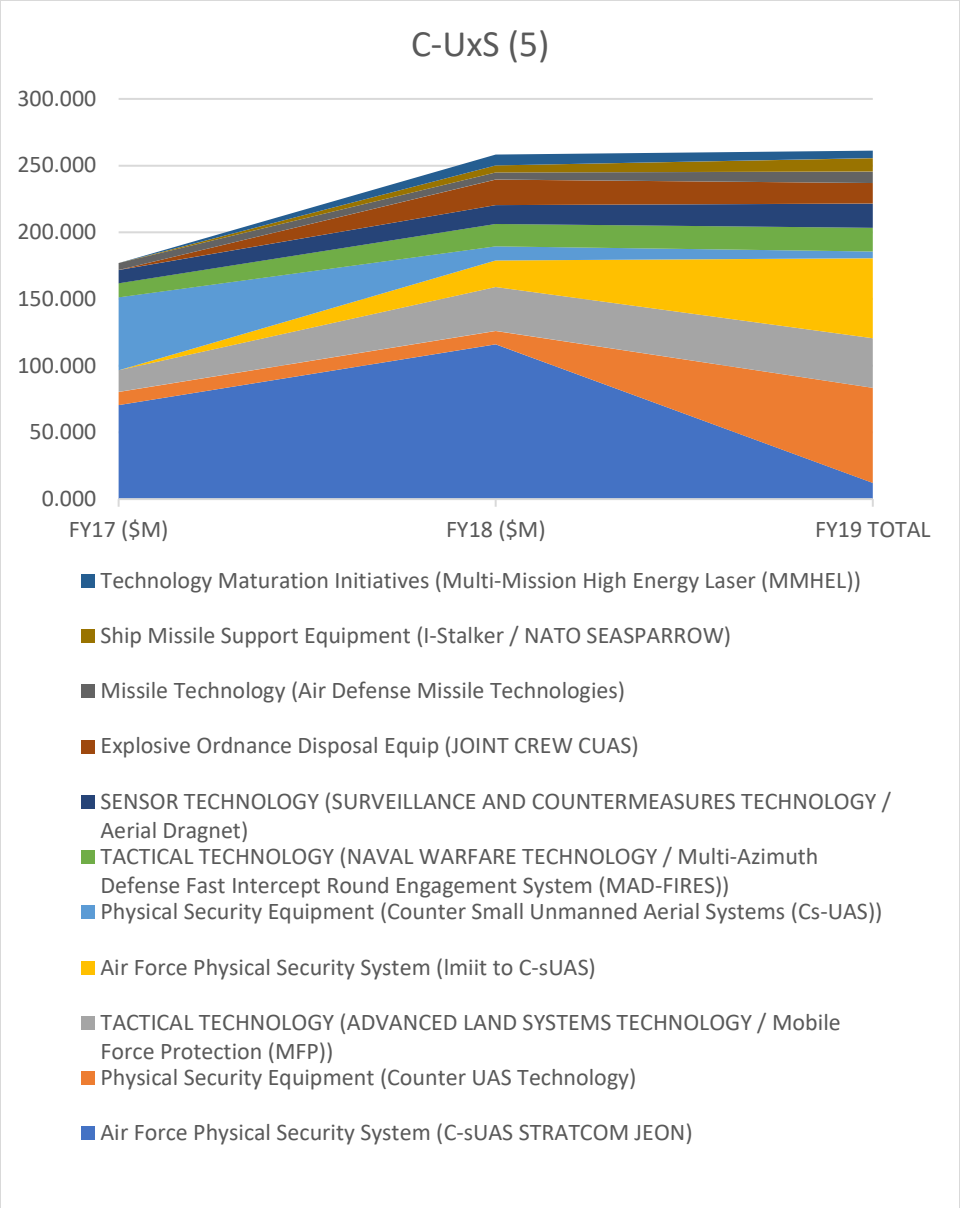


FIGURE 85: PROGRAMS SUPPORTING C-UXS

TABLE 75: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
USAF	834130	Procurement	Air Force Physical Security System (C-sUAS STRATCOM JEON)	Counter-UAS equipment
US Navy	8128	Procurement	Physical Security Equipment (Counter UAS Technology)	C-UAS systems

DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (ADVANCED LAND SYSTEMS TECHNOLOGY / Mobile Force Protection (MFP))	Mobile Force Protection (MFP): The goal of the Mobile Force Protection (MFP) program is to develop and demonstrate an integrated system capable of defeating a raid of self-guided small unmanned aircraft (sUAS) attacking a high value convoy on the move. FY 2019 Plans: - Conduct two open air demonstrations that will include advanced airborne threats and complex environmental factors. - Perform advanced modeling and simulation to validate system performance in operational environment. - Modify the end-to-end system to enable operations while on the move by reducing size, weight and power. - Finalize development of sub-systems that will be able to operate while on the move. - Validate graphic user interface that reduces manning false alarm rate, and reaction time. - Final update to affordability and cost analysis. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 increase reflects completion of detailed design and initiation of end-to-end system development and testing.
USAF	834130	Procurement	Air Force Physical Security System (C-sUAS)	Counter-UAS equipment
USAF	0604287F	RDT&E	Physical Security Equipment (Counter Small Unmanned Aerial Systems (Cs-UAS))	Counter Small Unmanned Aerial Systems (Cs-UAS) Joint Emergent Operational Need (JEON) - STRATCOM ($10.5M FY18): deployment capability existing of full kill (detect, track, assess and defeat with various capabilities (fixed, mobile, portable and hand-held.) It is a layered system-of-systems using COTS technologies, integrated via GOTS C2 system. (FY18: Complete Communication and Control (C2) and Fixed-Site DT/OT). Counter Small Unmanned Aerial Systems (Cs-UAS) Joint Urgent Operational Need (JUON)- EUCOM (no FY18 funding - FY17 only). Counter Small Unmanned Aerial Systems (Cs-UAS) Joint Urgent Operational Need (JUON) - CENTCOM (no FY18 funding - FY17 only). Counter Small Unmanned Aerial System (Cs-UAS) protection capabilities at downward selected high priority sites ($5M FY19): Research/development/integration into DE/laser options for C-sUAS defeat options. -Research/development/integration for passive and/or bistatic detection capabilities. -Continued research/development efforts into blue-force C-sUAS capabilities. -Research/development/integration for communicating up and down the C2 structure for C-sUAS SA and C2. -Integration of new/upgraded capabilities into our C-sUAS C2 system, and upgrades to our systems integration lab. -Incremental DT/OT required to verify/validate functional capabilities of newly integrated C-sUAS detect/track/id/defeat layers. -Development of C-sUAS technology roadmap. -Development/sustainment of signatures library.
DARPA	0602702E	RDT&E	TACTICAL TECHNOLOGY (NAVAL WARFARE TECHNOLOGY / Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES))	Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) program seeks to develop a point defense system against today's most stressing threats by developing a highly maneuverable, medium caliber, guided projectile, fire sequencing and control system capable of neutralizing large threat raids of high speed, highly maneuverable targets. MAD-FIRES, sized as a medium caliber system, enhances flexibility for installment as a new system and as an upgrade to existing gun systems with applications to various domain platforms across a multitude of missions to include: ship self-defense, precision air to ground combat, precision ground to ground combat, counter unmanned air vehicles (CUAV), and counter rocket and artillery and mortar (C-RAM).

DARPA	0603767E	RDT&E	SENSOR TECHNOLOGY (SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY / Aerial Dragnet)	Aerial Dragnet seeks to detect multiple small Unmanned Aerial Systems (UAS) in complex and/or urban terrain before they are within Line-Of-Sight (LOS) of friendly assets. FY 2018 Plans: - Conduct engineering subsystem tests to assess small UAS detection performance in an instrumented urban test area. - Complete development of initial hardware sensor payloads. - Evaluate software for non-line-of-sight UAS tracking and classification. - Demonstrate and test system performance over a neighborhood-sized urban area. FY 2019 Plans: - Update hardware sensor payloads to reduce size, weight, power, and cost. - Network multiple aerial surveillance platforms to increase coverage. - Develop autonomy algorithms to allow surveillance platforms to adapt to urban terrain. - Demonstrate and test the performance of the system in a multi-neighborhood-sized urban area. FY 2018 to FY 2019 Increase/Decrease Statement: The FY 2019 increase reflects the expanded integration and testing of the system.
US Navy	5509	Procurement	Explosive Ordnance Disposal Equip (JOINT CREW CUAS)	Counter-UAS equipment
US Army	0602303A	RDT&E	Missile Technology (Air Defense Missile Technologies)	Counter-UAS technology development including critical air defense interceptor technologies and components (mission computer, power system, control actuation system, software algorithms for common targeting across multiple systems such as radar/EO/IR/acoustic sensors)
US Navy	5231	Procurement	Ship Missile Support Equipment (I-Stalker / NATO SEASPARROW)	Situational awareness to support C-UAS and C-USV
US Army	0604115A	RDT&E	Technology Maturation Initiatives (Multi-Mission High Energy Laser (MMHEL))	This effort matures and integrates a 50 kW-class laser system into a Stryker platform, providing a system-level, High Energy Laser (HEL) experimental prototype for demonstration in realistic operating environments (capable of Counter-UAS)

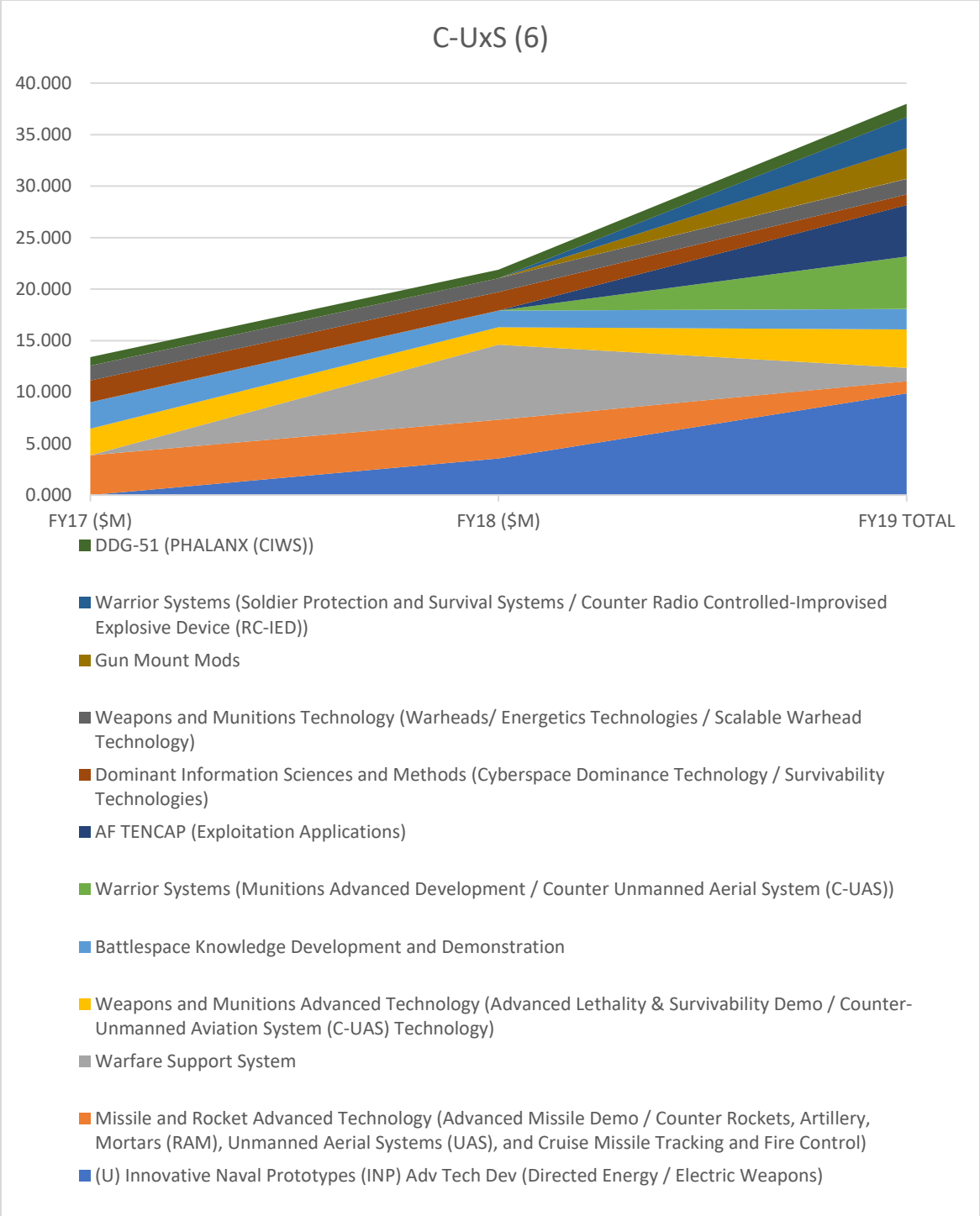


FIGURE 86: PROGRAMS SUPPORTING C-UXS

TABLE 76: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes

US Navy	0603801N	RDT&E	(U) Innovative Naval Prototypes (INP) Adv Tech Dev (Directed Energy / Electric Weapons)	Solid State Laser Technology development to support defense against small boats/UAV swarms and ISR disruption/defeat
US Army	0603313A	RDT&E	Missile and Rocket Advanced Technology (Advanced Missile Demo / Counter Rockets, Artillery, Mortars (RAM), Unmanned Aerial Systems (UAS), and Cruise Missile Tracking and Fire Control)	Will exploit data gathered from multi-mission radar and other sensors in order to mature algorithm to autonomously detect, track, identify, rank and defeat counter-Unmanned Aerial System threat.
US Navy	0604230N	RDT&E	Warfare Support System	CUAS Joint Urgent Operational Need (JUON) to identify, assess, integrate and test prototype technologies supporting NSW deployed forces encountering the proliferation of unconventional, unmanned system threats by non-state actors. Efforts will focus on continuing advancement of FY18 prototyping efforts and field evaluation of developed technologies.
US Army	0603004A	RDT&E	Weapons and Munitions Advanced Technology (Advanced Lethality & Survivability Demo / Counter-Unmanned Aviation System (C-UAS) Technology)	Integrate matured C-UAS technologies, to include precision fire control radar and small caliber munitions, onto a common weapons platform to form a system of systems for UAS detection, tracking, and defeat; perform system integration evaluations and validate the fire control radar and software for the UAS kill chain; update modeling and simulation tools based on collected data. (FY18) Will demonstrate integrated small (0.50) caliber counter UAS technologies at a live fire event; will demonstrate the ability to track outgoing rounds and incorporate data into fire control solution; will mature and demonstrate guided medium caliber armament system initially created through DARPA effort to search, identify, track and intercept maneuvering threats; will improve fire control and guidance algorithms for C-UAS/Air Defense scenarios; will optimize kinetic armament system components design for integration on a ground vehicle platform. (FY19) Increase due to fund efforts to validate radar technology capabilities and optimize integration of C-UAS system into a ground platform.
USAF	0603788F	RDT&E	Battlespace Knowledge Development and Demonstration	Cyber Offense: in FY19, Facilitate the development of a counter small unmanned aerial system open architecture specification to enable interoperability between disparate protection systems. Demonstrate ground-based and airborne delivery of mitigation (disrupt, deny, degrade, destroy, or deceive) effects, both cyber and physical/kinetic. Integrate and transition multiple Air Force Research Laboratory and Air Force Lifecycle Management Center counter small unmanned aerial system capabilities.
SOCOM	1160431BB	RDT&E	Warrior Systems (Munitions Advanced Development / Counter Unmanned Aerial System (C-UAS))	FY19: This funding will support the development, procurement and evaluation of High Velocity 40mm High Explosive Air Bursting Ammunition to be used with for use with MK-47 automatic grenade launcher. Improving the air-Bursting capability of this currently fielded weapon system will expeditiously provide kinetic Counter-Unmanned Aerial System (C-UAS) capabilities to the Warfighter.
USAF	1202247F	RDT&E	AF TENCAP (Exploitation Applications)	Will complete development and test of counter-unmanned aerial system prototype. (FY19 OCO only)

USAF	0602788F	RDT&E	Dominant Information Sciences and Methods (Cyberspace Dominance Technology / Survivability Technologies)	Continue to research concepts and capabilities for cyber survivability techniques and algorithms for counter-unmanned aerial systems. Design and develop a counter-unmanned aerial systems open architecture to enable interoperability. (FY19)
US Army	0602624A	RDT&E	Weapons and Munitions Technology (Warheads/ Energetics Technologies / Scalable Warhead Technology)	Novel designs that can enable multi-role munitions for Counter-UAS and Counter-Rocket/Artillery/Mortar such as shaped charge (SC) and multi explosively formed penetrators
US Navy	4217	Procurement	Gun Mount Mods	Improvement to MK38 Machine Gun System for C-UAS operations
SOCOM	1160431BB	RDT&E	Warrior Systems (Soldier Protection and Survival Systems / Counter Radio Controlled-Improvised Explosive Device (RC-IED))	FY 2019 OCO Plans: Continues the development of Counter - Unmanned Aerial Systems (C-UAS) technology and integration efforts in support of named operations.
US Navy	2122	Procurement	DDG-51 (PHALANX (CIWS))	Autonomous combat system that engages threats including UAS through integration of FLIR sensor

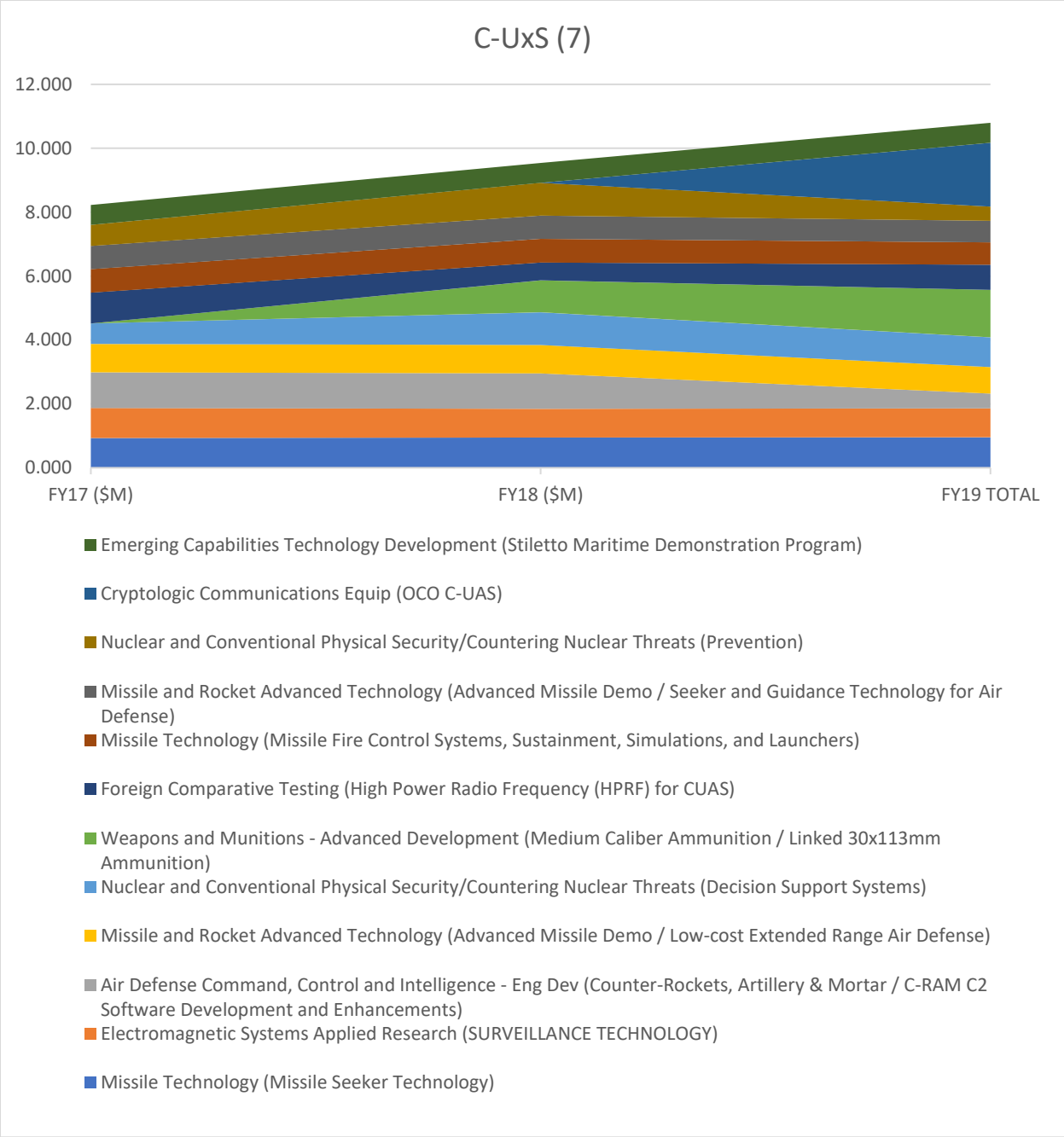


FIGURE 87: PROGRAMS SUPPORTING C-UXS

TABLE 77: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
US Army	0602303A	RDT&E	Missile Technology (Missile Seeker Technology)	Fabricate and evaluate technologies that support a low cost, strap down, active, electro-optic seeker system for counter unmanned aerial systems (UAS) and counter ground target missiles; design concepts for a multi-band active optical tracker

				that laser-designates small UAS to increase probability of defeat for seeker based kinetic weapons. (FY19)
US Navy	0602271N	RDT&E	Electromagnetic Systems Applied Research (SURVEILLANCE TECHNOLOGY)	Developing advanced signal processing techniques for the detection and discrimination of small UAS in a clutter filled environment
US Army	0604741A	RDT&E	Air Defense Command, Control and Intelligence - Eng Dev (Counter-Rockets, Artillery & Mortar / C-RAM C2 Software Development and Enhancements)	Test and validate C-UAS interoperability requirements (FY18); Implement C-UAS and M-SHORAD initiatives (FY19)
US Army	0603313A	RDT&E	Missile and Rocket Advanced Technology (Advanced Missile Demo / Low-cost Extended Range Air Defense)	Development of counter UAS technologies
OSD	0603161D8Z	RDT&E	Nuclear and Conventional Physical Security/Countering Nuclear Threats (Decision Support Systems)	In FY19, Develop a counter unmanned underwater, surface and ground vehicle Investment Guides
US Army	0603639A	RDT&E	Weapons and Munitions - Advanced Development (Medium Caliber Ammunition / Linked 30x113mm Ammunition)	30x113mm Linked Ammunition for use in existing M788 and M789 ammunition and develop airburst capable munitions fired from the Lightweight 30x113mm Link Fed Chain Gun (to counter the rapidly evolving threat of Unmanned Aerial Systems)
OSD	0603133D8Z	RDT&E	Foreign Comparative Testing (High Power Radio Frequency (HPRF) for CUAS)	High Power Radio Frequency (HPRF) for Counter-UAS (Navy/USMC): in FY19, Conduct Phase II system level testing against UAS 2Q FY 2019. Complete final test and closeout reports by end of 3Q FY 2019. If successful, an operational prototype will be available as a Quick Reaction Capability in support of urgent needs and results will inform various program office acquisition decisions.
US Army	0602303A	RDT&E	Missile Technology (Missile Fire Control Systems, Sustainment, Simulations, and Launchers)	Investigate a radar employing a Low Probability of Intercept chaotic waveform to detect and track small Unmanned Aircraft System (UAS); further develop UAS modeling validation processes with establishment of radio frequency (RF) predictive methodologies. (FY18)
US Army	0603313A	RDT&E	Missile and Rocket Advanced Technology (Advanced Missile Demo / Seeker and Guidance Technology for Air Defense)	Development of counter UAS technologies
OSD	0604161D8Z	RDT&E	Nuclear and Conventional Physical	Prevention: in FY19, Continue to develop a counter Unmanned Underwater / Surface / Ground Vehicle technology roadmap.

			Security/Countering Nuclear Threats (Prevention)	
US Navy	3501	Procurement	Cryptologic Communications Equip (OCO C-UAS)	Joint Urgent Operational Need for C-UAS
OSD	0603699D8Z	RDT&E	Emerging Capabilities Technology Development (Stiletto Maritime Demonstration Program)	FY17 Stiletto maritime demonstration program included Counter-UUV and maritime ISR from UAVs; FY18 includes improved decision making for autonomous vehicles.

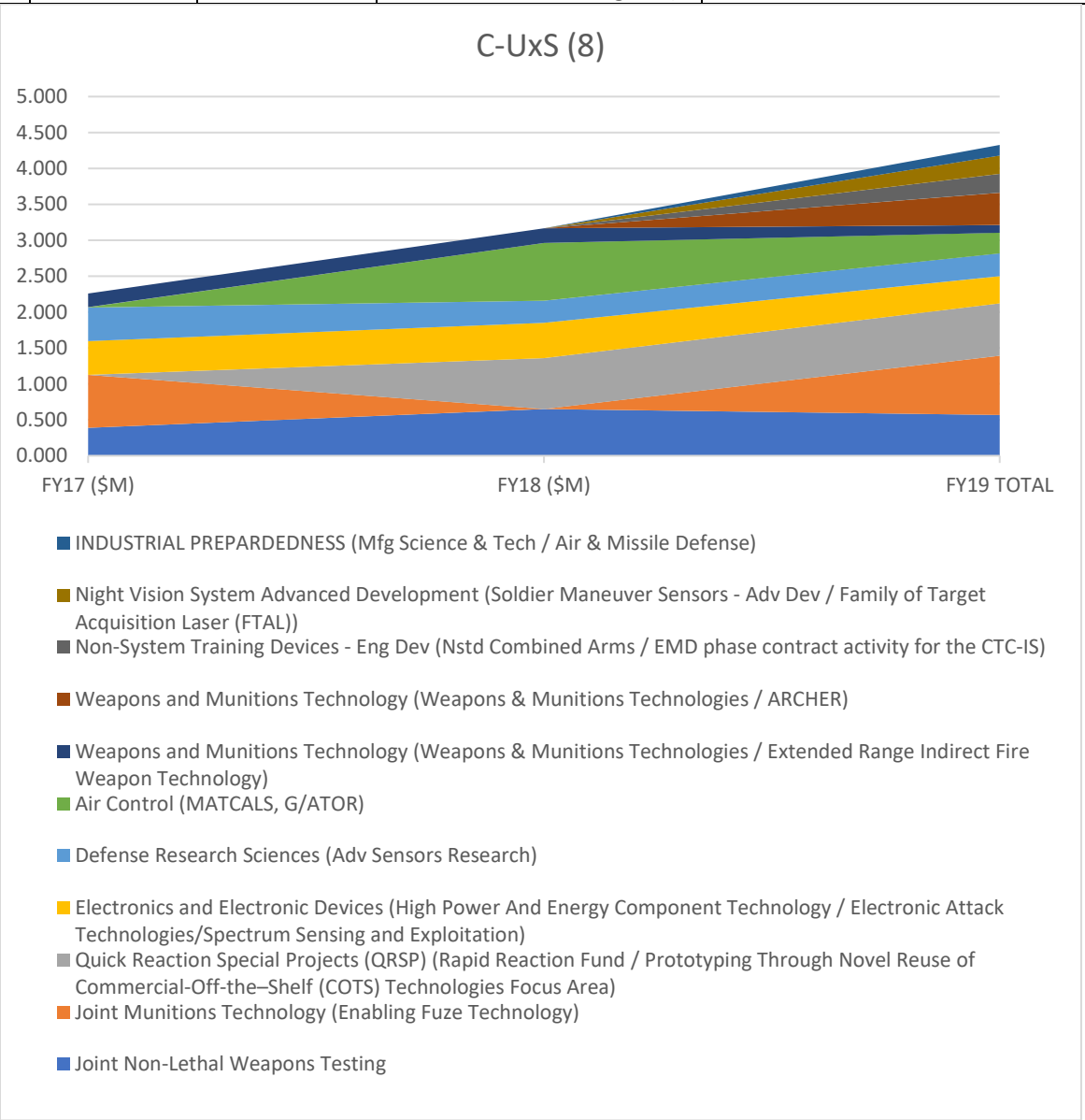


FIGURE 88: PROGRAMS SUPPORTING C-UXS

TABLE 78: LISTING OF PROGRAMS SUPPORTING C-UXS

Organization	PE Number	Funding Type	Title	Notes
US Navy	0603851M	RDT&E	Joint Non-Lethal Weapons Testing	Completed the 2017 NATO Non-Lethal Technology Concept Development Game and Tabletop Exercise - Counter Unmanned Aerial Systems (NNTEX-17C) (FY18); Complete the 2018 NATO Non-Lethal Technology Exercise - CUAS (NNTEX-18C) (FY19)
OSD	0602000D8Z	RDT&E	Joint Munitions Technology (Enabling Fuze Technology)	In FY19, Develop non-RF detection and advanced algorithm technologies for fuzing applications for Counter-UAS weapons.
OSD	0603826D8Z	RDT&E	Quick Reaction Special Projects (QRSP) (Rapid Reaction Fund / Prototyping Through Novel Reuse of Commercial-Off-the–Shelf (COTS) Technologies Focus Area)	Projects identified include airport radar systems for bird alerts repurposed for counter-unmanned aircraft system (UAS) (FY18)
US Army	0602705A	RDT&E	Electronics and Electronic Devices (High Power And Energy Component Technology / Electronic Attack Technologies/Spectrum Sensing and Exploitation)	Develop multi-device waveform packages for counter unmanned aerial vehicle (CUAS) EA applications (FY18); develop neutralization techniques for autonomous vehicles
US Army	0601102A	RDT&E	Defense Research Sciences (Adv Sensors Research)	Counter-UAS threat modeling and detection; EO sensors for robust target classification
US Navy	0604504N	RDT&E	Air Control (MATCALS, G/ATOR)	Ground/Air Task Oriented Radar System (G/ATOR) providing 3D surveillance of threats such as UAS
US Army	0602624A	RDT&E	Weapons and Munitions Technology (Weapons & Munitions Technologies / Extended Range Indirect Fire Weapon Technology)	Advance the capability of state of the art in fuze proximity sensors to track targets in order to improve burst point accuracy and countermeasure robustness (support Counter-UAS among other things)
US Army	0602624A	RDT&E	Weapons and Munitions Technology (Weapons & Munitions Technologies / ARCHER)	Develops advanced fire control algorithms and a multirole warhead guided projectile for area defense against medium (Groups 2 and 3) sized unmanned aerial systems (UAS) and other threats: investigate and mature command guided, medium caliber projectile designs on a tactical turret platform; will research and develop novel warhead and projectile stabilization architectures; will conduct lab experiments to mature designs of projectile critical components; will validate reliability, functionality and performance of various projectile component technologies; will research the target defeat effectiveness of material solutions for various concepts and develop algorithms based on armament system requirements.

US Army	0604715A	RDT&E	Non-System Training Devices - Eng Dev (Nstd Combined Arms / EMD phase contract activity for the CTC-IS)	FY19 Base RDTE dollars in the amount of $1.052 million will fund post deployment software support to pursue changes to current software to stimulate sensors, replicate counter measures that US forces will use against small Unmanned Aerial Systems (UAS), support selective jamming of GPS without impacting the instrumentation use of GPS, and selectively jam radars such as support for suppression of enemy Air Defense Artillery.
US Army	0603774A	RDT&E	Night Vision System Advanced Development (Soldier Maneuver Sensors - Adv Dev / Family of Target Acquisition Laser (FTAL))	Initiate development and integration of modular target acquisition laser components. (for Counter-UAS among other applications)
US Army	0708045A	RDT&E	INDUSTRIAL PREPARDEDNESS (Mfg Science & Tech / Air & Missile Defense)	Support areas such as High Energy Laser system components (e.g. diodes, optics), interceptor components, and armament systems for counter-unmanned aerial systems and counter-rocket, artillery, and mortar systems.

Budget Document Sources

Service	Type	Title	URL	NO MENTION of UxVs
US Army	Procurement	Aircraft (ACFT)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_ACFT.pdf	
US Army	Procurement	Missile (MSLS)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_MSLS.pdf	
US Army	Procurement	Weapons & Tracked Combat Vehicles (WTCV)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_WTCV.pdf	
US Army	Procurement	Ammunition (AMMO)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_AMMO.pdf	
US Army	Procurement	Other Procurement Army (OPA) 1 - Tactical & Support Vehicles	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_OPA1.pdf	
US Army	Procurement	Other Procurement Army (OPA) 2 - Communications & Electronics	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_OPA2.pdf	
US Army	Procurement	Other Procurement Army (OPA) 3 - Other Support Equipment	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_OPA34.pdf	
US Army	Procurement	Other Procurement Army (OPA) 4 - Initial Spares	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/procurement/PB19_OPA34.pdf	
US Army	Procurement	Chemical Agents and Munitions Destruction, Defense (CAMD,D)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/camdd/PB19_CAMDD.pdf	X
US Army	RDT&E	Budget Activity 1 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_1.pdf	
US Army	RDT&E	Budget Activity 2 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_2.pdf	
US Army	RDT&E	Budget Activity 3 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_3.pdf	
US Army	RDT&E	Budget Activity 4 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_4.pdf	
US Army	RDT&E	Budget Activity 5A (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_5A.pdf	
US Army	RDT&E	Budget Activity 5B (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_5B.pdf	

US Army	RDT&E	Budget Activity 6 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_6.pdf	
US Army	RDT&E	Budget Activity 7 (RDTE)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/army/rdte/PB19_RDTE_BA_7.pdf	
USN	Procurement	Weapons Procurement, Navy	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/WPN_Book.pdf	
USN	Procurement	Shipbuilding and Conversion, Navy	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/SCN_Book.pdf	
USN	Procurement	Procurement Marine Corps	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/PMC_Book.pdf	
USN	Procurement	Aircraft Procurement, Navy (BA 1 - 4)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/APN_BA1-4_BOOK.pdf	
USN	Procurement	Aircraft Procurement, Navy (BA 5)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/APN_BA5_BOOK.pdf	
USN	Procurement	Aircraft Procurement, Navy (BA 6)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/APN_BA6_BOOK.pdf	
USN	Procurement	Aircraft Procurement, Navy (BA 7)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/APN_BA7_BOOK.pdf	
USN	Procurement	Other Procurement, Navy (BA 1)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/OPN_BA1_BOOK.pdf	
USN	Procurement	Other Procurement, Navy (BA 2)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/OPN_BA2_BOOK.pdf	
USN	Procurement	Other Procurement, Navy (BA 3)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/OPN_BA3_BOOK.pdf	
USN	Procurement	Other Procurement, Navy (BA 4)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/OPN_BA4_BOOK.pdf	
USN	Procurement	Other Procurement, Navy (BA 5 - 8)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/OPN_BA_5-8_Book.pdf	
USN	RDT&E	Research & Development, Navy (BA 1 - 3)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/RDTEN_BA1-3_BOOK.pdf	
USN	RDT&E	Research & Development, Navy (BA 4)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/RDTEN_BA4_Book.pdf	
USN	RDT&E	Research & Development, Navy (BA 5)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/RDTEN_BA5_Book.pdf	
USN	RDT&E	Research & Development, Navy (BA 6)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/RDTEN_BA6_book.pdf	
USN	RDT&E	Research & Development, Navy (BA 7)	http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/RDTEN_BA7_book.pdf	
USAF	Procurement	Air Force Aircraft Procurement Vol I FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Aircraft%20Procurement%20Vol%20I%20FY19.pdf?ver=2018-02-13-093541-153	
USAF	Procurement	Air Force Aircraft Procurement Vol II Mods FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Aircraft%20Procurement%20Vol%20II%20Mods%20FY19.pdf?ver=2018-02-13-093538-670	
USAF	Procurement	FY19 Air Force Ammunition Procurement	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Ammunition%20Procurement%20FY19.pdf?ver=2018-02-12-190218-680	
USAF	Procurement	FY19 Air Force Missile Procurement	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Missile%20Procurement%20FY19.pdf?ver=2018-02-12-190220-227	
USAF	Procurement	FY19 Air Force Other Procurement	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Other%20Procurement%20FY19.pdf?ver=2018-02-12-190222-273	
USAF	Procurement	FY19 Air Force Space Procurement	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/Proc/Air%20Force%20Space%20Procurement%20FY19.pdf?ver=2018-02-12-190223-850	X

USAF	RDT&E	Air Force Research Development Test and Evaluation Vol I FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/RDT_E/Air%20Force%20Research%20Development%20Test%20and%20Evaluation%20Vol%20I%20FY19.pdf?ver=2018-02-13-094324-170	
USAF	RDT&E	Air Force Research Development Test and Evaluation Vol II FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/RDT_E/Air%20Force%20Research%20Development%20Test%20and%20Evaluation%20Vol%20II%20FY19.pdf?ver=2018-02-13-094316-763	
USAF	RDT&E	Air Force Research Development Test and Evaluation Vol IIIa FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/RDT_E/Air%20Force%20Research%20Development%20Test%20and%20Evaluation%20Vol%20IIIa%20FY19.pdf?ver=2018-02-13-094320-560	
USAF	RDT&E	Air Force Research Development Test and Evaluation Vol IIIb FY19.pdf	http://www.saffm.hq.af.mil/Portals/84/documents/FY19/RDT_E/Air%20Force%20Research%20Development%20Test%20and%20Evaluation%20Vol%20IIIb%20FY19.pdf?ver=2018-02-13-094324-170	
CBDP	Procurement	Chemical and Biological Defense Program (CBDP)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/01_CBDP_FY19_PB-Procurement_Exhibits.pdf	
DCAA	Procurement	Defense Contract Audit Agency (DCAA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/02_DCAA_FY19_PB_Procurement.pdf	X
DCMA	Procurement	Defense Contract Management Agency (DCMA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/03_DCMA_PROCUREMENT_MasterJustificationBook_PB_2019.pdf	X
DHRA	Procurement	DoD Human Resources Activity (DHRA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/04_DHRA_FY2019_Procurement_J-Book.pdf	X
DISA	Procurement	Defense Information Systems Agency (DISA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/05_DISA_PB19_PROC_J-Book.pdf	X
DLA	Procurement	Defense Logistics Agency (DLA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/06_DLA_0300_FY19_PB.pdf	X
DMACT	Procurement	Defense Media Activity (DMACT)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/07_DMA_Procurement_J-Book_PB19.pdf	X
DDE	Procurement	Department of Defense Education Activity (DoDEA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/11_DODEA_PROCUREMENT_PB19.pdf	X
DPA	Procurement	Defense Production Act Purchases (DPAP)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/08_DPA_PB19.pdf	X
DSS	Procurement	Defense Security Service (DSS)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/09_DSS_FY19_PB_BA01_0300.pdf	X
DTRA	Procurement	Defense Threat Reduction Agency (DTRA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/10_DTRA_PROCUREMENT_MasterJustificationBook_PB_2019.pdf	X
OSD	Procurement	Office of the Secretary of Defense (OSD)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/12_OSD_FY19_PB_Procurement.pdf	UAS mentioned but no recent funding
TJS	Procurement	The Joint Staff (TJS)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/13_TJS_0300_FY19%20PB.pdf	could not confirm funding

USS	Procurement	United States Special Operations Command (SOCOM)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/14_USSOCOM_FY19%20PB_%200300_PROC_J-Book.pdf	
WHS	Procurement	Washington Headquarters Service (WHS)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/15_WHS_FY19_PB_Procurement.pdf	
JIT	Procurement	Joint Improvised-Threat Defeat Fund (JIDF)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/17_JIDF_Procurement_PB19.pdf	X
MDA	Procurement	Missile Defense Agency	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/02_Procurement/U_PROCUREMENT_MasterJustificationBook_Missile_Defense_Agency_PB_2019_1.pdf	X
DARPA	RDT&E	Defense Advanced Research Projects Agency (DARPA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/DARPA_RDTE_MasterJustificationBook_Defense_Advanced_Research_Projects_Agency_PB_2019.pdf	
MDA	RDT&E	Missile Defense Agency (MDA)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/U_RDTE_MasterJustificationBook_Missile_Defense_Agency_PB_2019_1.pdf	
OSD	RDT&E	Office of the Secretary of Defense (OSD)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/RDTE_DAs_Vol_3A_of_5_OSD_FY19PB-RDTE_Exhibits_BA1-3.pdf	
OSD	RDT&E	Office of the Secretary of Defense (OSD)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/RDTE_DAs_Vol_3B_of_5_OSD_FY19PB-RDTE_Exhibits_BA4-7.pdf	
CBDP	RDT&E	Chemical and Biological Defense Program (CBDP)	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/RDTE_DAs_Vol_4_of_5_CBDP_FY19PB-RDTE_Exhibits.pdf	
OTHER	RDT&E	ALL OTHER	http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/budget_justification/pdfs/03_RDT_and_E/RDTE_DAs_Vol_5_of_5_RDTE_MasterJustificationBook_Defense-Wide_PB_2019.pdf	