Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Office of the Secretary Of Defense	Date: May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	11.762	15.152	18.221	-	18.221	-	-	-	-	-	-
245: *EW Enterprise Exploration and Innovation*	-	11.762	15.152	18.221	-	18.221	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The electromagnetic spectrum (EMS) environment (EME) is the largest and most complex warfighting environment because it is universally pervasive, largely unseen, and can only be perceived through the use of advanced electronic technologies. Understanding and addressing EME warfighting challenges is essential to all military operations because it is through the use of EMS technologies that we perceive operational realities - the state and disposition of all military and nonmilitary forces and groups within operational environments - and coordinate all actions of our military forces.

Historically, the United States has had significant technological advantages in EMS warfighting technologies, specifically sensors, communications, and countermeasures. This is no longer the case in many technology areas due to the rapid commercialization of advanced electronic systems and components, the broad proliferation of these technologies, and the concurrent rise of cyber-related EMS technologies. Potential adversaries have leveraged these advances to develop and field competing and asymmetric capabilities to offset historic U.S. advantages. These efforts have made U.S. operations in the EMS and cyberspace significantly more difficult, and they continue to do so at an accelerating rate. Adversary radars are evolving from fixed analog systems to programmable digital variants with agile waveforms and unknown behaviors making preprogrammed electronic countermeasure less effective. Foreign developments include new generations of challenging threats ranging from small unmanned air systems and easily transportable Man-Portable Air Defense Systems (MANPADS) to dedicated anti-access area denial (A2/AD) military systems including integrated air defense systems and increasingly capable cruise and ballistic missiles that have incorporated the most advanced sensors, communication and electromagnetic warfare (EW) technologies.

The accelerating pace of technological innovation has fast-tracked the rate at which new EMS and cyber threats are appearing. Concurrently, the effective operational lifetime of many advanced technologies is decreasing. For these reasons, the Department of Defense (DOD) must develop and field new EW and EW-cyber capabilities quicker and at much lower costs.

The Joint Electronic Advanced Technology (JEAT) Program was established to address these challenges through efforts designed to substantially accelerate the development and maturing of innovative technologies to address these EW and EW-Cyber warfighting challenges and enable the development, new leap-ahead EMS warfighting capabilities for U.S. warfighters. The program specifically focuses on EW and EW-Cyber-related technologies that fall outside the Services' purviews or are not being developed quickly enough.

PROJECT CODE 245, ELECTRONIC WARFARE ENTERPRISE EXPLORATION AND INNOVATION (EW E&I)

EW E&I research efforts identify, explore, and accelerate the maturing and demonstration of new EW- and EW-cyber related technologies. Technologies enabling and/or supporting all areas of electromagnetic spectrum warfare (EW) are covered including electromagnetic attack (EA), electromagnetic protection (EP), and

electromagnetic support (ES). EW E&I research is performed in state-of-the-art laboratories and validated side-by-side with competing developmental technologies from the Services, National laboratories, industry and academia in field environments under real-world conditions to meeting EW and EW-Cyber warfighting needs and providing leap-ahead EW and EW-Cyber capabilities.

EW E&I includes efforts focusing specifically on EW-Cyber-related technologies in a sub-project designated EW-Cyber Interface (EWCI). EWCI efforts specifically focus on develop and advance the technological bases for “over-the-air” algorithmic warfare utilizing existing and new generations of EW-Cyber technologies and systems.

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	12.063	15.164	15.425	-	15.425
Current President's Budget	11.762	15.152	18.221	-	18.221
Total Adjustments	-0.301	-0.012	2.796	-	2.796
• Congressional General Reductions	-	-0.012			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.301	-			
• Program Adjustment	-	-	2.796	-	2.796

Change Summary Explanation

The FY 2022 increase supports additional Electronic Warfare/Cyber efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense											Date: May 2021	
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603618D8Z / *Joint Electronic Advanced Technology*				Project (Number/Name) 245 / *EW Enterprise Exploration and Innovation*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
245: *EW Enterprise Exploration and Innovation*	-	11.762	15.152	18.221	-	18.221	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Project Code 245, Electronic Warfare Enterprise Exploration and Innovation (EW E&I) research efforts identify, explore, and accelerate the maturing and demonstration of new EW- and EW-Cyber-related technologies. Significant advances in all of the areas impacting EW and EW-cyber have resulted in new generations of threat systems that are challenging the traditional dominance the U.S. has had in these areas. These advances also provide opportunities to develop new generations of overmatch EW and EW-Cyber capabilities for U.S. warfighters.

While there are a wide variety of potential investment areas within this technology tradespace, the Joint Electronic Advanced Technology (JEAT) Program focuses on specific areas where Service investments are lagging to accelerate the development and advancement of technologies that will benefit warfighters across multiple Services and operational domains. The JEAT Program's current EW E&I thrusts include Passive Sensor Detection and Defeat, Platform Self-Protection, EW Technology Enablers, EW-Cyber Interface (EWCI), and EW Collaboration and Cognizance.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2020**	**FY 2021**	**FY 2022**
Title: EW Enterprise Exploration and Innovation (EW E&I)	11.762	15.152	18.221
Description: EW E&I research efforts identify, explore and accelerate the maturing and demonstration of new EW- and EW-Cyber-related technologies. Current EW E&I initiatives research thrusts include Passive Sensor Detection and Defeat (PSDD), Platform Self-Protection (PS-P), EW Technology Enablers (EW Tech), EW-Cyber Interface (EWCI) and EW Collaboration and Cognizance (EW C&C). Passive Sensor Detection and Defeat (PSDD): Modern integrated air defense systems (IADS) employ a variety of radar sensing technologies to detect, target and engage adversary aircraft. While classic IADS radars emitted radiofrequency radiation and collected the radiation reflected off targets within their field of view with the same aperture, computational advances have enabled passive (non-emitting) radar collectors to capture the reflected (radar) radiation and provide targeting solutions to engagement assets (missiles, aircraft, directed energy, etc.). Because these passive systems emit no radiation, current EW countermeasures (jamming and other EW techniques) cannot be effectively employed against them. This leaves U.S. aircraft attacking such IADS architectures vulnerable to unforeseen attacks. PSDD research identifies, explores and accelerates the maturing and demonstration of new technologies to provide defensive capabilities against these passive sensors. The initial PSDD goal is to develop and validate the technologies that will enable the development of a single user-configurable payload to can deliver multiple EW and EW-Cyber effects against passive systems.			

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Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603618D8Z / *Joint Electronic Advanced Technology*	**Project (Number/Name)** 245 / *EW Enterprise Exploration and Innovation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022

Platform Self-Protection (PS-P): A wide variety of radiofrequency (RF) and electro-optical (EO) technologies are employed by modern militaries to enable the engagement and negation of attacking military systems. RF sensor systems including IADS radars and radars on ships, aircraft, ground and naval vessels and engagement missiles (ballistic, cruise, air-to-air, surface-to-air, etc.) are used to detect and provide targeting and engagement solutions to counter adversaries' military capabilities. EO systems are incorporated into missile seekers and also associated with high energy laser engagement systems being fielded by near peer adversaries. To ensure successful U.S. military actions, technologies that protect U.S. platforms and facilities against these new generations of much more capable RF and EO detection/targeting/engagement sensors and seekers are essential. This thrust identifies, explores, and accelerates the maturing and demonstration of new technologies to counter adversaries' advanced RF and EO sensor and seeker threats. To begin identifying the most significant developmental opportunities, JEAT issued a Response for Information (RFI) call in FY 2020.

Electromagnetic Warfare Technology Enablers (EW Tech): Significant advances in materials, electronics (including photonics, plasmonics, spintronics, magnetronics, etc.), RF and communications sciences, optical and laser sciences, and information and computational sciences are enabling new generations of extremely powerful applications in a wide variety of fields. For example, artificial intelligence and machine learning (AI/ML) technologies are beginning to impact electromagnetic spectrum (EMS) operations. The advantages that AI/ML approaches can provide are considerable, but multiple runs addressing the same scenarios often provide disparate results for both the same assets in the same scenarios and for different assets in different locations within the scenarios. Ascertaining the optimal employment tactics and strategies thus becomes difficult for offensive and defensive operations in both proactive and reactive EW modes. EW Tech research seeks to leverage these advances to enable commensurate advances in the EW and EW-Cyber warfighting realms.

EW-Cyber Interface (EWCI): EWCI is a sub-project within EW E&I focusing specifically on EW-Cyber-related technologies). Leveraging technologies from other EW- and Cyber-related technology development efforts within the JEAT Program and across the (DOD), EWCI efforts develop and advance the technological bases for "over-the-air" algorithmic warfare utilizing existing and new generations of EW-Cyber technologies and systems.

EW Collaboration and Cognizance (EW C&C): EW C&C research efforts focus on maintaining an awareness of global research and development (R&D) efforts impacting EMS, EW and EW-Cyber warfighting technologies; guiding, facilitating, ensuring collaboration and providing the Office of the Secretary of Defense (OSD) oversight of technology development efforts across the DOD EW and EW-Cyber developmental communities; and providing key insights to senior leaders and decision-makers so they can more effectively direct all Department EW and EW-Cyber technology development programs and processes.

FY 2021 Plans:

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Passive Sensor Detection and Defeat (PSDD): • Research efforts leveraging AI/ML technologies to provide improved, more accurate characterization of emitters within the EMS (detection, classification and geolocation) will enhance and accelerate the development of technologies to provide greater electromagnetic protection (EP) and enable electromagnetic attack (EA) against passive sensors. Current efforts were identified in JEAT's EW Request for Information (RFI), which was completed in late 2020. o OX EYE will explore technologies to counter adversary attempts to deceive U.S. cognitive and autonomous operations capabilities. o RADEC, the RF Ensemble Classifier (RADEC), will explore AI/ML approaches to facilitate the rapid, accurate detection, identification, and geolocation of foreign RF emitters of interest. • Technologies developed in these and other efforts across DOD will be explored side-by-side with other developmental technologies in the SILENT HAMMER 2 (SH-2) field experimentation venue under very complex EM environment conditions. This venue was designed to identify the technologies that show the greatest potential for addressing passive sensor threats. Twice as many experiment teams are participating in SH-2 as there were in the first venue in this series of field experimentation venues, SH-1. Both EW and EW-Cyber technologies including the JEAT-funded LOCUST effort (see below) will be explored in SH-2. • Integrate the Future Autonomous Battlespace RF Integrating Capability (FABRIC) active electronically scanned aperture (AESA) antenna and direction finding algorithms into the LOCUST EW/EW-Cyber demonstrator for validation in (SH-2). Platform Self-Protection (PS-P): • Examine the RF countermeasure (RFCM) and electromagnetic attack (EA) trade and opportunity spaces in a study to identify new RFCM technologies to enable more effective aircraft countermeasures against RF-guided missile threats. Plans will be developed to begin exploring and developing the most promising technologies identified in the RFCM Study in FY 2022. EMW Technology Enablers (EW Tech): • Using AI/ML capabilities developed in JEAT's Digital Attack Surface Execution Environment (DASEE) effort, begin developing ontologies to enable better EMS modelling and simulation and advance the use of AI/ML-aided battlespace comprehension and course of action development to enhance U.S. tactical and strategic EMS wargaming and operational employment. • The first two field demonstrations of the Next Generation Fully Adaptive Radar (NG-FAR) will occur in FY 2021. EW-Cyber Interface (EWCI): • Complete the development and demonstration of a classified EW-Cyber capability (Sierpinski). • Complete enhancement of an EW-Cyber capability and integrate it into the LOCUST EW/EW-Cyber demonstrator for validation in SH-2.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
EW Collaboration and Cognizance (EW C&C): Several hundred million dollars are spent each year to develop better EW and EW-Cyber capabilities for U.S. warfighters. EW C&C efforts supporting the Office of the Under Secretary of Defense (Research and Engineering), EW and Countermeasures (OUSD(R&E),EW&C) facilitate greater collaboration across these initiatives through work with planners and developers across the Services, National Laboratories, Industry, academia, and international defense partners. Participation in the EW Community of Interest facilitates these efforts and provides insights for decision-makers within OSD and the Services and the EW Executive Committee. EW C&C efforts also enable the identification and development of collaboration opportunities such as JEAT's SILENT HAMMER field experimentation venues.			
FY 2022 Plans: Passive Sensor Detection and Defeat (PSDD): • The findings of SH-2 will guide the development of a follow-on SH venue (SH-3) to mature the technologies that showed promise in SH-1 and SH-2 and assess new approaches and technology enhancements that are being explored in JEAT research and in the DOD EW and EW-Cyber technology development communities. • Continue the development of OX EYE to explore technologies to counter adversary attempts to deceive U.S. cognitive and autonomous operations capabilities. • Complete initial assessment of RADEC's design and approach. Begin expansion of RADEC's AI/ML use to facilitate the rapid, accurate detection, identification and geolocation of multiple classes of specific foreign RF emitters of interest. Platform Self-Protection (PS-P): Conduct a Next Generation Infrared (IR) Countermeasures (IRCM) Study to identify the greatest technological challenges and developmental opportunities for protecting U.S. assets against foreign threats employing IR sensors and seekers. This study will provide developmental recommendations that will be explored in FY 2023 JEAT research efforts. • Explore and demonstrate capabilities of the Deep Space Radio (DESPERADO) technology demonstrator, which was identified in the FY 2020 EW RFI. Explore DESPERADO's capabilities to provide intelligent RF detection for enabling more effective EA and EP of U.S. assets. If DESPERADO warrants further investigation, subsequent development plans will be identified. • Wideband ISR (Intelligence Surveillance Reconnaissance) Cyber EW D5 (Disrupt, Degrade, Deceive, Deny, Destroy (WICKED CROW), which was identified in the FY2020 EW RFI, is a functionally dynamic and cost effective EW/EW-Cyber/ISR/information operations (IO) family of systems capable of both offensive and defensive operations. To validate its utility, FY21 efforts will assessing WICKED CROW's Self-Networking Electronic Attack (SNEAK) advanced-electronic-attack-combined-with-low-bandwidth-communications capability. SNEAK uses the frequency agility and signal processing capabilities of advanced EA systems to enable communication at the frequencies used by the threats while reducing their ability to detect or jam inter-vehicle communication. EW Technology Enablers (EW Tech):			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
• Complete the third, final demonstration of NG-FAR. Develop transition plans and plans for demonstrating NG-FAR in Northern Edge 2023. • Begin development and initial assessment of the Policy-Based EW Capability (PBEWC). PBEWC seeks to increase EW and EW-Cyber effectiveness in the battlefield through the development of ontologies and heuristics to guide EW and EW-Cyber employment, operational decision planning, and execution. EW Collaboration and Cognizance (EW C&C): Continue FY 2021 OUSD(R&E),EW&C work to guide, shepherd and oversee all EW and EW-Cyber technology development across DOD. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funds added in FY 2022 will enable expanded EW and EW-Cyber technology acceleration efforts within the JEAT Program.			
Accomplishments/Planned Programs Subtotals	11.762	15.152	18.221

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A