Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Defense Advanced Research Projects Agency	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 0603766E / *NETWORK-CENTRIC WARFARE 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	-	515.879	641.158	584.771	-	584.771	-	-	-	-	-	-
NET-01: *JOINT WARFARE SYSTEMS*	-	130.222	143.199	111.089	-	111.089	-	-	-	-	-	-
NET-02: *MARITIME SYSTEMS*	-	112.421	148.459	149.127	-	149.127	-	-	-	-	-	-
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	273.236	349.500	324.555	-	324.555	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The Network-Centric Warfare Technology Program Element is budgeted in the Advanced Technology Development budget activity because it addresses high payoff opportunities to develop and rapidly mature advanced technologies and systems required for today's network-centric warfare concepts. It is imperative for the future of the U.S. forces to operate flawlessly with each other, regardless of which services and systems are involved in any particular mission. The overarching goal of this program element is to enable technologies at all levels, regardless of service component, to operate as one system.

The objective of the Joint Warfare Systems project is to create enabling technologies for seamless joint operations, from strategic planning to tactical and urban operations. Joint Warfare Systems leverage current and emerging network, robotic, and information technology and provide next generation U.S. forces with greatly increased capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents using systems that are flexible, robust, and difficult to neutralize; and (2) U.S. doctrine that limits the use of firepower to lessen the impact of operations on noncombatants. These problems are magnified in urban and semi-urban areas where combatants and civilians are often co-located and in peacekeeping operations where combatants and civilians are often indistinguishable. Meeting these challenges places a heavy burden on joint war planning. Understanding opponent networks is essential so that creative options can be developed to counter their strategies. Synchronization of air and ground operations to apply force only where needed and with specific effects is required. This project supports all levels of the force structure including: (1) the strategic/operational level by generating targeting options against opponents' centers of gravity that have complex networked relationships; (2) the tactical/operational level by managing highly automated forces with tight coupling between air and ground platforms; and (3) the focused tactical level by developing platforms and tools, which acquire targets of opportunity and cue network-based analysis of likely enemy operations thus maximizing the effectiveness of ground forces in stability and support operations.

The Maritime Systems project is identifying, developing and rapidly maturing critical advanced technologies and system concepts for the naval forces' role in today's network centric warfare concept. Improvements in communications between and among submarines, surface ships and naval aircraft have allowed these forces to operate seamlessly with each other and with other Service's network centric systems. Naval forces will play an ever-increasing role in network centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea, and their versatile ability to provide both rapid strike and project-sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network centric forces.

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Defense Advanced Research Projects Agency	Date: May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603766E *I NETWORK-CENTRIC WARFARE TECHNOLOGY*

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	507.424	661.158	647.113	-	647.113
Current President's Budget	515.879	641.158	584.771	-	584.771
Total Adjustments	8.455	-20.000	-62.342	-	-62.342
• Congressional General Reductions	0.000	-20.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	9.327	0.000			
• SBIR/STTR Transfer	-0.872	0.000			
• TotalOtherAdjustments	-	-	-62.342	-	-62.342

Change Summary Explanation

FY 2020: Increase reflects reprogrammings offset by SBIR/STTR transfer.

FY 2021: Decrease reflects congressional adjustments.

FY 2022: Decrease reflects a shift from standing up a development and operations environment to demonstrating and modeling the Assault Breaker II (ABII) capability, as well as, completion of classified efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency			Date: May 2021
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-01 / *JOINT WARFARE SYSTEMS*	

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
NET-01: *JOINT WARFARE SYSTEMS*	-	130.222	143.199	111.089	-	111.089	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The objective of the Joint Warfare Systems project is to create enabling technologies for seamless joint operations, from strategic planning to tactical and urban operations. Joint Warfare Systems leverage current and emerging network, robotic, and information technology and provide next generation U.S. forces with greatly increased capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents using systems that are flexible, robust, and difficult to neutralize; and (2) U.S. doctrine that limits the use of firepower to lessen the impact of operations on noncombatants. These problems are magnified in urban and semi-urban areas where combatants and civilians are often co-located and in peacekeeping operations where combatants and civilians are often indistinguishable. Meeting these challenges places a heavy burden on joint war planning. Understanding opponent networks is essential so that creative options can be developed to counter their strategies. Synchronization of air and ground operations to apply force only where needed and with specific effects is required. This project supports all levels of the force structure including: (1) the strategic/operational level by generating targeting options against opponents' centers of gravity that have complex networked relationships; (2) the tactical/operational level by managing highly automated forces with tight coupling between air and ground platforms; and (3) the focused tactical level by developing platforms and tools, which acquire targets of opportunity and cue network-based analysis of likely enemy operations thus maximizing the effectiveness of ground forces in stability and support operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Prototype Resilient Operations Testbed for Expeditionary Urban Systems of Systems (PROTEUS)	15.960	13.136	8.030
Description: The Prototype Resilient Operations Testbed for Expeditionary Urban Systems of Systems (PROTEUS) program is demonstrating that a dynamically composable Mosaic warfare approach provides superior performance and adaptability in the dynamic, uncertain environment imposed on U.S. warfighters by urban combat operations. PROTEUS will be adaptive to an inherently dynamic and fluid environment that will account for the environmental influence of non-combatants in urban combat as well as kinetic warfighting. Technologies will be integrated using systems of systems principles developed under the System of Systems Integration Technology and Experimentation (SoSITE) program, budgeted in this PE/Project. To support concept development, testing, and warfighter interaction, the program will also develop a supporting virtual testbed. Technologies from this program will be transitioned to the Services.			
FY 2021 Plans: - Expand development of planning and force composition tools for multi-echelon operations. - Enhance features for logistics plan management and considerations for operational impacts. - Demonstrate integration of virtual testbed and composition tool using complex multi-domain scenario against near peer threat.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Demonstrate system integration with Service participants executing multi-domain operations at Marine Corps Air Ground Combat Center (MGACC). ***FY 2022 Plans:*** - Demonstrate system integration with Service participants executing multi-echelon, multi-domain operations. - Document and transition software to hosting on Navy and/or Marine Corps IT systems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects a continuation of demonstration and documentation, after initial testing and refinement activities.			
Title: Systems of Systems-Enhanced Small Units (SESU)	20.185	18.487	16.239
Description: The System of Systems-Enhanced Small Unit (SESU) program is developing and demonstrating 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. SESU-developed capabilities will provide the small unit with improved awareness of enemy force composition, disposition, and intent. It will also provide the means to deter escalation of threat, and, if deterrence fails, the ability to degrade, disrupt, and/or destroy enemy anti-access/area denial (A2/AD) and combat systems. Technologies to accomplish this include command and control (C2) that operates in a contested environment; distributed sensing, including the ability to leverage indigenous information sources; hybrid effects that include a mix of kinetic, non-kinetic, and information operations capabilities; and autonomous systems to deliver effects and conduct sensing. A Campaign of Learning (CoL) will be conducted in partnership with the Army, and technologies produced by this program will be transitioned to the Services. ***FY 2021 Plans:*** - Demonstrate impact of advanced technology suites in constructive and virtual simulations. - Integrate sensors and effectors in autonomous ground and air platforms and demonstrate real-time operation in hardware-in-the-loop or live environment. - Evaluate prototype distributed C2 software and hardware operating speeds. - Conduct live and virtual experiments to demonstrate and evaluate prototype architectures with distributed C2, sensors, and effectors. - Conduct live and virtual demonstrations of full SESU capabilities of autonomous platforms, sensors, and effectors. - Finalize plans for integration of government furnished third party sensors, effectors, and autonomous platforms. ***FY 2022 Plans:*** - Conduct live, virtual, constructive experiments for government-provided missions in realistic environments to demonstrate the ability of the system to support new missions and transition. - Apply SESU technologies to new threats and geographies in live, virtual, and constructive experiments.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Conduct independent SESU system overall performance and operational analysis in SESU's ability to destroy, disrupt, degrade, and/or delay aspects of an adversary's A2/AD capabilities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects a shift from development to live, virtual, and constructive demonstrations and testing.			
Title: Assault Breaker II (ABII)	67.358	71.350	51.154
Description: Assault Breaker II (ABII) seeks to change the current warfighting paradigm of reliance on a Service-specific and platform centric force that executes prescribed kill chains to a highly adaptable and capability-based force. This new paradigm operates as a disaggregated kill web able to execute rapidly composable, joint, and all domain kill chains. Building upon technologies developed in the Cross Domain Maritime Surveillance and Targeting (CDMaST) program, budgeted in PE 0603766E, Project NET-02, ABII will exploit both existing and emerging technologies across the Services to address known capability gaps, opportunities, and threats. ABII will conduct mission-centric, multi-Service and multi-domain analyses, modeling & simulation (M&S), and experimentation to inform research and development and program of record recommendations. ABII will build an enduring, multi-service M&S environment to support complex mission level kill web analysis. ABII will also design and develop a Vanguard Force DevOps Environment (VFDE) and battle management enclave with physical nodes that will enable the transition of ABII technologies, concepts and architectures to the Services. ***FY 2021 Plans:*** - Perform scenario focused studies of kill web architecture and effects. - Demonstrate completed modules for the modeling and simulation environment compatibility. - Initiate detailed design of multi-domain and multi-level security environment. - Begin experimentation efforts within the Distributed Experimentation Environment (DE2). - Design early user evaluations and field trial of technologies matured through ABII. - Demonstrate completed modules for VFDE and related facilities. - Develop modules and battle management capabilities of the VFDE. ***FY 2022 Plans:*** - Initiate studies for the finalization of kill web architectures and effects. - Execute model development for the M&S environment. - Demonstrate model and simulation initial operating capability. - Demonstrate completed modules for the multi-domain, multi-level security environment. - Execute experimentation campaign utilizing VFDE and DE2 capabilities. - Perform preliminary design for large scale exercise based experiment. - Demonstrate completed modules of battle management command and control tool sets.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Demonstrate operational capability of VFDE and execute initial integration of battle management tools. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects the completion of the Vanguard Force DevOps Environment infrastructure, and the completion of critical software and toolset modules associated with Advanced Battle Management and modeling & simulation.			
Title: Air Combat Evolution (ACE) ***Description:*** As the Services develop new Joint Multi-Domain Battle warfighting concepts, there is a strong demand for innovative ways to assess architectures, advance technology, and support operators developing advanced multi-domain tactics. Based upon technologies developed in the System of Systems Integration Technology and Experimentation (SoSITE) program, budgeted in this PE/Project, the Air Combat Evolution (ACE) program will apply technologies and principles of distributed autonomy and artificial intelligence (AI) to aerial within-visual-range (WVR) maneuvering, colloquially known as a dogfight, in modeling and simulation (M&S), sub-scale, and ultimately full-scale vehicles. The program will deliver an initial instantiation of a scalable AI controller enabling aircraft autonomy at levels ranging from an advanced tactical autopilot for dynamic maneuver to a form of multi-domain mosaic battle management controller. Experiments will explore both augmentation of existing manned platforms and enhanced future unmanned systems. ACE will provide an early opportunity to build operator trust in combat autonomy and demonstrate adaptive human-machine teaming tools and architectures. Technology developed by this program will transition to the Services. ***FY 2021 Plans:*** - Refine and implement WVR algorithms onto sub-scale commercial unmanned aerial vehicle (UAV) aircraft and test 1v1 scenarios in a live experiment. - Develop Human Machine Interfaces (HMIs) for sub-scale trust assessments. - Conduct trust assessment events in sub-scale aircraft environment. - Conduct extension of combat autonomy to initial campaign scenarios. - Prepare aircraft for testing with final 1v1 flight certification demonstrations. ***FY 2022 Plans:*** - Refine and implement WVR algorithms onto sub-scale commercial UAV aircraft progression to 2v1, 2v2 scenarios. - Implement HMIs for full scale aircraft trust assessments. - Conduct trust assessment events in M&S environment in more complex 2v1, 2v2 scenarios. - Conduct extension of combat autonomy to more complex campaign scenarios. - Prepare for full-scale aircraft testing of combat autonomy. ***FY 2021 to FY 2022 Increase/Decrease Statement:***	12.838	28.601	26.666

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
The FY 2022 decrease reflects a continuation of multiple live testing events and a shift from system development to testing.			
Title: System of Systems Integration Technology and Experimentation (SoSITE)	12.536	11.625	-
Description: The 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. Such assessments would optimize system-level trades of requirements and architectures to leverage an integrated set of system characteristics and capabilities. The demonstration assessment metrics will measure individual and combined system performance to streamline resource allocation to maximize operational impact. In addition, providing a modeling and simulation (M&S) environment to assess complex systems will enable greater utility of emerging system technologies, since they can be assessed in near-real-world simulations without the real-world costs of testing fully integrated systems. The program will also develop system synthesis and integration technologies that enable rapid assimilation of new and off-the-shelf technologies into the system of systems architecture. These technologies will break down current barriers to entry that new technologies face in system of systems using formal methods, compositional reasoning, and automated design space exploration. Technologies from this program will be transitioned to the Services. ***FY 2021 Plans:*** - Perform live flight experiments for USAF and USN partners. - Conduct integration events to characterize long-range fires sub-systems digitally to enable rapid integration into systems of systems. - Create and deploy System of Systems Technology Integration Tool Chain for Heterogeneous Electronic Systems (STITCHES) training software. - Establish Air Force STITCHES Warfighter Application Team (SWAT) effort to transition the SoSITE STITCHES toolchain to the USAF and USN. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects program completion.			
Title: Critical Infrastructure Defense (CID)	-	-	9.000
Description: The goal of the Critical Infrastructure Defense (CID) program is to develop a holistic framework by which DoD can measure its dependencies on civil infrastructure domestically and overseas as well as resulting vulnerabilities. CID will build on technologies developed in the Rapid Attack Detection, Isolation, and Characterization Systems (RADICS) program, budgeted in PE 0602303E, Project IT-03. The creation of CID will mitigate or decrease the impact of adversary attacks on civilian infrastructure. CID will also examine the ability for alternative capabilities that can rapidly take the place of civilian infrastructure on an interim basis. Technologies from CID will transition to the Services.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
FY 2022 Plans: - Design a modeling framework that examines critical infrastructure dependencies across all sectors. - Develop prototypes for capabilities that mitigate vulnerabilities that may be exploited by an adversary ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase reflects program initiation.			
Title: Resilient Synchronized Planning and Assessment for the Contested Environment (RSPACE) ***Description:*** Currently, Command and Control (C2) of air platforms is a highly centralized process operating largely independently across planning domains (Intelligence, Surveillance, and Reconnaissance (ISR), strike, and spectrum management) and is optimized for a permissive environment. To address the challenges faced in today's increasingly contested environments, the Resilient Synchronized Planning and Assessment for the Contested Environment (RSPACE) program developed tools and models to enable distribution of planning functions across the C2 hierarchy for resilience (e.g., loss of communications), while synchronizing strike, ISR, and spectrum planning to maximize the contribution of all assets through increased utilization and exploitation of synergies. The program developed tools supporting a mixed initiative planning approach, maximizing automation according to operator's choice, and enabling human-in-the-loop intervention and modification. RSPACE also developed tactical decision aids for maritime commanders and planners to build and assess courses of action (COAs) for fleet and ship movements and the employment of counter-ISR techniques. During execution, the tools provided lifecycle tracking of targeting and information needs and supported assessment of progress towards achieving the commander's intent. The tools dynamically responded as directed to ad hoc requests and significant plan deviations via a real-time dynamic re-planning capability and easily adapted to technology refreshes. RSPACE tools transitioned to the Air Force's Kessel Run Experimentation Lab as part of the Air Operations Center Weapon System Program of Record modernization effort and the Navy.	1.345	-	-
Accomplishments/Planned Programs Subtotals	130.222	143.199	111.089

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency			Date: May 2021
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-02 / *MARITIME SYSTEMS*	

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
NET-02: *MARITIME SYSTEMS*	-	112.421	148.459	149.127	-	149.127	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Maritime Systems project is identifying, developing and rapidly maturing critical advanced technologies and system concepts for the naval forces' role in today's network centric warfare concept. Improvements in communications between and among submarines, surface ships and naval aircraft have allowed these forces to operate seamlessly with each other and with other Service's network centric systems. Naval forces will play an ever-increasing role in network centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea, and their versatile ability to provide both rapid strike and project-sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network centric forces.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Cross Domain Maritime Surveillance and Targeting (CDMaST)	15.397	11.326	3.000

Description: The 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. By exploiting promising new developments in unmanned platforms, seafloor systems, and emerging long-range weapon systems, the program will develop an advanced, integrated undersea and above sea warfighting capability. The CDMaST program will establish an analytical and experimental environment to explore architecture combinations in terms of operational effectiveness as well as engineering feasibility and robustness. The program will leverage enabling technologies needed for command, control, and communication (C3) between physical domains in order to support the architecture constructs. Through experimentation, the program will not only demonstrate integrated system performance, but also develop new tactics that capitalize on features created by the heterogeneous architecture. The CDMaST program will invest in technologies that will reduce cost, manage complexity, and improve reliability. Technologies from this program will transition to the Navy.

FY 2021 Plans:
- Conduct additional at-sea and in-lab demonstrations, document results, and deliver test results report.
- Execute engineering tests to support the final experimentation event.
- Collaborate with the Navy on CDMaST experimentation events based on previously executed transition documentation (e.g., Memorandums of Agreement).

FY 2022 Plans:
- Perform final CDMaST experimentation event.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Complete transition of hardware, software, and reports to the Navy. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects the completion of design and integration activities and transition to final experimentation events.			
Title: Hunter ***Description:*** The Hunter program seeks to develop novel concepts for Extra Large Unmanned Undersea Vehicles (XLUUVs) to deliver complex payloads. The program will explore efficient encapsulation and buoyancy control concepts to be implemented with advanced fiber handling capabilities for high bandwidth communications in order to create a highly modular and adaptable ocean interface. This interface will give XLUUVs significantly increased payload handling ability and allow them to deliver completely new capabilities previously delivered only by manned platforms. Building upon research conducted under the Cross Domain Maritime Surveillance and Targeting (CDMaST) program budgeted in this PE/Project, the Hunter program will establish a new capability for integration into maritime system of systems warfare architectures. Technologies developed under the Hunter program will transition to the Navy. ***FY 2021 Plans:*** - Commence carriage integration with the XLUUV to include engineering testing of integrated subcomponents. - Conduct pool testing of entire payload system, which includes the Hunter carriage and the XLUUV payload module. - Conduct studies to upgrade XLUUV autonomy and ability to deploy alternate payloads. - Complete coordinated in-water systems-of-systems testing. ***FY 2022 Plans:*** - Upgrade Hunter carriage and XLUUV communications capability. - Conduct end-to-end mission demonstration. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects the transition from system integration and test to mission demonstrations.	15.242	11.863	6.924
Title: Ocean of Things ***Description:*** The goal of the Ocean of Things program is to advance oceanographic sensing and maritime awareness using low-power microelectronics and advanced data analytics. Ocean of Things builds upon advances made in the Cross Domain Maritime Surveillance and Targeting (CDMaST) program, budgeted in this PE/Project. Ocean of Things will develop large numbers of heterogeneous sensing floats to cover large ocean areas, while incorporating environmentally friendly construction materials. These platforms will leverage satellite communications to populate a large data repository with sensor outputs for shared processing. Ocean of Things will apply advanced analysis techniques to the stored data to synthesize and discover new signals and behaviors in the ocean environment. The program will research the spatio-temporal composability of sensors and	25.933	13.011	5.403

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
develop applications for distributed platform behavior using an internet of things (IoT) architecture deployed across the world's oceans. Further research will examine additional platform capabilities and system impacts of communication rate and edge processing. The Ocean of Things program will improve ocean awareness and provide persistent coverage to areas between existing platforms. Technologies developed in Ocean of Things will transition to the Navy. ***FY 2021 Plans:*** - Develop large data test results for Navy ingestion and application. - Develop advanced data analysis and control algorithms. - Evaluate test data to determine optimal deployment and test for Navy involvement. - Develop updated ocean models with improved resolution for Navy employment. ***FY 2022 Plans:*** - Develop advanced algorithms and automated performance. - Integrate analytic and ocean modeling products into Navy applications. - Test advanced algorithms on large-scale data. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects a shift from design and development to integration and testing.			
Title: Timely Information for Maritime Engagements (TIMEly)	11.778	20.259	16.500
Description: Integration of undersea elements for joint cross-domain operations is critical for developing the most effective distributed kill webs. The Timely Information for Maritime Engagements (TIMEly) program is creating a heterogeneous underwater network architecture that will span the ocean and bridge to other operating domains. Building upon technologies learned in the Positioning System for Deep Ocean Navigation (POSYDON) program, budgeted in this PE/Project, TIMEly will provide an adaptive, heterogeneous, scalable communications capability to link undersea and cross-domain assets together into kill webs with minimal operator burden. The program will focus on developing architectures with the capability to transfer the right information to its intended purpose. TIMEly will work within commonly understood limitations, with a focus on protocols, quality of service, and information exchange. The program will leverage developments demonstrating short-range and long-range acoustic communications at higher bandwidth and greater reliability, while minimizing detectability. The program will also leverage recent developments in network interoperability to manage heterogeneous undersea and cross-domain networks. Technology developed by this program will transition to the Navy. ***FY 2021 Plans:*** - Conduct hardware in-the-loop simulation and testing. - Conduct limited in-water risk reduction testing for high risk technology areas specific to individual TIMEly architectures.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Develop analytically based architecture performance predictions to evaluate TIMEly performance across a range of mission scenarios. - Commence hardware design and fabrication efforts for TIMEly nodes. - Begin development of hardware control logic and integration with hardware nodes. ***FY 2022 Plans:*** - Fabricate prototype TIMEly nodes for in-water demonstration. - Refine data management architecture and TIMEly communication protocols. - Develop networking and node autonomy behaviors. - Conduct end-to-end testing of TIMEly architectures to evaluate performance. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects a shift from fabrication and integration efforts to testing.			
Title: Manta Ray	11.415	22.000	29.500
Description: The Manta Ray program seeks to develop a new class of long-duration, long-range, payload-capable unmanned underwater vehicles (UUVs) at an acquisition and lifecycle cost significantly less than current payload-capable UUVs. This new class of UUV will give the combatant commander an amplification of capacity without disrupting current operations by remaining independent of manned vessels and ports once deployed. The primary goal of the Manta Ray program is to open a design space for future UUVs that are capable of both long duration missions and large payload capacity. A secondary goal of the program is to advance key technologies that will benefit other naval designs such as low lifecycle cost UUV operations, energy management technologies to enable long-duration operations, biofouling reduction technologies, and long-duration navigational enablers. The anticipated transition partner is the Navy. ***FY 2021 Plans:*** - Conduct preliminary and critical design review. - Develop platform subsystems. - Demonstrate and test subsystems in a controlled maritime environment. ***FY 2022 Plans:*** - Continue demonstration and testing of subsystems in controlled maritime environment. - Complete subsystem development and integration. - Begin fabrication of integrated vehicle. - Conduct preliminary integrated platform tests. ***FY 2021 to FY 2022 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
The FY 2022 increase reflects a shift from technology demonstrations to integrated platform fabrication and testing.			
Title: No Manning Required Ship (NOMARS) ***Description:*** No Manning Required Ship (NOMARS) seeks to develop small, low-cost, disaggregated naval platforms to demonstrate the ability to perform persistent power projection and force application combat missions currently conducted from large, high-value capital ships. The NOMARS program seeks to design a ship that can operate autonomously for long durations at sea, enabling a ship design process that eliminates considerations associated with crew. NOMARS focuses on exploring novel approaches to the design of the sea frame (the ship without mission systems) while accommodating representative payload size, weight, and power. The goal of the program is to demonstrate the feasibility of Unmanned Surface Vessels (USVs) that can operate autonomously for months to years without human intervention, in large numbers, with only periodic, depot-based maintenance. This capability will enable disaggregated persistent USVs, which allows the surface fleet to credibly threaten peer adversaries and negate their investments in high-cost weapon systems designed to counter large naval targets such as aircraft carriers. A successful NOMARS program will prove feasibility of a small unmanned ship with significantly improved reliability and functional performance over current USVs providing a pathway to allow a distributed lethality concept to become viable: small ships, in large numbers, each of which is individually low-cost and low-value, but in aggregate presents a significant deterrent. ***FY 2021 Plans:*** - Complete Conceptual Design Review. - Complete system requirements review. - Conduct preliminary system design of multiple concept vessels. ***FY 2022 Plans:*** - Conduct detailed design of selected concept vessels and complete critical design review. - Initiate NOMARS demonstrator vessel development. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase is due to detailed design of the selected concept vessel(s) and beginning development of the demonstrator vessel.	13.000	24.000	30.600
Title: Angler ***Description:*** The undersea domain has significant importance to national security and military operations. Yet it is a challenging domain in which to operate due to extreme water pressures, restricted communications, ever changing bottom environments, and marine fouling and corrosion. The Angler 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 search and manipulate objects autonomously, even in dark, turbulent, and semi-opaque sea conditions without the need for human control and without reliance	14.937	26.000	4.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
on the Global Positioning System (GPS). Key Angler technical challenges include sensing techniques that provide high-resolution navigation without GPS, perception and manipulation strategies for objects with unknown parameters, long duration autonomy approaches to support mission execution, and autonomy approaches that do not rely on human intervention. This program was initiated in an applied research effort budgeted in FY 2020 PE 0602702E, Project TT-03. The anticipated transition is to the Navy. ***FY 2021 Plans:*** - Conduct Post-Preliminary Design Review (PDR) activities to identify and transition autonomy and manipulation technologies to Navy partners. - Develop fully integrated robot subsystems. - Demonstrate Phase 1 objectives in a representative maritime environment. ***FY 2022 Plans:*** - Complete program closeout activities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects completion of Phase 1 activities.			
Title: Sea Train ***Description:*** The Sea Train program will support the delivery of masses of unmanned surface vessels into theater, without reliance on large, manned capital assets. The Sea Train program will develop and demonstrate approaches to exploit the efficiencies of longer slender hulls, while enabling a distributed fleet of tactical Unmanned Surface Vessels (USVs). The Sea Train concept enables vessels that are efficient for transoceanic transport while enabling dispersed operations as individual vessels. The Sea Train program will develop and demonstrate connector approaches to couple the vessels, the control laws required to drive the vessel in open ocean conditions, sensor approaches to understand the wave environment to efficiently navigate the vessel, and the autonomy required to connect and disconnect the vessels without human intervention. The goal of this effort is to improve transport efficiency over what can be achieved with current monohull designs. This allows for the efficient transport of smaller vessels into and out of theater, an operation that is normally accomplished today by carrying smaller vessels on board larger vessels or reliance on at-sea refueling of smaller vessels. ***FY 2021 Plans:*** - Perform Conceptual Design Review of the Objective System. - Conduct Systems Requirements Review of the Phase 1 Demonstration System. - Perform subsystem integration and test. ***FY 2022 Plans:*** - Conduct scaled model testing, analysis, and simulation to inform demonstrator system Preliminary Design Review.	-	20.000	33.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Conduct objective system Concept Design Review. - Begin development of a one-quarter scale demonstrator system to support towing tank and in-water testing of the fully assembled, self-powered vehicle. - Initiate demonstrations to evaluate control laws and autonomy behaviors in high sea-state conditions. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase is due to development of large-scale demonstration system.			
Title: Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) ***Description:*** The Multi-Azimuth Defense Fast Intercept Round Engagement (MAD-FIRES) program seeks to develop and demonstrate a point defense system against today's most stressing threats by developing a highly maneuverable, medium caliber, guided supersonic projectiles, fire sequencing and control system capable of neutralizing large threat raids of high speed, highly maneuverable threats. Leveraging recent advancements in gun hardening, miniaturization of guided munition components, and long-range sensors, MAD-FIRES advances fire control technologies, medium caliber gun technologies, and guided projectile technologies enabling the multiple, simultaneous target, kinetic engagement mission at greatly reduced costs. MAD-FIRES seeks to achieve lethality overmatch through accuracy rather than size, thus expanding the role of smaller combat platforms into missions where they have been traditionally outgunned. MAD-FIRES, sized as a medium caliber system, enhances flexibility for installment as a new ship self-defense system. The final phase of the project will end with testing against supersonic targets. Prior to FY 2022, this program was funded in PE 0602702E, Project TT-03. ***FY 2022 Plans:*** - Begin design effort for tactically sized radar illuminator. - Begin design cycle for supersonic threat engagement demonstration. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase reflects initiation of MAD-FIRES advanced technology efforts to complete the final phase of supersonic testing.	-	-	6.000
Title: Goblin ***Description:*** The undersea domain has significant importance to national security and military operations, however, manned missions are restricted in their operational ranges. The Goblin program seeks to enhance U.S. autonomous capabilities in the challenging undersea domain by enabling complex underwater systems able to search, locate, and execute mission objectives without the need for human control. Navigation approaches will focus on the use of commercial, low-cost navigation hardware combined with environmental feature-based algorithm approaches to eliminate reliance on GPS for long duration missions. Key Goblin technical challenges include sensing techniques that provide high-resolution navigation without GPS, perception and	-	-	14.200

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency		Date: May 2021
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
effector strategies for objects with unknown parameters, long-duration autonomy approaches to support mission execution, and autonomy approaches that do not rely on human interaction. The anticipated transition is to the U.S. Navy. ***FY 2022 Plans:*** - Begin subsystems design, long-lead purchase items, and initial subsystems integration. - Test subsystems in a representative maritime environment. - Risk reduction activities supporting preliminary development of fully integrated test system. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase reflects program initiation.			
Title: Positioning System for Deep Ocean Navigation (POSYDON) ***Description:*** The Positioning System for Deep Ocean Navigation (POSYDON) program provided continuous, Global Positioning System (GPS)-level positioning accuracy to submarines and autonomous undersea vehicles (AUVs) in the ocean over extended periods of time. Undersea navigation cannot use GPS because the water blocks its signals. At shallower depths, masts can be raised to receive GPS signals, but masts present a detection risk. Typically, the alternative to GPS for undersea navigation has been inertial navigation systems (INS), but INS accuracy can degrade unacceptably over time. The POSYDON program distributed a small number of acoustic sources, analogous to GPS satellites, around an ocean basin at known locations. Undersea platforms equipped with a passive acoustic receiver and appropriate processing software are capable of obtaining and maintaining location. By transmitting specific acoustic waveforms and developing accurate acoustic propagation models to predict and interpret the complex arrival structure of the acoustic sources, the submarine or AUV could determine its range from each source and thus calculate its position. Technologies developed under this program transitioned to the Navy's Maritime Surveillance Systems Program Office for fleet experimentation and future Office of Naval Research (ONR) research as endorsed by the Undersea Rapid Capabilities Insertion effort.	4.719	-	-
Accomplishments/Planned Programs Subtotals	112.421	148.459	149.127

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Defense Advanced Research Projects Agency			Date: May 2021
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-06 / *NETWORK-CENTRIC WARFARE 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
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	273.236	349.500	324.555	-	324.555	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Classified DARPA Program	273.236	349.500	324.555
Description: This project funds Classified DARPA Programs. Details of this submission are classified. ***FY 2021 Plans:*** Details will be provided under separate cover. ***FY 2022 Plans:*** Details will be provided under separate cover. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	273.236	349.500	324.555

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A