Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Defense Advanced Research Projects Agency	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	-	417.826	439.386	438.569	-	438.569	451.035	417.272	393.145	354.315	-	-
NET-01: *JOINT WARFARE SYSTEMS*	-	54.177	67.114	72.402	-	72.402	120.342	161.307	169.622	176.992	-	-
NET-02: *MARITIME SYSTEMS*	-	135.967	138.112	130.511	-	130.511	126.643	106.465	140.323	147.323	-	-
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	227.682	234.160	235.656	-	235.656	204.050	149.500	83.200	30.000	-	-

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 expanded capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents utilizing 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 collocated, 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.

The Maritime Systems project will identify, develop and rapidly mature 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 2019 Defense Advanced Research Projects Agency	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	428.894	439.386	420.714	-	420.714
Current President's Budget	417.826	439.386	438.569	-	438.569
Total Adjustments	-11.068	0.000	17.855	-	17.855
• Congressional General Reductions	-9.000	0.000			
• 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	6.355	0.000			
• SBIR/STTR Transfer	-8.423	0.000			
• TotalOtherAdjustments	-	-	17.855	-	17.855

Change Summary Explanation

FY 2017: Decrease reflects Congressional reduction and the SBIR/STTR transfer offset by reprogrammings.

FY 2018: N/A

FY 2019: Increase reflects expanded scope in the Systems of Systems-Enhanced Small Units (SESU) and Prototype Resilient Operations Testbed for Expeditionary Urban Systems of Systems (PROTEUS) programs.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
NET-01: *JOINT WARFARE SYSTEMS*	-	54.177	67.114	72.402	-	72.402	120.342	161.307	169.622	176.992	-	-

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 2017	FY 2018	FY 2019
Title: System of Systems Integration Technology and Experimentation (SoSITE)	24.212	27.932	26.518
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 properly leverage an integrated set of system characteristics and capabilities. The demonstration assessment metrics will measure individual and combined system performance to further 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 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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 2017	FY 2018	FY 2019
- Secure test articles for mobile target strike flight test experiments: manned and unmanned platforms, and experimental mission systems from DARPA and Service Science and Technology programs. - Demonstrate the capability of new engineering tools to validate system of systems architecture designs prior to live flight experiments. - Demonstrate the capability of formal verification techniques to validate integration of constituent systems into a system of systems prior to live flight experiments. - Conduct experiments of system of systems architectures for mobile target strike missions in live flight integrated with architectures for offensive counter-air, augmented with virtual and constructive simulation of test articles not ready for live flight; analyze experiment outcomes and document accomplishment of risk reduction objectives. - Secure test articles for networked electronic attack flight test experiments manned and unmanned platforms, and experimental mission systems. ***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. - Demonstrate the capability of new engineering tools to validate system of systems architecture designs prior to live flight experiments. - Demonstrate the capability of formal verification techniques to validate integration of constituent systems into a system of systems prior to live flight experiments. - Conduct integration events to digitally characterize sub-systems to enable rapid integration into systems of systems. - Conduct live flight experiments of system of systems architectures for networked electronic attack, distributed opposed strike, and suppression of enemy air defense missions. - Apply Return Oriented Programming methods to enable rapid upgrade and improve portability of both new and legacy aircraft platform software. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects fewer flight experiments.			
Title: Resilient Synchronized Planning and Assessment for the Contested Environment (RSPACE)	20.350	17.772	15.475
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 will develop 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			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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 2017	FY 2018	FY 2019
increased utilization and exploitation of synergies. The program will develop tools supporting a mixed initiative planning approach, maximizing automation according to operator's choice, and enabling human-in-the-loop intervention and modification, as well as 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-Intelligence, Surveillance, and Reconnaissance (ISR) techniques. During execution, the tools will provide lifecycle tracking of targeting and information needs and support assessment of progress towards achieving the commander's intent. The tools will dynamically respond as directed to ad hoc requests and significant plan deviations via a real-time dynamic replanning capability, and easily adapt to technology refreshes. The RSPACE tools will transition to the Air Force and the Navy. ***FY 2018 Plans:*** - Develop a fully integrated software system prototype to demonstrate a distributed concept of operations. - Conduct a series of capability and system-level assessments in conjunction with potential transition partners in preparation for 2019 Air Force experimentation. - Refine models of ISR and counter-ISR capabilities based on Navy guidance following Pacific Fleet (USPACFLT) experiments. - Refine decision aid algorithms and prototype implementations based on Navy guidance following USPACFLT experiments and guidance from Navy transition program of record. - Develop use cases, concepts of operations, and requirements for extension of RSPACE algorithms to the multi-domain (air, space, and cyber) and system of systems command and control problem. - Extend distributed air warfare planning tools to provide land warfighters with targeting, situation awareness, and terrain knowledge. ***FY 2019 Plans:*** - Conduct one or more live-virtual, simulation-based tests in conjunction with a scheduled live Air Force experiment to facilitate transition to the Air Force. - Integrate prototype software with external systems and scale to large, high operational tempo scenarios. - Enhance models and user support interfaces in preparation for transition to operational testing by the Navy. - Commence development of market-based resource prioritization technology. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects the change of emphasis from development and integration to demonstration and experimentation during the final year of the program.			
Title: Systems of Systems-Enhanced Small Units (SESU)	-	6.960	13.124
Description: The 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			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
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 destroy enemy combat systems. The goal of the fight will be to push enemy decision makers beyond loss tolerance before they achieve operational objectives. Technologies to accomplish this include command, control, & communications (C3) that operate in a contested environment and interoperate with host-nation forces; distributed sensing, including the ability to leverage indigenous information sources; and hybrid effects that include a mix of kinetic, non-kinetic, and information operations capabilities. 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. SESU technologies will be integrated using system-of-systems principles developed under the System of Systems Integration Technology and Experimentation (SoSITE) program, also budgeted in this Program Element/Project. 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 2018 Plans:*** - Begin development of system-of-systems architecture that supports rapid and adaptive kill-web composition. - Begin development of baseline mission scenarios and define SESU components. - Develop architectures for autonomous drones to provide land warfighters with targeting, situation awareness, and terrain knowledge. ***FY 2019 Plans:*** - Demonstrate initial technologies in a simulated environment. - Develop C3 and situation understanding technologies. - Develop plan for live field experimentation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase reflects a shift in focus from initial development to demonstrations.			
Title: Prototype Resilient Operations Testbed for Expeditionary Urban Systems of Systems (PROTEUS)	-	8.866	17.285
Description: The Prototype Resilient Operations Testbed for Expeditionary Urban Systems of Systems (PROTEUS) program will demonstrate that dynamically composable systems of systems (SoS) provide superior performance and adaptability in the dynamic, uncertain environment posed on U.S. warfighters by urban combat operations. PROTEUS will provide the tools and automation to enable small tactical units to compose force packages optimized to specific urban combat objectives and challenges. These tools will support planning and force composition for all missions relevant to the urban environment: command & control, fires, maneuver, logistics, intelligence, force protection, and medical. PROTEUS will be adaptive to an inherently dynamic and fluid environment that will extend to the social complexity of urban combat as well as kinetic warfighting. Technologies will be integrated using systems of systems principles developed under the System of Systems Integration			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Technology and Experimentation (SoSITE) program, also budgeted in this Program Element/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 2018 Plans:*** - Initiate development of a virtual testbed. - Begin development of planning and force composition tools for fires, command and control, and maneuver warfighting functions. - Initiate planning for demonstration of initial capabilities. ***FY 2019 Plans:*** - Develop a multi-resolution scenario within the virtual testbed and compare outcomes against a Marine Corps exercise benchmark. - Define friendly and opposing force systems for kinetic functions. - Demonstrate integration of the virtual testbed and the composition tool using the benchmarked scenario. - Demonstrate adaptive composition capability with Service participants. - Commence development of mathematical tools to define and score the value of materiel in a logistics flow. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase reflects increased effort associated with development and demonstration objectives.			
Title: Retrodirective Arrays for Coherent Transmission (ReACT)	9.615	5.584	-
Description: Worldwide advancements in signal processing and electronics have decreased the effectiveness of single-platform, power-based Electronic Warfare (EW) as a viable technique in the future. The goal of the Retrodirective Arrays for Coherent Transmission (ReACT) program is to develop and demonstrate the capability to combine distributed mobile transmitters to direct high-power spatially resolved radio frequency (RF) beams to a single location. ReACT will achieve this capability by synchronizing multiple distributed transmitters to form a much larger effective array than a single aperture. The key technical challenge is to synchronize distributed and moving transmitters while compensating for platform motion and vibration. The ReACT system will sense the target's emissions and then optimally configure the ReACT transmitters to focus on the area of interest. The ReACT technology is planned to transition to the Air Force and Navy. ***FY 2018 Plans:*** - Continue broadband estimation analysis and algorithm development for accomplishment of program metrics. - Integrate node capabilities, hardware, and externally mounted apertures for a dynamic airborne demonstration on multiple aircraft. - Operate airborne array at suitable test facility with real world scenario/environment.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Finalize transition package for Navy technology demonstration group. - Obtain technical data package, to include Matrix Laboratory (MATLAB) code for other transition paths. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects program completion.			
Accomplishments/Planned Programs Subtotals	54.177	67.114	72.402

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
NET-02: *MARITIME SYSTEMS*	-	135.967	138.112	130.511	-	130.511	126.643	106.465	140.323	147.323	-	-

A. Mission Description and Budget Item Justification

The objective of the Maritime Systems project is to identify, develop, and rapidly mature 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 2017	FY 2018	FY 2019
Title: Cross Domain Maritime Surveillance and Targeting (CDMaST)	16.238	29.869	25.432

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 Cross Domain Maritime Surveillance and Targeting (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 Cross Domain Maritime Surveillance and Targeting (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 2018 Plans:
- Continue development of architectures and prepare for experimental operations.
- Finalize experimentation master plan.
- Continue operation and enhancement of the system of systems experimentation environment.
- Initiate spiral experimentation and demonstration of the advanced CDMaST architecture.
- Initiate elemental, engineering and operational tests on selected segments of the CDMaST architecture.
- Conduct Battle Management and Command and Control (BMC2) analysis to evaluate highly resilient kill chains.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- Develop autonomous surface platform architecture for distributed sensing and effects. ***FY 2019 Plans:*** - Integrate system of systems assets and perform operational tests leading to at-sea demonstrations of CDMaST capability to facilitate transition to the Navy. - Continue to refine the CDMaST architecture segments and service layers. - Continue to conduct elemental, engineering, and operational tests on selected segments of the CDMaST architecture. - Complete planning for at sea demonstrations of the CDMaST architecture. - Conduct at-sea demonstrations of the CDMaST architecture. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects reduced testbed development and platform integration efforts.			
Title: Mobile Offboard Command, Control and Attack (MOCCA)	16.799	20.894	18.694
Description: The 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. The program seeks to achieve breakthrough capability for long-range submarine detection and precision target tracking. The program will develop compact, high output acoustic transducers and novel low probability of intercept/low probability of detection (LPI/LPD) communication signaling. In addition, the MOCCA system will be integrated into submarine onboard sonar and weapons control systems. This program will transition to the Navy. ***FY 2018 Plans:*** - Complete critical technology testing to evaluate at-sea performance of UUV mobile sonar demonstrating source level and beam control, LPI/LPD communications waveforms detectability, range performance and data rate, and sonar processing algorithms. - Complete feasibility and system design trade space studies. - Finalize MOCCA payload UUV packaging and integration studies. - Design, build, and unit test MOCCA sonar and communication payloads and Roll-on/Roll-off processors. - Initiate process for approval of temporary alteration plans for integration of MOCCA sonar and communications Roll-on/Roll-off processors into submarine systems for test and evaluation. - Conduct system utility analysis to identify optimal performance specifications for concept of operations under multiple tactical situations. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
- 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. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects transition from development and demonstrations of competitive system solutions to a single solution integrated into a submarine platform to demonstrate operational performance.			
Title: Positioning System for Deep Ocean Navigation (POSYDON)	24.346	23.718	18.118
Description: The 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. 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 will distribute a small number of acoustic sources, analogous to GPS satellites, around the ocean basin. A submarine or AUV will be equipped with an acoustic receiver and appropriate software in order to obtain, maintain, and re-acquire, if lost, an initial 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 can determine its range from each source and thus trilaterate its position. Technologies developed under this program will transition to the Navy. ***FY 2018 Plans:*** - Complete development of user equipment. - Continue development of the acoustic propagation models and signal waveforms. - Complete development of user equipment ocean models to support real-time ranging. - Demonstrate interference mitigation and anti-spoof capabilities. - Demonstrate real-time undersea positioning with an AUV tracking multiple acoustic sources. ***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. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The FY 2019 decrease reflects reduction of at-sea testing.			
Title: Tactical Undersea Network Architecture	20.173	19.973	13.573
Description: Systems fighting as a network are vulnerable to a loss of connectivity in a contested environment. This connectivity is important for synchronizing forces, establishing and maintaining situation awareness, and control of remotely operated vehicles and systems. Additionally, undersea systems are challenged to maintain connectivity and must carry their own energy and operate over their design lifetime with little to no maintenance and repair. These factors inhibit their use in collaborative networks and prevent the full exploitation of the potential of undersea systems. The Tactical Undersea Network Architectures program will overcome these limitations by developing the technologies necessary for autonomous, reliable, and secure undersea data transfers; true plug, play, and operating standards; and rapid, cost effective deployment technologies. 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. The program will focus on innovative system architecture designs, lightweight optical fiber technologies, and rapidly deployable buoy node designs and component technologies. The Tactical Undersea Network Architectures program will emphasize early risk reduction with future scaled at-sea integrated demonstrations of increasing complexity. Program technologies will transition to the Navy. ***FY 2018 Plans:*** - Test system architecture and information assurance architecture in hardware-in-the-loop simulation. - Complete detailed system design, conduct Critical Design Review, and complete prototype system fabrication. - Complete and publish all environmental compliance documentation. - Complete system integration for and demonstrate at-sea deployment, operation, and connectivity. ***FY 2019 Plans:*** - Complete system integration for and perform at-sea networking demonstration to facilitate transition to the Navy. - Transition interface control and system architecture documentation to Navy. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects the completion of engineering design, build, and unit test efforts.			
Title: Hunter	-	15.250	22.542
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			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
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 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.			
Title: Tactical Exploitation of the Acoustic Channel (TEAC)	-	13.350	23.152
Description: The Tactical Exploitation of the Acoustic Channel (TEAC) program will provide the capability to coherently combine acoustic energy from a distributed network of underwater acoustic sources to improve signal transmission in an undersea environment. The ability to cohere multiple underwater sensors will have a transformative impact on a number of compelling applications including surveillance, communications, and vehicle positioning. For all of these applications, coherent sensor gain is currently achieved by deploying large, costly, and cumbersome cabled arrays. Based on technologies explored in the Mobile Offboard C2 and Attack (MOCCA) program, budgeted in this PE/Project, the TEAC program will create the opportunity to deploy groups of low unit-cost sources that work cooperatively and semi-autonomously to focus energy undersea. This concept would provide an extensible, affordable, and flexible method to harness the rapid development of undersea vehicles, ocean energy sources, and new acoustic source technologies. Technologies developed under this program are intended to transition to the Navy. ***FY 2018 Plans:*** - Develop underwater source positioning requirements and identify alignment strategies. - Begin system architecture design and acoustic propagation modeling. - Develop the fixed source network, algorithms, and signal waveforms for at-sea demonstration.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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 2017	FY 2018	FY 2019
- Develop a model for multi-vehicle representation, which will serve as a baseline for the maritime collaborative networks. ***FY 2019 Plans:*** - Demonstrate and test at-sea cohering of acoustic sources. - Analyze sea-test data to identify system performance robustness. - Begin development of motion mitigation algorithms. - Begin development of command and control for a semi-autonomous distributed system. - Develop concept of operations for TEAC system deployment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase reflects large-scale testing.			
Title: Ocean of Things ***Description:*** The goal of the Ocean of Things program is to advance maritime sensing and battlespace awareness and provide non-lethal maritime effects 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, which is also in this Program Element. Ocean of Things will develop large numbers of heterogeneous sensing and effects platforms to cover large ocean areas. 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 develop applications for distributed platform behavior using an internet of things architecture deployed across the world's oceans. Further research will examine additional platform capabilities and system impacts of various communication rates and platform behaviors. The Ocean of Things program will improve ocean awareness and provide access to areas not covered by existing platforms. Technologies developed in Ocean of Things will transition to the Navy. ***FY 2019 Plans:*** - Conduct initial sensor and payload studies to examine optimal sensor and payload types for platform configurations. - Develop initial hardware design and sensor configurations for test platform delivery. - Prepare data platform, model ocean inputs and design initial machine learning applications. - Develop advanced platform design. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 increase reflects program initiation.	-	-	9.000
Title: Hydra	32.682	7.558	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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 2017	FY 2018	FY 2019
Description: The Hydra program will develop and demonstrate advanced capabilities for the undersea deployment and employment of unique payloads. Hydra integrates existing and emerging technologies and the ability to be positioned in the littoral undersea battlespace to create a disruptive capability. The system consists of a modular enclosure with communications, command and control, energy storage, and standard interfaces for payload systems. The modular enclosures are deployed by various means, depending on the need for speed and stealth, and remain deployed until awakened for employment. Hydra will develop critical enabling technologies for energy storage and recharging, communications, command and control, deployment, and autonomous operations. Technology developed under this program is transitioning to the Navy. ***FY 2018 Plans:*** - Complete modular enclosure demonstration. - Launch air vehicle from undersea. - Continue testing of alternative payload deployment methods, and conduct at-sea demonstration. - Complete testing of undersea-launched air vehicle. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects program completion and transition of technologies from this program to the Navy.			
Title: Hybrid Multi Material Rotor Full Scale Demonstration (HyDem)	7.500	3.000	-
Description: The goal of the Hybrid Multi Material Rotor Full Scale Demonstration (HyDem) program is to dramatically improve U.S. Navy submarine superiority. HyDem will apply breakthroughs in materials and material system technologies, and multi-disciplinary design methods to a Virginia Class submarine propulsor, a critical component in submarine performance. The U.S. Navy's ability to operate their submarine fleet with improved capability allows for the creation of strategic surprise. Submarines could exploit expanded areas that were previously unattainable for the purpose of submarine warfare, including antisubmarine warfare (ASW), antisurface warfare (ASuW), intelligence, surveillance and reconnaissance (ISR) gathering, strike, Special Forces operations, and strategic deterrence missions. The HyDem program will design, manufacture, and supply the Navy with a novel component for integration into a new construction Virginia Class submarine. The Navy will evaluate this component in sea trials. It is envisioned that the Navy will integrate this design change into the future development of the Virginia Class and Ohio Replacement submarines, and back-fit previously constructed Virginia Class submarines. Technology developed under this program is transitioning to the Navy. ***FY 2018 Plans:*** - Complete sea trials of the propulsor on a Virginia Class submarine. - Complete naval shafting applications study.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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 2017	FY 2018	FY 2019
- Deliver a scaled shafting component. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The FY 2019 decrease reflects program completion and transition to the Navy.			
Title: Blue Wolf ***Description:*** Undersea platforms have inherent operational and tactical advantages such as stealth and surprise. Platform drag due to fluid viscosity and platform powering requirements varies with the speed through the water. Platform energy and power density limitations create two distinct operational usage profiles: one for unmanned undersea vehicles (low speed, long endurance) and another for undersea weapons (high speed, short endurance). Designers have historically solved this with hybrid systems such as the Navy's Vertical Launch Anti-Submarine Rocket, or by increasing the size of undersea systems. However, hybrid systems can be vulnerable to air and undersea defensive systems and larger undersea systems can result in significant launch platform modifications. 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. Significant technical challenges to be addressed include: dynamic lift and drag reduction, hybrid energy system development compatible with existing manned platform safety requirements and certification, and system integration and demonstration in at-sea environment. The program will leverage Navy connectivity, autonomy, guidance, navigation, and obstacle avoidance technologies. Under an existing Memorandum of Agreement, following vehicle integration and initial testing, the program will transition to the Navy. ***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.	15.140	4.500	-
Title: Virtual Acoustic Microphone System (VAMS) ***Description:*** The Virtual Acoustic Microphone System (VAMS) program developed additional acoustic sensor capabilities for underwater platforms. The VAMS program sought to develop and demonstrate technologies that enable projection of underwater acoustic sensor arrays with performance comparable to existing arrays. The VAMS approach combined novel transmitters with	3.089	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
novel signal extraction methods and exploit new and emerging high-speed sensor and processor capabilities which are not currently possible with existing technology. The acoustic sensor technology developed under the VAMS program transitioned to the Navy.			
Accomplishments/Planned Programs Subtotals	135.967	138.112	130.511

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Defense Advanced Research Projects Agency			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	227.682	234.160	235.656	-	235.656	204.050	149.500	83.200	30.000	-	-

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 2017	FY 2018	FY 2019
Title: Classified DARPA Program	227.682	234.160	235.656
Description: This project funds Classified DARPA Programs. Details of this submission are classified. ***FY 2018 Plans:*** Details will be provided under separate cover. ***FY 2019 Plans:*** Details will be provided under separate cover. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	227.682	234.160	235.656

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Details will be provided under separate cover.