Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Navy											Date: April 2022	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602235N *I Common Picture Applied Research*							
COST ($ in Millions)	**Prior Years**	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	42.219	51.477	51.911	-	51.911	54.616	55.709	56.823	57.960	Continuing	Continuing
0000: *Common Picture Applied Research*	0.000	42.219	51.477	51.911	-	51.911	54.616	55.709	56.823	57.960	Continuing	Continuing

A. Mission Description and Budget Item Justification

Activities and efforts in this program examine concepts and technologies that enable the transformation to Distributed Maritime Operations (DMO). Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission- focused communications and networks; and pervasive and persistent sensing drive network centric Science and Technology (S&T) investments.

Today's Sailors and Marines are enabled by Naval S&T. Since 1946, the Office of Naval Research (ONR) has fostered scientific research related to the maintenance of maritime superiority and national defense. ONR manages the Department of the Navy's (DON) portfolio of naval Basic and Applied research, and Advanced Technology Development investments to ensure naval forces can effectively deter conflict, but when called upon, fight, win and come home safe. Current investments hedge against uncertainty, providing solutions to commanders today, and options for the future. The Naval S&T budget supports higher guidance defined by the National Defense Strategy, and responds to requirements identified by the Secretary of the Navy through research priorities set by the Chief of Naval Research, coordinated across the Naval Research Enterprise (NRE), and outlined in the Naval R&D Framework.

This Program Element (PE) funds Applied Research, which is the systematic study to understand the means to meet a recognized and specific need. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments).

Due to the number of efforts in this Program Element (PE), the programs described herein are representative of the work included in this PE.

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B. Program Change Summary ($ in Millions)	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**
Previous President's Budget	43.495	51.477	0.000	-	0.000
Current President's Budget	42.219	51.477	51.911	-	51.911
Total Adjustments	-1.276	0.000	51.911	-	51.911
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.276	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Adjustments to Budget Year	-	-	51.911	-	51.911

Change Summary Explanation

Funding: No significant change

Technical: No significant change

Schedule: No significant change

FY 2023 funding increase reflects the fact that the FY 2022 President’s Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy			Date: April 2022
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COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
0000: *Common Picture Applied Research*	0.000	42.219	51.477	51.911	-	51.911	54.616	55.709	56.823	57.960	Continuing	Continuing

A. Mission Description and Budget Item Justification

Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric Science and Technology S&T investments.

The activities described in this Program Element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Office of the Chief of Naval Operations, and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Title: Communication and Networks	5.952	6.294	6.345	0.000	6.345
Description: The overarching objective of this activity is to develop high throughput dynamic wireless communications and network technologies critical to the mission performance and robustness of naval communications for widely dispersed, mobile air, land, surface and submerged platforms. These platforms are often Size, Weight and Power (SWaP) limited, and will operate under constraints of cluttered Radio Frequency (RF) spectrum, harsh Electro-Magnetic Interference (EMI) and Beyond Line Of Sight (BLOS) conditions. The technical payoff is increased network data rates, interoperability across heterogeneous radios, dynamic bandwidth management, and greater mobile network connectivity. The operational payoff is that warfighters from the operational command to the tactical edge have near real-time access to information, knowledge and decision-making necessary to perform their tasks, including coalition and allied forces. Emphasis is on tactical edge communications and networks to fully realize net-centric warfare, bridging the Global Information Grid (GIG) and the 'disadvantaged user', e.g., small-deck combatants, submarines, unmanned vehicles, distributed sensors and ground units in urban and RF challenged environments. The current specific objectives are:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Radios and Apertures: - Develop technologies for high band radio, electrically-small and actively scanned antennas, addressing critical issue of radio spectrum bandwidth efficiency, spectrum contention and clutter, agile frequency communications with dynamic spectrum access, all-digital front-end with wide dynamic range, power amplifier efficiency, multipath effects, saltwater propagation and Beyond Line Of Sight (BLOS) communications. - Develop algorithms and signal processing for space-time-frequency diversity communications, including measures for electronic protection, such as low-intercept, antijam waveforms and modulation. - Develop affordable antenna technologies for small size and weight, high radiation efficiency, and wideband operation with rapid beam-steering. - Develop alternatives to Radio Frequency (RF) communications in airborne and terrestrial environments as well as high data rate underwater communications for undersea warfare (distributed sensor netting, unmanned underwater vehicle data exfiltration, submarine Communications at Speed and Depth) using Electro-Optic/Infra-Red (EO/IR) technologies. - Develop secure, high bandwidth communications systems and the exploitation of existing and emerging network protocols that will avail development of new, Low Earth Orbit (LEO) based data transport mechanisms. Tactical Networking and Network Control/Management: - Develop advanced networking techniques for robust, highly dynamic environments; interoperable networks for secure communications and protocols, bandwidth and network management techniques that manage and allocate bandwidth across tactical and theater levels in support of net-centric operations. - Develop rapidly auto-configuring and self-organizing networks with efficient and survivable routing, secure authentication, mobility management and Quality-of-Service guarantee, while optimizing network resources. - Address low bandwidth, synchronization and reliability for Service Oriented Architecture (SOA)/Middleware Architecture in both Mobile Ad-hoc Networks (MANET) and infrastructure-based Internet Protocol (IP) backbone networks. - Develop cognitive network planning and operations engines whose criteria are based directly on mission objectives, while self-adapting and managing the spectrum allocation and radio resources in such a way that network operations, SOA community of interest, and computer network defense are integrated to form a single common tactical network picture that requires a minimum of human intervention and skill. ***FY 2022 Plans:*** Communication and Networks: - Continue research on communications with low probability of detection.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue research on novel path computation algorithms and autonomous distributed network control. - Continue research on efficient approaches for wideband, multi-beam, high-power communications. - Continue research on optical beam distortion and phase front corrections with machine learning and neural networks. - Continue research on quantum techniques for secure underwater magnetic and optical communications systems. - Continue research on artificial intelligence approaches to establish network policies based on Commander Intent. - Initiate research on transmission security enhancements to 5G for tactical operations. - Initiate research addressing several known problems in signal processing theory related to synchronization and detection theory specifically for covert communications waveforms. - Initiate research on optimization techniques to develop robust data coordination systems for dynamic and denied Naval environments.					
FY 2023 Base Plans: Communication and Networks: - Continue research on communications with low probability of detection. - Continue research on novel path computation algorithms and autonomous distributed network control. - Continue research on efficient approaches for wideband, multi-beam, high-power communications. - Continue research on optical beam distortion and phase front corrections with machine learning and neural networks. - Continue research on quantum techniques for secure underwater magnetic and optical communications systems. - Continue research on artificial intelligence approaches to establish network policies based on Commander Intent. - Continue research on transmission security enhancements to 5G for tactical operations. - Continue research addressing several known problems in signal processing theory related to synchronization and detection theory specifically for covert communications waveforms. - Continue research on optimization techniques to develop robust data coordination systems for dynamic and denied naval environments.					
FY 2023 OCO Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** There is no significant funding change from FY 2022 to FY 2023.					
Title: Applied Information Sciences for Decision Making ***Description:*** The goal of this activity is to develop enablers for decision making and mission execution in order to achieve battlespace superiority. It focuses on the development of algorithms and software technologies that identify and integrate informational content from multiple sources, leading to decision aids that support user-cognitive processes. Because persistent sensors are generating massive amounts of data, the focus is on technologies that not only integrate information from diverse sources, but also provide indications of information significance in ways that support the user's decision needs, regardless of location and operational situation. To achieve this, it must be possible to automate understanding of the battlespace by identifying objects, determining relationships among the objects, recognizing activities, assessing intent, and automatically generating courses of action with associated risks and uncertainty. Effort will also be devoted to developing technology for increasing assurance and security for Communication, Command and Control (C3) information systems and technology for improving information discovery and information presentation in such systems. The Nano Electronics Technology activity is focused on developing ultra-low power, higher performance computing devices and components that are based on novel functionalities of nanometer scale materials and are enabled by improved understanding of nanomaterials, new devices and circuit design concepts, as well as new architectures uniquely suited for nanoscale systems. Applied research in artificial intelligence focuses on the unique challenges of the Naval domain by providing intelligent decision aids while operating in the complex spatio-temporal environments of distributed Naval forces. ***FY 2022 Plans:*** Quantum Information Sciences: - Complete quantum communication research as it applies to practical approaches to secure key generation that include technologically limited eavesdropper assumptions. - Complete research into interconversion of optical and microwave quantum states for memory and information processing tasks. - Continue research into the application of on-chip optical processing with distributed quantum states of light for suppressing noise for measurement and communication devices. - Initiate research into efficient protocols to implement quantum information processing with atoms and photons.	29.059	37.088	37.883	0.000	37.883

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Initiate research into quantum approaches to solve hard decision problems with naval relevance that may outperform classical techniques. Computational Methods for Decision Making: - Complete methods for recognition of activities in urban and semi-urban areas from surveillance video based on weakly supervised deep learning techniques. - Complete methods based on probabilistic (and-or) graphs for modeling events and activities toward automated understanding of data acquired by Naval information systems. - Complete methods based on computer vision, deep learning, and reasoning for detection, tracking, and reacquisition of small vessels in (intermittent) aerial surveillance imagery for interdiction of sea-borne smuggling. - Complete efforts of combining priming queues and learning agendas to optimize memory retrieval, resulting in decreased computational effort and a lower memory footprint for missions in the 2-15 year lifetimes. (NRL Input) - Complete efforts to create explainable deep networks within the context of automated surveillance and demonstrating how this approach can be used to locate and explain why something is a potential threat. (NRL Input) - Continue development of methods for robust recognition of activities in surveillance videos based on the integration of plan recognition and short-duration action recognition. - Continue development of methods for large-scale coordination and aggregation of individual preferences. - Continue development of methods for adaptive training on individual and group levels. - Continue development of methods for continuous learning and expertise assessment. - Continue development of mathematical models, theory, and solution methods for most effectively allocating scarce resources (funds, information, personnel, equipment) within competitive environments. - Continue development of methods for Unmanned Aerial Vehicle (UAV)-based video surveillance along roads and rivers that are partially occluded by tree canopies using a marsupial system consisting of a large UAV capable of long-duration flight and several small quadcopters. - Continue analysis of information flow and dynamics of influence in large networks. - Continue development of tools for structured and distributed deliberation and decision-making. - Continue development of secure and privacy-preserving tools for information sharing. - Continue development of visual sense making capabilities for distributed Navy teams to successfully run operations in increasingly contested, diverse, multi-expertise, and highly data driven decisional contexts. - Continue a research emphasis on defender-attacker-defender problems that seek strategies for obtaining resilient operational systems under the threat of attack.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Initiate efforts such as using Machine Learning (ML) models to recognize and predict what the operator is doing, allowing the system to then facilitate the operator's goals. - Initiate development of robust computer vision systems inspired by human visual system. - Initiate investigation of Radio Frequency (RF) imaging for motion detection and activity recognition behind optically opaque walls. - Initiate development of algorithmic methods for detection of objects and activities in very low light environments. - Initiate development of algorithms for unmanned surface vehicles that determine optimal sensor placement for detecting and tracking targets of interest in littoral areas, as well as to develop verification methods and tools to increase the operational assurance of the autonomous vehicles. Nanoscale Electronics Technology: - Continue research on Two-Dimensional (2D) materials and related device and circuit functions. Specifically, the program will push the limit of 2D semiconductor transistors through van der Waals integration, explore surface and interface engineering of Two-Dimensional (2D) heterostructures, devise and test devices and circuits with graded 2D materials, and explore flexible wearable electronic system by exploiting large-scale graphene and other 2D materials. - Initiate exploratory research on graphene based vacuum electronics. Cyber Defense: - Continue to conduct applied research toward dependable and resilient cyber systems, leveraging results from basic research program, and developing and evaluating technical approaches for future naval capabilities. The program investigates technologies addressing root causes of cyber vulnerability and enhancing efficiency, robustness and cyber resiliency for all classes of computing systems in naval enterprise systems. - Continue efforts to mature technologies and continue work to introduce new capabilities into many cyber security areas, such as automated cryptographic design exploration, cyber decoys and disinformation, and more including development of tools and techniques for understanding and improving security of cyber-physical systems, an area of focus for naval systems, which will inform multiple follow-on efforts. - Initiate/Complete efforts to improve the security of lookup and the security of entrance for Internet sites developing subdomain onion addresses for self-authenticating subdomains of registered domains that will work with ordinary browsers and will appear as alt names in Transport Layer Security (TLS) certificates. (NRL Input) - Initiate development of tools and techniques to model and understand adversary motivation and intent that scale beyond traditional artifact analysis in order to achieve robust, hardened and scalable cyber defense					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
techniques that can be employed throughout Navy networks that address nation state adversary activities. (NRL Input) Data Analytics: - Continue development of methods for large-scale assessment and evaluation of distributed information. (formerly in Computational Methods for Decision Making) - Initiate/complete Agile Enclave capability transitioning to Consolidated Afloat Networks and Enterprise Services (CANES) Program of Record. The Agile Enclave capability will be deployed to all Navy ships and submarines as an additional enclave to enable effective operations in a Command and Control Denied, Degraded, Environment (C2D2E). - Initiate applied research in optimizing coordination, efficient exchange of information and integration of large amounts of data in real time among distributed operations centers. - Initiate development of an architecture that supports distributed/resilient Maritime Operations Center operations that supports multi-level system with zero trust enforcement. - Initiate development of disseminating data in a prioritized way and under zero-trust conditions between a shore-based multi-level system cloud environment and an on-premise cloud multi-level system at the tactical edge. Science of Artificial Intelligence: - Continue development of principled computational frameworks for integrating domain knowledge and machine learning for fast robust learning of diverse, complex concepts and tasks with light supervision. Domain knowledge includes physical models, as well as rules, relations and semantic descriptions. - Continue efforts exploring a unified framework for perception and planning for resources distributed across multiple platforms (agents, platforms, autonomous systems or vehicle swarms) to exploit the massive, diverse data obtained, while subject to communication limitations. - Continue work on new brain-inspired artificial intelligence algorithms and architectures that provide richer computational capabilities than current deep learning networks and model compact neuromorphic hardware suitable for edge computing and signal processing in Naval platforms. - Initiate research on Artificial Intelligence (AI) for enhanced collaborative complex decision-making, and human-machine dialogue. - Initiate research on embedding AI in robotic systems to enable human-machine collaboration and robot training.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Initiate work to integrate physical models with machine learning to enable predictive maintenance for autonomous Naval platforms. - Initiate AI-based analysis of data from wearable sensors and performance measures to optimize human performance and predict risk of injury. - Initiate research on the ability to enable a humanoid robot to adapt skills, learned in one environment or context, to new situations. Cues of the current context, including the environmental state or goals of the robot or its teammates, will modulate the execution of existing robotic skills, such as adjusting the robot's speed. (NRL SUBMIT) Electromagnetic Warfare: - Continue the development and demonstration of a novel Electronic Attack (EA) capability. It will accomplish this by enhancement of a suite of Radio Frequency (RF) signature-related technologies. The result will provide a new capability to counter advanced threats.					
FY 2023 Base Plans: Quantum Information Sciences: - Continue research into the application of on-chip optical processing with distributed quantum states of light for suppressing noise for measurement and communication devices. - Continue research into efficient protocols to implement quantum information processing with atoms and photons. - Continue research into quantum approaches to solve hard decision problems with naval relevance that may outperform classical techniques. - Initiate research on robust devices compatible with long distance distribution of entanglement. Computational Methods for Decision Making: - Complete development of algorithmic methods for detection of objects and activities in very low light environments. - Complete development of methods for robust recognition of activities in surveillance videos based on the integration of plan recognition and short-duration action recognition. - Complete a research on defender-attacker-defender problems that seek strategies for obtaining resilient operational systems under the threat of attack.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue development of methods for Unmanned Aerial Vehicle (UAV)-based video surveillance along roads and rivers that are partially occluded by tree canopies using a marsupial system consisting of a large UAV capable of long-duration flight and several small quadcopters. - Continue development of robust computer vision systems inspired by human visual system. - Continue investigation of Radio Frequency (RF) imaging for motion detection and activity recognition behind optically opaque walls. - Continue efforts using Machine Learning (ML) models to recognize and predict what the operator is doing, allowing the system to then facilitate the operator's goals. - Continue development of algorithms for unmanned surface vehicles that determine optimal sensor placement for detecting and tracking targets of interest in littoral areas, as well as to develop verification methods and tools to increase the operational assurance of the autonomous vehicles. - Continue development of methods for large-scale coordination and aggregation of individual preferences. - Continue development of methods for adaptive training on individual and group levels. - Continue development of methods for continuous learning and expertise assessment. - Continue development of mathematical models, theory, and solution methods for most effectively allocating scarce resources (funds, information, personnel, equipment) within competitive environments. - Continue analysis of information flow and dynamics of influence in large networks. - Continue development of tools for structured and distributed deliberation and decision-making. - Continue development of secure and privacy-preserving tools for information sharing. - Continue development of visual sense making capabilities for distributed Navy teams to successfully run operations in increasingly contested, diverse, multi-expertise, and highly data driven decisional contexts. - Initiate development of robust reinforcement learning methods for autonomous agents that can learn performing multiple tasks in several different environments. - Initiate research into stochastic integer programming models and algorithms to achieve strategic and tactical superiority in a variety of contexts. - Initiate research into developing practical integer programming approaches to solving binary classification problems. Nanoscale Electronics Technology: - Continue research on Two-Dimensional (2D) materials and related device and circuit functions. Specifically, the program will push the limit of 2D semiconductor transistors through van der Waals integration, explore surface and interface engineering of 2D heterostructures, devise and test devices and circuits with graded 2D materials.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue exploratory research on graphene based vacuum electronics. - Initiate research on electronic effects of "Moire" textures induced by broken symmetry between 2D atomic layers, for example in twisted bilayer graphene capable of assuming a sequence of correlated phases. Cyber Defense: - Complete thrusts into automated cryptographic design exploration. - Continue to conduct applied research toward dependable and resilient cyber systems, leveraging results from basic research program, and developing and evaluating technical approaches for future naval capabilities. The program investigates technologies addressing root causes of cyber vulnerability and enhancing efficiency, robustness and cyber resiliency for all classes of computing systems in naval enterprise systems. - Continue thrust in cyber decoys and disinformation, exploring how to automatically analyze the artifacts from cyber adversary campaigns for noise generation that could degrade and disrupt those campaigns. - Continue design and development of tools and techniques for understanding and improving security of cyber-physical systems, which are a critical area of focus for assuring mission success of naval platforms. The systematic extension of techniques in cyber fault tolerance are informing new resilience architectures for sensor processing systems, which continues to inform future planned follow-on efforts. - Continue efforts to improve the security of lookup and the security of entrance for Internet sites developing subdomain onion addresses for self-authenticating subdomains of registered domains that will work with ordinary browsers and will appear as alt names in Transport Layer Security (TLS) certificates. - Continue development of tools and techniques to model and understand adversary motivation and intent that scale beyond traditional artifact analysis in order to achieve robust, hardened and scalable cyber defense techniques that can be employed throughout Navy networks that address nation state adversary activities. - Initiate design of approaches to apply techniques from signal processing and machine learning to ingestion of granular system events in context of memory structure for advanced understanding of system state that would be more effective at discovering activity of stealthy adversaries. Data Analytics: - Continue development of methods for large-scale assessment and evaluation of distributed information. - Continue applied research in optimizing coordination, efficient exchange of information and integration of large amounts of data in real time among distributed operations centers. - Continue development of an architecture that supports distributed/resilient Maritime Operations Center operations that supports data in multi-level system with zero trust enforcement.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue development of disseminating data in a prioritized way and under zero-trust conditions between a shore-based multi-level system cloud environment and an on-premise cloud multi-level system at the tactical edge. - Initiate development of advanced data analytics to enable automated and orchestrated threat detection consistent with the DISA Zero Trust Reference Architecture to refine and extend Agile Enclave to provide secure data access in challenging warfighting environments. Science of Artificial Intelligence: - Continue applied research on principled computational frameworks for integrating domain knowledge and machine learning for fast robust learning of diverse, complex concepts and tasks with minimal supervision to analyze the sparse, noise and unlabeled data of the Naval domain. - Continue the application of new brain-inspired artificial intelligence algorithms and architectures for the development of compact neuromorphic hardware suitable for edge computing and signal processing in Naval platforms. - Continue the use Artificial Intelligence (AI) for enhanced collaborative complex decision-making and human-machine dialogue to increase the speed and quality of operational decisions. - Continue research on embedding AI in robotic systems to enable human-machine collaboration and robot training for hazardous missions. - Continue to integrate physical models with machine learning to enable predictive maintenance for autonomous Naval platforms and enable long duration autonomous missions. - Continue to conduct AI-based analysis of data from wearable sensors and task performance measures to monitor and optimize human performance. - Continue research on the ability to enable a humanoid robot to adapt skills learned in one environment or context, to new situations. Cues of the current context, including the environmental state or goals of the robot or its teammates, will modulate the execution of existing robotic skills, such as adjusting the robot's speed. - Initiate applied research to design embedded neuromorphic processors into intelligent autonomous systems to permit onboard analysis of target data to enable single-pass mine countermeasures missions. - Initiate applied research to validate AI algorithms to provide distributed perception in networks of interacting autonomous agents in the presence of varying levels of reliability and trust at both network and individual agent. - Initiate applied research on AI tools for multi-level optimization of shipyard maintenance scheduling to accelerate on time delivery of ships out of maintenance and improve ship availability and fleet readiness. - Initiate research techniques for training AI to perform tasks from human behavior and natural language instruction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Electromagnetic Warfare: - Continue the development and demonstration of a novel Electronic Attack (EA) capability. It will accomplish this by enhancement of a suite of Radio Frequency (RF) signature-related technologies. The result will provide a new capability to counter advanced threats. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** There is no significant funding change from FY 2022 to FY 2023.					
Title: Multi-Source Integration and Combat Identification ***Description:*** This activity addresses Theater Air And Missile defense (TAMD), and responds to warfighter needs for rapid, high confidence Combat Identification (CID) of air and missile threats at long range, using real time and non-real time threat attributes and intelligence information. ***FY 2022 Plans:*** Electromagnetic Warfare: - Complete efforts into discovering features of ship signatures vulnerable to certain threat detections and determine how to mitigate these. - Continue research into the use of models to determine the enhanced radar cross section of HVV and provide improved prediction and interpretation from HVV flights for early detection/identification and performance evaluation of these vehicles. - Continue research into efficient broadband two-dimensional high frequency transmit arrays for Over-The-Horizon (OTH) Radar. This will enable two dimensional transmit beam steering, adaptive transmit side lobe control and reduced prime power requirements for long range detection of objects in the environment. ***FY 2023 Base Plans:*** Electromagnetic Warfare:	1.665	1.870	1.774	0.000	1.774

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Complete research into the use of models to determine the enhanced radar cross section of Hyper Velocity Vehicles (HVV) and provide improved prediction and interpretation from HVV flights for early detection/ identification and performance evaluation of these vehicles. - Complete efforts into efficient broadband two-dimensional high frequency transmit arrays for Over-The-Horizon (OTH) Radar. This will enable two dimensional transmit beam steering, adaptive transmit side lobe control and reduced prime power requirements for long range detection of objects in the environment. - Initiate development of sensors and sensor networks to locate and track any target of interest in the Maritime Domain. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** There is no significant funding change from FY 2022 to FY 2023.					
Title: Tactical Space Exploitation ***Description:*** The Tactical Space Exploitation initiative explores the application of new space craft technologies on small, light-weight and low-cost satellites, to enhance naval warfighting capabilities by taking advantage of the global access, revisit and connectivity provided by orbital platforms. To perform early-applied discovery Research and Development (R&D) to ensure Navy-Marine Corps access to critical space-associated capabilities on the ground, at sea, and in a contested space environment; research thrusts include spacecraft R&D in five strategic cross-cutting areas that lead to the fielding of systems which perform functions critically important to operations. These areas are: (1) Advanced Space Platform Technologies, such as development of new and prototype space systems that are tailored to specific threats, including technologies which reduce cost, mass, power and/ or extend on-orbit lifetimes, and sub-systems that advance propulsion and control capabilities towards precision maneuvering while minimizing fuel; (2) Next-generation Payloads and Sensors, including space robotic capabilities to address on-orbit inspection, servicing, repair, assembly, and mission life extension; (3) Connectivity for disadvantaged users that is rugged, high-bandwidth and space based; (4) Space Weather, and (5) Space Situational Awareness. ***FY 2022 Plans:***	5.543	6.225	5.909	0.000	5.909

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602235N / *Common Picture Applied Research*	**Project (Number/Name)** 0000 / *Common Picture Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Space Research and Spacecraft Technology: - Complete the development and validation of models of cathode breakdown and plasma formation to demonstrate reliable, repeatable cathode ignition using plasma heating, which will benefit the Navy by enabling instant ignition within seconds for responsive, low-power operation aboard highly mobile small satellites. - Complete the development of a Global Positioning System (GPS)-denied satellite autonomous navigation system that can operate for years with no input from operators or external systems and still perform a useful mission; and the development of a simulation tool capable of predicting the change in the aerodynamic performance of hypersonic vehicles after impact with atmospheric cloud formations over a range of mission scenarios and weather conditions. - Complete effort towards the successful completion of a robotic assembly task using a formally stable haptic feedback scheme in the presence of communication latency that allows an operator to feel how the robot is moving, rather than rely only on camera views or simulations.					
FY 2023 Base Plans: Space Research and Spacecraft Technology: - Initiate early-applied discovery Research and Development (R&D) to ensure Navy-Marine Corps access to critical space-associated capabilities on the ground, at sea, and in a contested space environment. Research thrusts include space related R&D in three strategic cross-cutting areas that lead to the fielding of systems which perform functions critically important to Naval operations and addressing Navy/Marine Corps current and future needs and requirements. These areas are: 1) Advanced space technologies, such as development of new prototype and exploratory space systems that are relevant to maritime navigation, maritime domain awareness, and distributed maritime operations (DMO), including technologies which reduce cost, mass, power. 2) Next-generation payloads and sensors, including space-based environmental monitoring instruments and on-orbit autonomous calibration and/or data processing addressing the DON's Electromagnetic Environment (EME) needs. 3) Connectivity for disadvantaged maritime and littoral users that is rugged, high-bandwidth and space based. - Initiate efforts for the development and demonstration of new measurement and data assimilation capabilities to predict phenomena that influence Over-the-Horizon Radar (OTHR) and communication, which will advance OTHR related capabilities and communication avenues.					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Initiate research efforts for the development of robust and reliable hypersonic air breathing platforms. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** There is no significant funding change from FY 2022 to FY 2023.					
Accomplishments/Planned Programs Subtotals	42.219	51.477	51.911	0.000	51.911

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A