Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy											Date: May 2017	
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing
0000: *Common Picture Applied Research*	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing

Note

N/A

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

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 S&T investments.

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

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	42.538	41.185	37.916	-	37.916
Current President's Budget	42.973	41.185	36.450	-	36.450
Total Adjustments	0.435	0.000	-1.466	-	-1.466
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.107	0.000			
• SBIR/STTR Transfer	-0.672	0.000			
• Program Adjustments	0.000	0.000	-1.466	-	-1.466

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy					Date: May 2017
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*			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy			Date: May 2017
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*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0000: *Common Picture Applied Research*	0.000	42.973	41.185	36.450	-	36.450	38.376	38.548	38.716	39.490	Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (20 January 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

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 S&T investments.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: COMMUNICATION AND NETWORKS	6.975	7.194	7.283	0.000	7.283
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:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
a) 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 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 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. b) 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. Develop technology for improving tactical edge networking and for improving voice communications. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Radios and Apertures: - Continued design and development of electronic protection for high frequency communications.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued technologies to improve spectrum co-existence of military waveforms with commercial communications (e.g., overlay/underlay techniques, interference cancellation, machine learning and reasoning algorithms for distributed spectral awareness/management, etc.). - Continued development of low cost approaches for electronic beam steering and multi-beam radio frequency systems. - Continued development of technologies to enable troposcatter communications on the move with reduced size, weight, and power antennas. - Continued development of blue-green filter technologies with wide field of view, narrow bandwidth, and reduced size, weight, complexity, etc. - Continued design and development of electronic protection for HF communications. - Completed development of integrated metamaterial antennas for ship and ground platforms. - Completed demonstration of high peak power, short pulse operation of fiber lasers in blue-green region. - Completed development of blue-green receiver and detector technologies with greater sensitivity, while reducing size, weight, power, and/or cost. Tactical Networking and Network Control/Management: - Initiated the development of software-defined networking capabilities for tactical platforms. - Continued dynamic routing mechanisms that focus on robust data delivery -- in near real time -- under harsh networking conditions (i.e.,intermittent connectivity, limited throughput, etc.). - Continued development of techniques and algorithms to manage resources of tactical networks in a manner consistent with Commander's Intent. - Continued development of techniques and algorithms to ensure end-to-end delivery of data across undersea networks with large delays and multi-modal communications. - Completed design and development of cognitive netops for tactical communications.					
FY 2017 Plans: Radios and Apertures: - Continue all efforts of FY 2016 less those noted as complete. - Complete design and development of electronic protection for HF communications. - Initiate the development of novel antenna technologies for communications with small satellites. - Initiate the development of optical technologies for tracking and communications with small satellites. - Initiate the development of interference alignment and chaotic waveform techniques for secure communications.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Initiate development of MEMS enabled reflectarray phased array antennas. Tactical Networking and Network Control/Management: - Continue all efforts of FY 2016 less those noted as complete. - Complete development of techniques and algorithms to ensure end-to-end delivery of data across undersea networks with large delays and multi-modal communications. - Initiate development of performance-aware dynamic communication protocols (including multicast with network coding) that adapt to varying network conditions and application requirements. ***FY 2018 Base Plans:*** Continue research in antenna technology to include electrically small antennas, wideband multifunction antennas, compatibility of phased array antennas with naval platforms and marine environments, directional beam forming/steering techniques, and special-purpose submarine communication antenna systems; radio communications to include anti-jam and low-probability-of-intercept techniques, SATCOM performance enhancements, interference mitigation, adaptive equalization, bandwidth efficient modulation, cognitive radio for dynamic spectrum management, and high data rate tactical communications techniques including communications at speed and depth (for submarines); and wireless networks to include mobile ad-hoc wireless networking algorithms/protocols, end-to-end Quality-of-Service, joint/coalition interoperability, service oriented tactical networking, mission-based policy and network controls and management. Continue network-centric and information warfare capability for the Navy/Marine Corps by addressing deficiencies and science gaps in tactical networks. These capabilities address unique military environment and application challenges enabling new mission concepts requiring minimal human intervention. Focus on three specific objectives: dynamic network structural analytics and adaptation; robust network organization and transport, distributed group collaboration and discovery; and adaptive signaling and sensing to improve military wireless communications. Demonstrate a digital design receiver testbed for compressed sensing techniques for a communications relay; and real time application of analytic complex network theory metrics to both aid the prediction of network performance and to assist a cyber tool to identify and track network strengths and weaknesses. ***FY 2018 OCO Plans:*** N/A					
Title: APPLIED INFORMATION SCIENCES FOR DECISION MAKING	24.366	25.225	22.519	0.000	22.519

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Description: The goal of this activity is to develop enablers for decision making and mission execution, 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, 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 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. Funding increase from FY16 to FY17 is a result of increased research in Cyber Defense. Funding decrease from FY17 to FY18 is a result of the completion of Cyber Investment Management Board Initiative (CIMBI) Gap Mitigation effort. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity. ***FY 2016 Accomplishments:*** Data Understanding: - Initiated efforts for reconstructing events from a loose network of heterogeneous cameras. - Continued development of algorithms for extraction of information from Light Detection and Ranging (LIDAR) and Radar. - Continued efforts to develop an automated tool to improve checkpoint security by identifying accents of non-native English speakers. - Continued development of methods for integration of low-level image processing and high-level knowledge for simultaneous image segmentation and object recognition, and visual reasoning for image understanding. - Continued development of 3D image processing for object recognition and meaningful change detection.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued development of modular, interactive, intelligent, video-based surveillance systems. - Continued methods for building sophisticated visual knowledge bases, development of methods for visual reasoning and integrating them in image/video understanding, and development of methods for image description. Information Integration: - Continued development of methods for analysis and integration of text with imagery and video. - Continued development of methods for analysis of structured and unstructured data. - Continued development of algorithms and tools for information representation of unstructured data and structured data in such a way that shared concepts/relationships in disparate data sets can be automatically compared, matched, or associated, and in a way that can facilitate and improve information fusion. - Continued development of algorithms and tools for information fusion of heterogeneous data for classification and reconstruction based on high level features inherent in each data source, with the goal of forming a more complete picture of battlespace environment. - Continued development of algorithms and tools for discovering and extracting higher-level features -- objects, events, patterns, intents, relationships, anomalies -- from various data types in support of future asymmetric warfare. - Continued research to extend user interfaces for immersive simulation to enable users to better express themselves through non-verbal communications. - Continued research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. - Furthered research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. - Completed research to extend user interfaces for immersive simulation to enable users to better express themselves through non-verbal communications. Data Analytics (Formerly Titled: Mission Focused Autonomy (MFA) - Initiated Maritime domain awareness toolkit development for small vessel tracking. - Initiated cyber information awareness decision tools for hull, mechanical and electrical security for Naval vessels. - Continued bringing capability into a multi-level security environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continue automating current set of time critical reports to ensure timely decision making that is informed by forensics data. - Continued efforts to develop a task scheduler for unmanned aerial system operators that reflects operator workload. - Continued research in mission-focused autonomy and reasoning methods; expanded autonomy from simple platform. kinematics to include all-source information exploitation and surrounding cultural and social influences. - Continued integrating this analytic environment into parallel Navy Tactical Cloud environment. Resource Optimization: - Continued development of methods for selecting sensors and platforms for search and surveillance operations in a theater, allocating the selected sensors and platforms to specific missions, operating the allocated sensors during a mission, and fusing the information from the sensors and other sources. - Continued development of optimization-based decision aids for resource allocation, such as those required for mission planning at the strategic, operational, and tactical level. Cyber Defense: - Initiated development for methods and tools for semi-/fully- automated software model extraction and online program execution monitoring toward achieving adaptive and resilient computing system. - Continued development of anti-tamper methods that are capable of lengthy operation in unattended and un-powered environments, have very high probability of tamper detection and very low probability of false alarm, and remain undetected in the host system. - Continued development of automated tools that identify and mitigate potential software vulnerabilities, such as tools that analyze code as it is being written, vulnerability-aware compilers that automatically enhance code security, and techniques for enhancing the client-side security of web applications. - Continued research into better protecting Department of Defense systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. - Furthered research into better protecting Department of Defense systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. Nanoscale Electronics:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued effort to develop a highly linear, low-noise radio frequency amplifier using aligned arrays of single-walled carbon nanotubes. - Continued new research in graphene synthesis and device concepts. - Continued effort to develop the synthesis, fabrication and testing of graphene-based electromechanical structures and devices. - Continued work on graphene-based devices and circuits for low power flexible electronics. - Continued research on graphene-organic hybrid materials interfaces and device structures. Quantum Information Sciences: - Continued free-space Quantum Key Distribution applied research program for secure communication. Network Situation Awareness & Security: What happened to this Project? - Continued development of algorithms/methods for providing attribution of threat-agents through the network/ infrastructure. Emphasis will be placed on addressing translational boundaries, cross-domains, and obfuscation techniques to avoid detection and tagging. - Continued new mobile agent technology that provides network protection, thwarts botnet attacks, and provides for a resilient computational infrastructure and communications environment. Investigate new methods for subverting the control plane of the mobile code attacking the infrastructure. - Continued development of algorithms/methods for providing attribution of threat-agents through the network/ infrastructure. Building upon previous results, develop network-based techniques to provide pro-active response to attributed threat agents to mitigate attack vector and ensure mission success. - Continued investigating new methods for subverting the control plane of the mobile code attacking the network infrastructure. - Continued the development of new algorithms for taking control of bots once the control plane is compromised. - Continued development of new algorithms/techniques to characterize Navy and Marine Corps network assets in order to develop robust security mechanisms and support technologies based on criticality and mission essential operations. Network Traffic Analysis and Assessment: - Continued development of new algorithms focused on detection of nation state sponsored activities through the network infrastructure. Develop algorithms to address sophisticated malicious code techniques.					

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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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued algorithms to address sophisticated malicious code techniques that exploit network traffic/data that is fragmented, encrypted, and/or obfuscated using polymorphic methods, as well as techniques that transgress security perimeters and exfiltrate data. - Continued development of new algorithms that provide attack prediction and targets of opportunity. - Continued the development of algorithms and techniques to detect stealthy protocols that enable covert communication by exploiting channels available in existing widely used protocols. Information Assurance: - Continued the development of methods and techniques to provide component repurposing/agility to flatten the attack surface from sophisticated nation-state sponsored attacks. - Continued the development of trusted computing technologies to minimize/limit authentication/sign-on services across various network, virtual, and/or cloud environment.					
FY 2017 Plans: Data Understanding: - Continue all efforts of FY 2016 less those noted as complete above. - Complete efforts to develop an automated tool to improve checkpoint security by identifying accents of non-native English speakers. Information Integration: - Continue all efforts of FY 2016, less those noted as completed above. - Complete research into designing more resilient networks that better adapt to disruption and change by developing new analytical models and methodologies for characterizing network node relationships to improve prediction of statistical communication performance and structural relationships within dynamic ad hoc networks. Data Analytics (Formally Titled Mission Focused Autonomy (MFA): - Continue all efforts of FY 2016, less those noted as completed above. - Complete efforts to develop a task scheduler for unmanned aerial system operators that reflects operator workload. Resource Optimization: - Continue all efforts of FY 2016, less those noted as completed above.					

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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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Cyber Defense: - Continue all efforts of FY 2016, less those noted as completed above. - Furthering research into better protecting DoD systems by developing methods and tools that are applicable both to source and binary code for the detection and mitigation of attacks in commercial-off-the-shelf (COTS) software that exploit vulnerabilities in the Windows platform. Nanoscale Electronics: - Continue all efforts from FY 2016, less those noted as completed above. Quantum Information Sciences: - Continue all efforts of FY 2016, less those noted as completed above. Network Situation Awareness & Security: - Complete all efforts of FY16 Network Traffic Analysis and Assessment: - Complete all efforts of FY16 Information Assurance: - Complete all efforts of FY16					
FY 2018 Base Plans: Information Technology: Initiate research to improve the operational capability of Naval decision support systems and decrease the cost of these systems through transformative advances in information management that enables agility in timely and accurate decision and action. The military capability from this task area is technology to support improved situational awareness and operational effectiveness, improved techniques for dealing with information-intensive applications, and information management processes that improve the speed and accuracy of decisions and actions. Electromagnetic Warfare: Initiate research in advancing the state-of-the-art in being able to uniquely identify target of interest in very complex environments using passive technologies to assure high confidence to the decision maker when					

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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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
combined with other information sources. This is being accomplished by expanding specific emitter identification technologies into areas detecting previously unaddressed and unexplored with the intent of maintaining battlespace superiority. Quantum Information Sciences: Continue research of quantum key distribution (QKD) protocols and implementations for the purpose of understanding the security implications for QKD in the maritime environment, the development of protocols that simultaneously minimize leakage of information to the environment and the creation of secure networks, as well as schemes to maximize the information carried by a continuous or discrete variable; and research of algorithms for naval functions such as routing, weapon-target pairing, etc., a key application such as radar cross section calculation. Computational Methods for Decision Making (formerly Data Understanding, Information Integration, and Resource Optimization): Continue research of Information Integration, Automated Image Understanding, and Resource Optimization for the purpose of developing innovative methods for combining traditional and non-traditional data from sensors and disparate sources to provide the best estimate of objects, events, and conditions in the battlespace, in terms of their identity, associated error or uncertainty, context, impact, while inferring relationships and their intentions; developing automated, image and signal intelligence understanding tools based on rigorous mathematical and statistical methods that lead to improved change detection, improve object and activity detection and recognition capabilities, context and scene understanding, and inferring of the threat levels to support decision making and persistent and adaptive surveillance; and developing automated decision-support tools based on mathematically rigorous techniques (e.g., mathematical optimization) that support decision-making to ensure the best use of scarce and/or expensive resources, achieving optimal allocations for large complex scenarios, including ones that contain uncertainty, in drastically reduced amounts of time. Develop methods that support decision making in networked sensor management and allocation to ensure sensor assets are deployed in an optimal, or near optimal, manner. Nanoscale Electronics Technology: Continue research in novel nanometer scale (feature size near or below 10nm) logic/memory devices and related circuits and architectures to deliver ultra-low power, light weight and high performance computational capability for autonomous vehicles and individual warfighters.					

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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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Cyber Defense: Continue research in cyber systems, leveraging results from basic research program, developing and evaluating technical approaches for future naval capabilities. The program investigates technologies for enhancing efficiency, robustness and cyber resiliency for all classes of computing systems in naval enterprise systems as well as Navy's real-time safety critical cyber physical systems. Data Analytics: Continue research in new approaches to support tactical decision makers and information superiority. This is performed by producing distributed situation assessment of a commander's environment through development of a common tactical picture; developing collaborative, distributed mission plans; monitoring and dynamically replanning mission execution as required; understanding their environment by being able to access distributed heterogeneous enterprise information stores intelligently through use of autonomic software; effectively using sensor information and making resource allocation decisions and information operations. Specific research involves real-time computing, decision aids and collaborative workspaces; secure distributed architectures; and information warfare methods to protect secure information. ***FY 2018 OCO Plans:*** N/A					
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. Funding decrease from FY16 to FY17 is a result of the completion of the development of Associative Learning signal classification framework. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2016 Accomplishments:*** - Continued development of a new radar signature analysis technique based on nonlinear dynamics. - Continued development of coordinated, multi-platform, multi-component waveforms. - Continued development of a real-time, electronic warfare support, de-interleaving capability. - Continued development of advanced communications emitter identification.	3.818	2.863	1.530	0.000	1.530

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued to develop and demonstrate Multiple Input Multiple Output (MIMO) radar concepts and technology using High Frequency (HF) Skywave radar. - Continued development of electronic protection techniques for long range emitter classification systems. - Continued development of Associative Learning signal classification framework to provide robust automatic target recognition. - Continued development of methodology to incorporate electromagnetic (EM) vector sensors in unmanned surface vehicles (USVs) to enable high frequency signal detection and geolocation. - Continued development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave high frequency radar. - Furthered development of methodology to incorporate EM vector sensors in USVs to enable high frequency signal detection and geolocation. - Furthered development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave high frequency radar.					
FY 2017 Plans: - Continue all efforts of FY 2016. - Furthering development of methodology to incorporate EM vector sensors in USVs to enable HF signal detection and geolocation. - Furthering development of advanced 2D array geometries and signal processing techniques to expand the operational envelope of surface wave HF radar. - Complete development of Associative Learning signal classification framework to provide robust automatic target recognition.					
FY 2018 Base Plans: Electromagnetic Warfare (NRL) New algorithmic approaches are being developed to conduct automatic target recognition using associative learning. A small sized design has been built to improve RF detection of targets at HF frequencies as precursors to adversary air attacks. This in conjunction with improvements being made in HF surface wave radar array geometries should greatly improve operational capabilities in this reinvigorated part of the RF spectrum. A new concept for rapidly assessing concurrently multiple missiles with multiple EW responses is being investigated to provide for rapid high quality assessment in this complex environment.					
FY 2018 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: TACTICAL SPACE EXPLOITATION	5.782	5.903	5.118	0.000	5.118
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. a) Spacecraft Technology: Affordable, expendable payload and bus technologies will be developed, which will serve as building blocks for future responsive space systems: payloads, bus technologies and significant space robotic technologies that address on-orbit inspection, servicing, repair and assembly, and mission-life extension. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity: ***FY 2016 Accomplishments:*** - Continued program to use chemical release from satellites launched into selected low-Earth orbits to de-populate intense trapped electrons in radiation belts following a low-altitude nuclear explosion in space. - Continued effort to develop technologies using autonomous, bi-dexterous manipulation for close proximity operations in space. - Continued developing the underlying fluid transfer technologies for steerable radiators that will enable spacecraft thermal radiators to be pointed away from the sun. - Continued developing a proof-of-concept, reliable, touch sensitive skin for robotic arms, with emphasis on space applications, and the associated fault detection and model identification algorithms required to utilize it. - Continued developing the ability to artificially generate and maintain a dust layer in the near earth plasma environment to induce enhanced drag on space debris, aiming toward debris mitigation. - Continued effort to develop the key advanced technologies leading to robust use of space-based electrodynamic propulsion, which will enable spacecraft that perform large scale maneuvers fuel-free, and more cheaply than is currently possible. - Continued effort to design and develop a novel miniature radiation displacement damage sensor that will accurately measure the impact of displacement damage in a space environment.					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
- Continued efforts to develop a novel actuator and associated control laws that will enable lighter weight architectures for spaceflight robot arms, thereby dramatically reducing size, weight, complexity, and cost of spaceflight robotic manipulators. - Continued efforts to quickly assimilate tracking data of orbiting debris and space objects, while simultaneously shrinking position uncertainties, in order to create more room to operate in space. - Continued efforts to radically reduce thermionic cathode temperature and power by developing the capability for rapid 3D printing of complex cathode parts using the new low-temperature emitter C12A7. - Continued efforts to develop and demonstrate a low power, radiation-hard micro-satellite receiver on a chip which has wide dynamic range and a flexible architecture. - Completed effort to design and develop a novel miniature radiation displacement damage sensor that will accurately measure the impact of displacement damage in a space environment. - Completed effort to develop the key advanced technologies leading to robust use of space-based electrodynamic propulsion, which will enable spacecraft that perform large scale maneuvers fuel-free, and more cheaply than is currently possible.					
FY 2017 Plans: Spacecraft Technology: - Continue all efforts of FY 2016 unless noted as complete. - Furthering efforts to radically reduce thermionic cathode temperature and power by developing the capability for rapid 3D printing of complex cathode parts using the new low-temperature emitter C12A7. - Furthering efforts to develop and demonstrate a low power, radiation-hard micro-satellite receiver on a chip which has wide dynamic range and a flexible architecture. -Complete efforts to develop a novel actuator and associated control laws that will enable lighter weight architectures for spaceflight robot arms, thereby dramatically reducing size, weight, complexity, and cost of spaceflight robotic manipulators. - Complete efforts to quickly assimilate tracking data of orbiting debris and space objects, while simultaneously shrinking position uncertainties, in order to create more room to operate in space.					
FY 2018 Base Plans: Spacecraft Technology Develop advanced, high-payoff technologies that will preserve, protect, and enhance space capabilities in the performance of functions that are of critical importance to Naval operations while also reducing the cost of DoD space activities. Initiate efforts to develop the key tomographic algorithm needed to construct three-dimensional ionospheric electron density from persistent space-based stereoscopic observations, to enable significant					

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
passive reduction of Over The Horizon Radar (OTHR) registration errors. Initiate use of the new NRL Loop Heat Pipe transient numerical model and stability theory to design oscillation-free LHPs, to enable precise, reliable spacecraft thermal regulation for higher mission reliability. ***FY 2018 OCO Plans:*** N/A					
Title: AUTONOMOUS SYSTEMS AND ROBOTICS ***Description:*** The Autonomous Systems and Robotics initiative explores the application of new technologies to advance capabilities in the area of robotics, autonomous systems propulsion and control, and integration of autonomous systems. Efforts will be focused on the Assistant Secretary of Defense (Research and Engineering) (ASD (R&E)) priorities in autonomous systems. The decrease from FY 2016 to FY 2017 reflects the completion of the efforts for sustainment of Autonomous Systems and Robotics initiative. ***FY 2016 Accomplishments:*** - Completed all FY15 efforts for sustainment of Autonomous Systems and Robotics initiative. ***FY 2017 Plans:*** N/A ***FY 2018 Base Plans:*** N/A ***FY 2018 OCO Plans:*** N/A	2.032	0.000	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	42.973	41.185	36.450	0.000	36.450

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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E. Performance Metrics

This PE supports the development of technologies that enable the transformation to network centric warfare. Net-centric operations include communications and information assurance capabilities to enable all-source data access, tailored dissemination of information to Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) users across the network, and rapid, accurate decision making based on this information. The operational benefits sought are increased speed of response, accuracy, and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority.

Specific examples of metrics under this PE include:
- Increase network data rates and interoperability across heterogeneous radios; improve dynamic bandwidth management and mobile network connectivity.
- Increase the understanding of the battlespace by the development of automated tools for extracting information from images and signals, identifying objects, determining relationships among the objects, assessing intent, and generating courses of action.
- Improve the integration of sensors, networks, decision aids, weapons, and supporting systems into a highly adaptive, human-centric, comprehensive maritime system.
- Improve integrated signals electronics packages in small, light-weight, and low-cost satellites to test new concepts for global ship tracking and two-way data exfiltration.