Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Navy											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*					R-1 ITEM NOMENCLATURE PE 0601152N: *In-House Lab Independent Res*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	17.642	18.261	18.230	-	18.230	18.758	19.126	19.499	19.852	Continuing	Continuing
0000: *In-House Lab Independent Res*	0.000	17.642	18.261	18.230	-	18.230	18.758	19.126	19.499	19.852	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority by providing new technological concepts for the maintenance of naval power and national security, and by helping to avoid scientific surprise while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNCs). The Department of Navy (DON) component responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements and is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command. It enables technologies that significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. The In-house Laboratory Independent Research (ILIR) program also adds increased emphasis to the revitalization of the scientist and engineer workforce component at the Navy's Warfare Centers and Laboratories by attracting superior candidates and retaining our best members through the provision of exciting and meaningful work.

This PE addresses DON Basic Research, which includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental, and life sciences, and is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in thirteen research focus areas: Power and Energy; Operational Environments; Maritime Domain Awareness; Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Distributed Operations; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; Affordability, Maintainability and Reliability.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for: basic research to support the execution of their assigned missions; developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems; promoting hiring and development of new scientists; and encouragement of collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

ILIR efforts are selected by Naval Warfare Centers/Lab Commanding Officers and Technical Directors near the start of each Fiscal Year through internal competition. Efforts typically last three years, and are generally designed to assess the promise of new lines of research. Successful efforts attract external, competitively awarded funding. Because the Warfare Centers and Labs encompass the full range of naval technology interests, the scope of ILIR topics roughly parallels that of PE 0601153N, Defense Research Science.

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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 2012	FY 2013	FY 2014 Base	FY 2014 OCO	FY 2014 Total
Previous President's Budget	18.092	18.261	18.522	-	18.522
Current President's Budget	17.642	18.261	18.230	-	18.230
Total Adjustments	-0.450	0.000	-0.292	-	-0.292
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.271	0.000			
• SBIR/STTR Transfer	-0.179	0.000			
• Program Adjustments	0.000	0.000	-0.292	-	-0.292

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Navy			DATE: April 2013
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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
0000: *In-House Lab Independent Res*	0.000	17.642	18.261	18.230	-	18.230	18.758	19.126	19.499	19.852	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project sustains U.S. Naval S&T superiority, provides new technological concepts for the maintenance of naval power and national security, and mitigates scientific surprises, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNC's). It responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements. It is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command (NWDC) and the Marine Corps Combat Development Command (MCCDC), and enables technologies that significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for basic research to support the execution of their assigned missions, for developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to naval problems, to promote hiring and development of new scientists, and to encourage collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: ADVANCED MATERIALS	3.438	3.243	2.918
Description: Efforts include: structural materials; functional materials; maintenance reduction, hydrodynamics; power generation; energy conservation and conversion. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research on the use of Density Functional Theory (DFT) for intelligently designing the next advancement in chromophore (dye) structures. - Completed research to develop new, narrow and wide band gap electroactive polymer materials with tunable energy levels for high power and energy density batteries. - Completed research to develop several novel experimental techniques to understand the phenomena of mixing in energetic material in the metal-metal oxide combustion zone.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Completed research for Acoustic Metamaterials. - Completed research for Absorbent Materials for Fuel Desulfurization. - Completed research on Phase Equilibria and High-Temperature Ceramics for Zirconium Based Systems. - Completed research on the Atomic Structure and Lattice Dynamics of Thermoelectric Materials. - Completed research for the Fundamental Understanding of the Thermodynamic Properties of Metamaterials. - Completed research for the Internal Behavior of Electromagnetic Properties of Metamaterials and Wideband Tunability. - Completed research for Liquid-Crystalline Polymers for Broadband Noise Attenuation in Towed Array SONAR Systems. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete research for Biaxial Fatigue in Corrosive Environment with the overall effort to: (1) characterize the biaxial fatigue behavior in a corrosive environment, comparing with that in air, (2) identify the basic mechanism of environment-assisted biaxial fatigue cracking, (3) expand the model for corrosion fatigue crack growth under biaxial loading, and (4) demonstrate and validate the model in the application to aircraft structure. - Complete research for Control and Dispersion of Electromagnetic Energy Using Metamaterials, where the dispersion and control of electromagnetic (EM) waves in the microwave (RF) region, using fabricated metamaterial structures, were demonstrated. Six metamaterial structures were modeled using in-house programs, DOD supercomputer resources, and High Frequency Structure Simulation (HFSS) software, and fabricated use photolithography, vapor deposition, and chemical and reactive ion etching. Scattering parameters (transmittance and reflectance), were acquired using a Network Analyzer coupled to a free space analysis setup. - Complete research for Polyurea Silicate Composites. The objective of this research is to identify the structural transitions and interactions of the polyurea and nanoparticle that underlie the enhanced mechanical mechanisms for the protective response of polyurea nanocomposites. The approach is to use small angle and wide angle x-ray scattering (SAXS and WAXS) simultaneously with tensile and recovered impact tests to obtain a fundamental understanding of the polyurea nanoparticle effect at the molecular level. The strain rate material responses, both elastic and plastic, would be incorporated into a constitutive equation needed for modeling and for hydrocode simulations for further calculations of optimized geometries and layer thicknesses. - Initiate fundamental research on high strength nanostructures/nanomaterials. - Initiate research for new concepts, configurations, and applications for metamaterials. - Initiate research for high temperature alloys for engine applications. - Initiate research for low-cost, high-strength material repair.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete understanding on how stresses and environment affect Aeta-phase precipitation in Al-Mg Alloys to ensure laboratory sensitized samples reflect the microstructure and phase stability of Al sensitized in service. Effort takes into account contributions of stress (residual and applied) and environment on the kinetics of Aeta-phase precipitation. - Initiate research for nanocomposite materials for increased armor protection of naval structures. - Initiate research for polymer materials to understand improved helmet blast protection. - Initiate fundamental research for composite materials for reduced signature for undersea vehicles. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering.			
Title: ELECTRONICS SENSOR SCIENCES ***Description:*** Efforts include: sensing, diagnostics, and detectors; navigation and timekeeping; nano electronics; real time targeting, Electro Optical/InfraRed (EO/IR) electronics; EO/IR electronic warfare; and EO/IR sensors for surface and subsurface surveillance. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year. - Continued research for computer vision techniques on optical and acoustic sensor data for underwater object detection and classification. - Continued research for wideband retro-reflective arrays. - Continued research on an application of Green's function technique to explore exotic and unexpected nano-phenomena in the electromagnetic scattering of finite-length nanowires. This effort has broad applicability to a variety of nano devices, such as: nano-antennas; nano-lasers; nanosensors; subwavelength photonic integration; and metamaterial designs. - Continued research for high finesse optical domain radio frequency (RF) filters. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research efforts in basic understanding of electromagnetic scattering in the nano-regime. - Completed research investigation for Millimeter Wave Spectroscopy.	2.531	2.415	2.178

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Completed research for Underwater Coherent Target Detection in Sonar Imagery in Clutter. - Completed research on Non-Traditional Sensors for Surveillance. - Completed research for Analog Photonic Amplification. - Completed research in the Investigation of Acoustic Cloaking. - Completed research for Scattered Acoustic Vector Fields in the Near Field Resonance Region. - Completed research efforts for Magnetoelastic/Piezoelectric Layered Composite Structures. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility in Undersea Weaponry.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete research for High Finesse Optical Domain RF Filters, where the objective is to design and fabricate a chip scale integrated optical filter architecture with periodic flat passbands of narrow bandwidth compatible with conventional digital signal processing (i.e. < 50MHz) and a finesse of 100 or greater. This type of filter design is previously unexploited in the optical domain and will help enable real time spectrum analysis and channelization in the photonic domain across multi-GHz RF signals. - Complete research for Computer Vision Techniques on Optical and Acoustic Sensor Data for Underwater Object Detection and Classification. The goal of this research is to use advances in machine learning and computer vision to utilize optical and acoustic sensors in concert for object detection and classification in underwater applications. This technology can be used for object identification in a multitude of scenarios, as well as for visual surveillance of a harbor. Furthermore, advanced computer vision can be used for self localization of an underwater vehicle. A specific goal of the research will be object detection and classification of mines found on the sea floor. - Complete research for Wideband Retro-Reflective Arrays. Metamaterial transmission lines (MTMs) are proposed to be investigated for the design of a wideband, retroreflective Van-Atta array. The technical objectives of the project are to explore the basic science behind metamaterial transmission line technologies and their practical implementation. The goal is to achieve enhanced bandwidth and increased gain performance of a Van-Atta array that is compact in size for low-observable, retro-reflective applications. - Initiate research for Wireless Highly Reliable Networks. - Initiate research for the Optimization of Autonomous ASW Sensor Suites. - Initiate research for Nano-sensor Technology. - Initiate research for Nano-circuit Devices. - Initiate research on Advanced Chem-Bio Sensor and Detection.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete the development of algorithms and simulation environment which addressed key issues in order to find approximate solutions to the coverage problem for static (wireless sensor networks) WSNs and dynamic WSNs (or UxVs). Resultant data will yield valuable tools for WSN and UxV developers who seek to understand and maintain their WSNs' and UxVs' quality of coverage service, and thus extend their WSNs' and UxVs' lifespan, utility and autonomy. - Complete dynamic hybrid routing algorithm for Under Sea Sensors with integrated localization and tracking that can be implemented in a distributed manner, such that each node of such a network can intelligently and autonomously determine a wise routing strategy. This approach combines existing routing techniques (proactive, reactive, and geographical) along with localization and tracking to create a novel underwater communications algorithm. The tracking component employing modeling of node movement will allow nodes to maintain an estimate of the locations of other nodes without repeatedly having to communicate with them to gather geographic information. - Initiate research for the fundamental understanding of graphene type Radio Frequency (RF) Antennas. - Initiate research for complex unmanned sensor networks. - Initiate fundamental research for the understanding of optimization of undersea sensor distribution in littoral environments. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering.			
Title: ENERGY SCIENCES ***Description:*** Efforts include: undersea weaponry; energetic materials and propulsion; directed energy; and TeraHertz Time-Domain Spectroscopy (THz-TDS) technology that addresses overseas contingency operations and Counter Improvised Explosive Device (C-IED) detection by detecting and spectroscopically identifying military and home-made explosives and formulations. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year. - Continued research on the microbial biosynthesis of critical energetic ingredients. - Continued research for accelerated quantum chemistry simulations of energetics using a novel metadynamics approach. - Continued research for convergent synthesis of high performance heterocycles via late amination.	1.326	1.267	1.144

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Continued research to investigate the dispersion and control of electromagnetic (EM) waves in the microwave (RF) region using fabricated metamaterial structures. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed the research on Molecular Switching of Explosive Molecules. - Completed the research on the Synthesis of Non-toxic, High-energy, Explosive Materials. - Completed research and understanding of Modified Energy Released Weapons. - Completed research for the Analytical Ballistic Penetration Study of the Adaptable High-Speed Underwater Munitions. - Completed research effort for the understanding of Sulfur Hexafluoride as an Oxidant for Unmanned Underwater Vehicle (UUV) Electrochemical Power Systems. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete the research on the Microbial Biosynthesis of Critical Energetic Ingredients which investigated new methods of microbial synthesis in the production of feedstocks for energetics. Microbial synthesis is the controlled harvesting of organic molecules from biological factories such as E. coli. It is hypothesized that large scale control and manipulation of these efficient microbial factories could lead to increased availability of traditionally rare feedstocks, enhanced sustainability due to the reduced need for organics from non-petroleum-derived feedstocks, and the significant reduction of hazardous waste. - Complete the research for Accelerated Quantum Chemistry Simulations of Energetics using a Novel Metadynamics Approach, the goal of which is to develop methods based on a metadynamics approach that can predict important chemical properties of energetic materials and additives that are normally inaccessible to first-principles simulation. The main properties used to evaluate the method are uni- and bimolecular decomposition barriers, oxidation reactions, accelerated aging studies, and crystalline density predictions. The focus will be on complex or novel systems that have previously been difficult to simulate, such as polymer chains, novel high-nitrogen explosives, and organometallic compounds - Complete the research for Convergent Synthesis of High Performance Heterocycles via Late Amination, which focuses on convergent synthesis of energetic, high nitrogen CHNO heterocycles using novel energetic synthons to provide increased performance to Navy ordnance. Designing higher heats of formation and higher densities into novel energetic CHNO compounds, while retaining good kinetic stability and safety properties, requires new structural motifs. The 1,2,3,4-tetrazine 1,3-dioxide structural motif, first described by Tartakovsky et al. in the 1991 synthesis of benzo tetrazine dioxide, remains an undeveloped energetic synthon. Although furazano tetrazine dioxide has been known for the last decade, its energetic properties are still			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
unknown. The synthetic routes chosen are expected to permit ready transition to the pilot level and offer reasonably priced materials. - Initiate research for High-Output, Low-Cost Energetic Materials - Initiate research for High-Speed Energetic Weapons. - Initiate research on Fundamental Development of Polymer Materials with Tunable Energy Levels. - Initiate Research for High-Density, High-Output Batteries. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete increased weapon lethality focused on the design and synthesis of aluminum based cluster compounds so as to increase their reaction rates to the order of common CHNO High Explosives (HE). This effort will provide fundamental understanding of this chemistry, and produce new cluster compounds that are amenable to use in formulations and various synthetic routes to new, low-valent aluminum clusters as energetic ingredients. - Complete the development and investigation of new magnetoelastic/piezoelectric composite materials and technology that combine extraordinary magnetoelectric (ME) coupling of composites with broadband tunability needed for applications such as sensitive magnetic sensors, transducers for sonar and energy harvesting. - Initiate research for understanding effects of energetic materials under high pressure environment - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
Title: HUMAN PERFORMANCE SCIENCES	2.116	2.021	1.821
Description: Efforts include: biosensors, biomaterial, bioprocesses; marine mammals; casualty care management, undersea medicine; human factors and organizational design; manpower, personnel and advanced cockpit; and operational training and education. These efforts are coordinated with the Navy Medical Research Center (NMRC). ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year. - Continued research for characterization of decision making behaviors associated with Human Systems Integration (HSI) design tradeoffs.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Continued research for Localization of human spatial processing using dense-array Electroencephalography. - Continued Integration of an implantable potentiostat for continuous monitoring of Nitric Oxide (NO) into a rat model of Hyperbaric Oxygen (HBO) toxicity. - Continued research to characterize the naturalistic decision making processes used in Naval Aviation acquisition programs to assess cost, schedule and performance tradeoffs within and between Human Systems Integration (HSI) domains. Content analysis will be performed to identify knowledge, skills, abilities, heuristics, and biases associated with HSI decision making. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research on Exhaled Nitric Oxide (NO) and Carbon Monoxide (CO) as Noninvasive Markers of Hyperbaric Oxidative Stress in Humans (decompression treatment, carbon monoxide poisoning, wound healing, and crush injuries for which pulmonary oxygen toxicity is a potential side effect). - Completed research on Characterization of Mesenchymal Stem Cell Contribution to the Formation of Heterotopic Ossifications (understanding treatment/recovery of devastating injury patterns - involving massive zones of injury that violate soft tissue). - Completed research on the Evaluation and Training of Institutions Using Individual Differences - Completed research on the study to identify the Underlying Mechanisms Resulting from IR Exposure. - Completed research for Advanced Adsorbent Materials for Chemical, Biological, Radiological Filtration and/or Detection. - Completed research on Mission Defined Language and Unmanned Vehicle (UV) Capacitance Using Predictive Tools. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete research for Characterization of Decision Making Behaviors Associated with Human Systems Integration (HSI) Design Tradeoffs, where analysis is performed to identify knowledge, skills, abilities, heuristics, and biases associated with HSI decision making. This incorporates a coding study to gauge inter-rater reliability as part of the content analysis. The results will be used to (a) generate assessment test materials for a follow-on decision making experiment, and (b) create a summary of the recorded HSI tradeoff case studies, including key learnings and a description of tradeoff decision requirements. - Complete research for Localization of Human Spatial Processing using Dense-array Electroencephalography. Aviation mishap statistics confirm that in-flight spatial disorientation (SD) poses one of the greatest human factor problems for military aviators. The impact of this cognitive threat costs the DoD an average of 20 aircraft and 25 flight personnel annually. Recent animal research has identified specialized neural structures involved in spatial orientation. The objective of this research is to determine if spatial neural mechanisms found in animal studies and in human functional magnetic resonance imaging tests can be further localized and defined by introducing limited ranges of normal human motion.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Complete Integration of an Implantable Potentiostat for Continuous Monitoring of Nitric Oxide (NO) into a Rat Model of Hyperbaric Oxygen (HBO) Toxicity. The U.S. Navy has long used oxygen breathing for covert underwater operations. The major limitation to HBO is the risk of HBO-induced pulmonary and central nervous system toxicity. NO is a critical second messenger involved in the pathophysiology of HBO-induced toxicity. The study examines an implantable NO sensor in conjunction with both traditional and experimental implantable potentiostats. This work will lead to the development of new research capabilities to measure NO production in vivo. - Initiate research for Brain and Spinal (and other) Injury Due to Shock Blast. - Initiate research for Adaptive Learning Tools Based on Individual Awareness. - Initiate research for Warfighter Impact Due to Operational Noise on Navy Ships. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
FY 2014 Plans: - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete Principal Dynamic Mode (PDM) analysis to test the feasibility of detecting a mild emotional stressor and comparison of its performance against the standard power spectral density approach. PDMs are calculated using the 2nd-order Volterr-Wiener kernels based on expansion of Laguerre polynomials. The 2nd-order Volterra-Wiener kernel accounts for nonlinear properties of the heart rate dynamics, which the power spectrum does not. - Complete effects of CO2 tolerance training on the incidence of high altitude pulmonary edema in rodents. US Military personnel operating at high elevations such as those found in Afghanistan are susceptible to two forms of altitude sickness: the primarily neurological acute mountain sickness (AMS) and high altitude pulmonary edema (HAPE), the leading cause of altitude related death. - Complete investigation of the neural correlates of posttraumatic stress disorder (PTSD), both before and after clinical therapy, to discover the neural circuits most affected by the disorder and to use this information to optimize treatment strategies. In general, the findings implicate a number of inter-related brain regions that might underlie some of the emotion- and memory-related PTSD will manifest as a systematic alteration of EEG patterns in the brain as compared to a similar military cohort without PTSD. - Initiate research on Operational Fatigue of Warfighters due to Stress Environments. - Initiate research on Human Gesture and Computer Interface and Functionality. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
-			
Title: INFORMATION SCIENCES	2.140	2.044	1.846
Description: Efforts include: mathematical foundation and computational theory and tools for design communications; decision support theory; algorithm and tools, information assurance, secure and reliable infrastructure for command and control; mathematical optimization for optimal resource allocation and usage; modeling and computational propagation; seamless, robust connectivity and networking and cyber warfare. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. - Continued research for the numerical analysis and design of methods for Partial Differential Equations (PDE) constrained optimization. - Continued research for framework for collaborative robotic asset management. - Continued research to develop a theory of Systems-of-Systems (SoS) network engineering and analysis based on the theory of time series of attributed graphs to understand how such systems can be mathematically formulated, simulated, analyzed, and tested. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research on Novel Image Processing Algorithms for Matrix Completion, Automated Scene Understanding, and Biotechnology Algorithms for Genetic and Proteomic analysis. - Completed research for the use of Neural Networks in Clustering Classification. - Completed research on the Relationship of Quantum Random Walk and Search Efficiency. - Completed research for Statistical Modeling and Analysis of Object Shapes in Sonar Imagery. - Completed research on Cognitive Correlators for Cyber Operations. - Completed research on Off-Hull Intermittent Connectivity Network Management using Computational Intelligence. - Completed research for Vision-Capable Unmanned Vehicle (UxV) Calibration, Environment Mapping, and Obstacle Avoidance. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. ***FY 2013 Plans:*** - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete research for the Numerical Analysis and Design of Methods for Partial Differential Equations (PDE) Constrained Optimization. PDE Constrained Optimization problems arise in many areas of science and engineering, and include problems			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
such as optimal shape design and parameter estimation. While advanced methods for general, non-linear optimization have existed for over a half century, the existence of PDE constraints in optimization problems make the existing optimization methods at best inefficient, and often times infeasible. The goal is to design and analyze new methods which build on previous efforts developed over the last decade, and enable these new methods to be used on problems currently seen in the analysis of naval systems. - Complete research for Systems-of-Systems (SoS) Network Analysis where the design of Systems-of-Systems (SoS) requires careful analysis of not only the subsystems, but also the interconnections between the subsystems. These interconnections could possibly correspond to dependencies, communications, shared information, joint operation, or other relationships. This research seeks to develop a theory of SoS engineering and analysis based on graph theory, in particular the theory of time series of attributed graphs, in which the vertices and edges may have attributes (such as readiness levels or communication throughput). This theory will involve both a mathematical formulation of the SoS problem, but also a consideration of how such systems can be simulated, analyzed, and tested. - Complete research for Framework for Collaborative Robotic Asset Management where a formalized and extensible approach for discovering, modeling, monitoring, and managing a distributed collection of disparate unmanned systems is defined. This framework will support near real-time system modeling, resource appraisal, and brokering functionalities while using scalable, abstract representations of mission, job, and resource capabilities to provide new levels of intelligent resource utilization to the Navy. The proposed work directly supports research initiatives in the areas of underwater communication networks, minimal operator intervention, intelligent decision-making, and promotes increased situational awareness. This project will present the design of a hierarchical architecture of software components and definition of the elements that comprise the framework Knowledge Representation Scheme in order to provide deliberative management capabilities for a system of collaborating robotic assets. - Initiate research on Weak Signature Identification. - Initiate research on Advanced Target Classification. - Initiate research on Collaborative Unmanned Systems Communication and Asset Management - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
FY 2014 Plans: - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete development of quantum codes and methods of construction, and verify their theoretical performance through various types of noise. Of particular interest are constructions that perform optimally through the Amplitude Damping channel. The			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
research applies to Naval problems in the areas of Science and Technology, C5ISR, quantum sensors, and next-generation computing. - Complete efforts to generate sharp and accurate images from synthetic aperture sonar (SAS) by utilizing Adjoint Control Filters for Nonlinear Partial Differential Equations - Complete Automatic Code Parallelization utilizing Genetic Programming, where the computer code takes full advantage of the available parallel computers. - Initiate research framework for Efficient Quantum Computing. - Initiate research for Autonomous Routing of Unmanned Vehicles. - Initiate fundamental research for undersea imaging and analysis. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
Title: NAVAL PLATFORM DESIGN SCIENCES	1.461	1.396	1.257
Description: Efforts include: novel hull forms, materials, structures and signatures; and virtual shaping concepts for structures and platforms. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year. - Continued research for high fidelity, Reynolds-averaged Navier-Stokes (RANS) cavitation simulation. - Continued research for development of a new vehicle dynamics-based motion planning and control algorithm into the motion planning process. - Continued research for wall pressure fluctuation measurements in high Reynolds number turbulent pipe flow. - Continued research to characterize the biaxial fatigue behavior of carrier-based aircraft in a corrosive environment, identify the basic mechanism of environment assisted biaxial fatigue cracking, develop an accurate model for corrosion fatigue crack growth under biaxial loading, and demonstrate and validate the model in the application to aircraft structure. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research on Hydrodynamic Self-cleaning and Ship Performance using Flow Generated Forces. - Completed research on New Approach to Dynamic Similarity for Surface Ship Scale Modeling. - Completed research on Internal Actuation for Marine Sensor Platforms. - Completed research on High Accuracy Inertial Measurement Unit from an Array of Low Cost Sensors. - Completed research on the Applications of Hydrofoils with Leading Edge Protuberances.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete research for High Fidelity, Reynolds-averaged Navier-Stokes (RANS) Cavitation Simulation. This research advances the state of the art in cavitation prediction, enhancing the understanding of the dynamics of cavitation on control surfaces and propellers though the use of computational fluid dynamics (CFD). Advances in cavitation modeling will be accomplished through the use of a true, two-phase method to model the vapor and liquid as separate fluids rather than as a homogenous mixture, which is commonly used. The final product should be a RANS code useful for predicting cavitation on control surfaces and propulsors of interest to the US Navy, where these predictions may reveal new details of the cavitation sheet break up and associated acoustics. - Complete research for Development of a New Vehicle Dynamics-Based Motion Planning and Control Algorithm into the motion planning process. The Sampling-Based Model Predictive Control (SBMPC) algorithm is in development as an efficient Model Predictive Control (MPC) algorithm that generates control inputs and system trajectories. The method is based on sampling the input space at each sample period, and implementing a goal directed optimization method in place of linear programming, nonlinear programming or evolutionary algorithms. This formulation of MPC readily applies to systems with nonlinear dynamics, and avoids the local minima which can limit the performance of MPC algorithms implemented using nonlinear programming. The generic framework will be adapted to enable time and energy optimal trajectory generation for UUV/USV systems. - Complete research for Wall Pressure Fluctuation Measurements in High Reynolds Number Turbulent Pipe Flow. The objective of this effort addresses the problem of flow noise and flow induced vibration experienced by hull mounted and towed SONAR arrays. Turbulent wall pressure fluctuations at moderate to high Reynolds numbers constitute a primary source of direct flow noise for hull mounted and towed SONAR arrays. In addition, they act as a primary source of radiated noise from undersea vehicles. Furthermore, contemporary finite element structural analysis requires forcing functions as input parameters. The general complexity of the turbulent wall pressure field leads to the requirement for measurements and modeling in order to characterize the field and better understand the physics of this unique class of flows. - Initiate research for Vehicle Dynamics and Turbulent Wake Characterization. - Initiate research for Hydrodynamic Self Cleaning and Improved Ship Performance - Initiate research for Predicting Complex Drag on Towed Arrays.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete effort addressing the problem of flow noise and flow induced vibration experienced by hull mounted and towed SONAR arrays. - Complete Sampling-Based Model Predictive Optimization With Application to Robot Kinodynamic Motion Planning for naval vehicles. The method is based on sampling (i.e., discretizing) the input space at each sample period and implementing a goal-directed optimization method (e.g., A*) in place of linear programming, nonlinear programming or evolutionary algorithms. This formulation of Model Predictive Control (MPC) readily applies to systems with nonlinear dynamics and avoids the local minima which can limit the performance of MPC algorithms implemented using nonlinear programming. - Complete parametric study of the effects displacement and step location have on the performance of a stepped planing hull for high speed naval craft. The stepped planing hull is popular in the pleasure craft industry to achieve faster speeds than a traditional deep-vee planing monohull. Currently in the pleasure craft industry, stepped planing hull design is done by trial and error; unknown to the Navy are the combined effects of military payload and stepped hull configuration on craft performance - Initiate research for modeling super-cavitation of Advanced Propulsor Designs. - Initiate research for Predictive Performance Modeling of Advanced Naval Hull Designs. - Initiate research for Design and Performance of High Speed Naval Vessels. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
Title: OCEAN/SPACE SCIENCES ***Description:*** Efforts include: Littoral Geosciences, Optics, and biology; Marine Mammals; Ocean Acoustics; and autonomous systems. Funding levels in the Ocean/Space Sciences activity decrease in FY 2013 due to creation of a separate activity to highlight Science Technology Engineering and Math (STEM) efforts at Navy labs previously funded in this activity. ***FY 2012 Accomplishments:*** - Continued ILIR projects that are intended to be approximately three years in length. Based on historical trends, approximately 30% of ILIR projects will turn over each year.	4.630	3.590	3.236

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Continued optical propagation studies for Non-Line-of-Sight (NLOS) underwater laser communications. - Continued research for turbulent wake characterization - Continued research for surface piercing strut wake signature reduction. - Continued research to assess the effects of Mid-Frequency Active (MFA) sonar on the movement of fish species in a natural environment, to compare the behavior and movement of fish prior to exposure to sonar, during exposure, and for a significant amount of time post-exposure to provide valuable data on fish behavior, movement, and survival following exposure to high-intensity, tactical MFA sonar. - Completed FY 2010 initiated ILIR projects during FY 2012. - Completed research on Free-Surface Interface Capturing Algorithm for CFD in the Understanding/Modeling of Autonomous Undersea Systems. - Completed research for Coherent Terrain Navigation. - Completed research on Multipath Signal Processing Cancellation Techniques for Mine Hunting. - Completed research for Optical Integration Algorithm for Global Positioning System (GPS). - Completed research for Flight Behavior and Surveillance for Unmanned Underwater Systems for Anti-Submarine Warfare (ASW) Mission. - Completed research for Full Spectrum Propagation Prediction. - Initiated ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2012 will focus on supporting Naval Battlespace Awareness, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility initiatives in Ocean Acoustics and Undersea Weaponry.			
FY 2013 Plans: - Continue all efforts of FY 2012, less those noted as complete above. - Complete FY 2011 initiated ILIR projects during FY 2013. - Complete Optical Propagation Studies for Non-Line-of-Sight (NLOS) Underwater Laser Communications. This project's objective investigated the fundamental propagation characteristics of "broad beam", or diffused, light sources for N-LOS optical links. N-LOS links provide the benefits of decreased pointing-and-tracking complexity, increased time for link closure, and decreased sensitivity to obstructions. This project studied how the spatial distribution of light caused by scattering, or shaping of the initial source beam distribution, affects the propagation of modulated light in water and optimal source distributions matched to particular undersea environments. - Complete research for Turbulent Wake Characterization, where understanding the details of complex turbulent flows around a submerged body is critical for analysis of a propulsor operating in its wake. The inflow characteristics to the propulsor have a significant impact on its performance. This project focuses on predicting the turbulent wake characteristics of a submerged, appended, model-scale body using Large Eddy Simulation (LES) techniques. Because the propulsor impacts the pressure field,			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
it has an effect on its own inflow; therefore, the ultimate goal of this project will be to model a propulsor and an appended body in the same domain using LES. - Complete research for Surface Piercing Strut Wake Signature Reduction. Surface piercing struts in motion relative to water generate a fairly complex wave, producing a rising bow wave in the front of the strut, a cavity on the sides and a wake behind. The size of this white water wake is a function of the strut shape, Reynolds number (Re), Froude number (Fr), water salinity, surfactants, etc. The objective of this effort is to understand the bubble generation and transport phenomena, ideally minimizing the bubble entrainment visual detection to a level comparable to the strut itself. Two approaches are investigated: 1) an experimental method that provides insight into the physics of the flow field; and 2) a computational method that validates the existing results and tests new concepts. - Initiate research for Littoral Mine Detection and Avoidance. - Initiate research for Compact Broad Band Low Frequency Sonar. - Initiate research for Advanced Obstacle Avoidance for Unmanned Systems. - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2013 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed. - Complete FY 2012 initiated ILIR projects during FY 2014. - Complete fundamental performance limitations imposed by acoustic interference on active sonar systems, concentrating on undersea networks in acoustically congested environments. - Complete embedded graph systems for robust, coordinated control of heterogeneous unmanned system networks. Here, graphs are used to model the network with its sensor, data, and control topologies. Embedded graph rules define how sub graphs can transform, corresponding to groups of systems switching topologies and control modes. The system allows for highly autonomous task and role allocation, as well as quick reconfiguration and adaptation to new data, including errors, threats, and system failures. - Complete research for the Improved Understanding of Complex Flow Distribution over Towed Arrays. - Initiate research for Advanced Smart Wireless Cooperative Vehicular Network. - Initiate research for Undersea Laser Communication and Identification in Littoral Environments - Initiate ILIR projects that are intended to be approximately three years in length. Projects selected for FY 2014 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.			
Title: SCIENCE TECHNOLOGY ENGINEERING AND MATH (STEM) EFFORTS AT NAVY LABS	0.000	2.285	3.830

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: This effort will support both the Science and Engineering Apprenticeship Program (SEAP) and the Naval Research Enterprise Intern Program (NREIP) summer programs to encourage participating students to pursue science and engineering careers, to further their education via mentoring by laboratory personnel and their participation in research, and to make them aware of DoN research and technology efforts, which can lead to employment within the DoN. Participating students will spend eight to ten weeks during the summer doing research at approximately 19 to 20 DoN laboratories. Participants will receive a stipend distributed by the Contractor. The stipend is a monthly allowance paid to interns for their participation in the research efforts. This activity is created starting in FY 2013 to highlight Science Technology Engineering and Math (STEM) efforts at Navy labs that were previously funded within the Ocean/Space Sciences activity in this PE. The increase in the STEM Efforts is in response to the Secretary of the Navy's commitment to doubling the Navy's investment and establishing a strong naval STEM program over the next five years. ***FY 2013 Plans:*** - Continue Naval Research Enterprise Intern Program (NREIP) to support undergraduate and graduate students performing Navy-related research at Naval Warfare Centers under the supervision and mentorship of DON Scientists, thus exposing them to interesting and challenging work done at the centers. NREIP is a continuing Navy education program. - Initiate Science, Technology, Engineering and Mathematics (STEM) projects that are intended to be approximately three years in length. Projects selected for STEM funding will focus on engaging and educating future Naval scientists and engineers and incorporating naval relevance, diversity, and STEM best practices. These efforts will complement and support the ongoing independent research, education and outreach efforts taking place at the Naval laboratories. ***FY 2014 Plans:*** - Continue all efforts of FY 2013.			
Accomplishments/Planned Programs Subtotals	17.642	18.261	18.230

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

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E. Performance Metrics

The ILIR initiative seeks to improve the quality of defense research conducted predominantly through the Naval Warfare Centers/Laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered environment since it is basic research, but many projects focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing systems. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. The National Research Council of the National Academies of Science and Engineering's Congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.