Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Navy	Date: March 2014
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
Total Program Element	0.000	433.080	488.387	443.697	-	443.697	451.763	470.745	477.972	479.279	Continuing	Continuing
0000: *Defense Research Sciences*	0.000	424.830	484.387	443.697	-	443.697	451.763	470.745	477.972	479.279	Continuing	Continuing
9999: *Congressional Adds*	0.000	8.250	4.000	-	-	-	-	-	-	-	-	12.250

The FY 2015 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, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy approved by the S&T Corporate Board (Sep 2011). This new 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 exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs).

This PE addresses basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach).

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), fields upon which a wide range of fundamental Naval capabilities depend. There are currently five NNRs.

S&T investment in basic research also includes the Basic Research Challenge program which was established to competitively select and fund promising research programs in new areas not addressed by the current basic research program. The Basic Research Challenge Program stimulates new, high-risk basic research projects in multi-disciplinary and departmental collaborative efforts, and funds topics that foster leading edge science and attracts new principal investigators and organizations. Basic Research Challenge awards are for a period of four years.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Navy	Date: March 2014
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*

B. Program Change Summary ($ in Millions)	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO	FY 2015 Total
Previous President's Budget	473.070	484.459	493.716	-	493.716
Current President's Budget	433.080	488.387	443.697	-	443.697
Total Adjustments	-39.990	3.928	-50.019	-	-50.019
• Congressional General Reductions	-	-0.072			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	4.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-9.205	-			
• Rate/Misc Adjustments	-	-	-50.019	-	-50.019
• Congressional General Reductions Adjustments	-39.785	-	-	-	-
• Congressional Add Adjustments	9.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)

	FY 2013	FY 2014
Project: 9999: *Congressional Adds*		
Congressional Add: *Nanotechnology Research (Cong)*	8.250	4.000
Congressional Add Subtotals for Project: 9999	8.250	4.000
Congressional Add Totals for all Projects	8.250	4.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy												Date: March 2014
Appropriation/Budget Activity 1319 / 1					R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*				Project (Number/Name) 0000 / *Defense Research Sciences*			
COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
0000: *Defense Research Sciences*	-	424.830	484.387	443.697	-	443.697	451.763	470.745	477.972	479.279	Continuing	Continuing

The FY 2015 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, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy. 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 exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs).

This PE addresses basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support. Activities in this area also support maintenance of the Science and Engineering Workforce and STEM Education and Outreach.

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), S&T areas that are uniquely important to maintaining U.S. Naval superiority. With the designation in 2011 of Sea-Based Aviation as an NNR, there are currently five NNRs.

S&T investment in basic research also includes the Basic Research Challenge program which was established to competitively select and fund promising research programs in new areas not addressed by the current basic research program. The Basic Research Challenge Program stimulates new, high-risk basic research projects in multi-disciplinary and departmental collaborative efforts, and funds topics that foster leading edge science and attracts new principal investigators and organizations. Basic Research Challenge awards are for a period of four years.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: AIR, GROUND AND SEA VEHICLES	63.436	63.646	55.759
Description: Surface/subsurface reduced signatures; free-surface, subsurface, and propulsor hydromechanics; hull life assurance; advanced ship concepts; distributed intelligence for automated survivability; advanced electrical power systems; air			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
vehicles; air platforms propulsion and power; air platforms survivability and signature control; special aviation projects; Unmanned Air Vehicle/Unmanned Combat Air Vehicle (UAV/UCAV); environmental quality; logistics; power generation, energy conversion, and storage; and advancements in naval technology innovations. Funding decrease in FY 2015 is the result of changing S&T investment priorities within the Department of the Navy. Research planning activities associated with the new Sea Based Aviation National Naval Responsibility (SBA NNR) took place in FY 2012-13, with most projects starting in FY 2014. Accomplishments and plans described below are examples for each effort category. ***FY 2013 Accomplishments:*** Air Vehicles - Continued investigations into controlled initiation and recovery from aggressive, non-linear aero-maneuvers conducted by unmanned air vehicles. - Continued university research in rotorcraft technology areas such as tilt rotor aeromechanics, rotor flow field/ship air wake coupling during shipboard operations, flight simulation of advanced ducted fan air vehicles, active rotor control for enhanced shipboard operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications. - Continued research in computational simulation of rotorcraft operations in a shipboard environment. - Continued investigation of advanced structural concepts, providing a high degree of crew protection during crashes. - Continued research into new analytical methods for high-fidelity prediction of rotorcraft performance, loads, and vibration. - Continued university and Navy Lab research in basic rotorcraft science with emphasis on enabling concepts for variable geometry/variable rotor-speed aircraft. Science of Autonomy - Continued multi-disciplinary research into the science of autonomy, including multi-vehicle collaboration, intelligence, and human interaction. - Continued research in scalable and robust distributed collaboration among autonomous systems. - Continued research in human/unmanned system collaboration. - Continued research in autonomous perception and intelligent decision-making. - Continued research in intelligent architectures for autonomous systems. Ship Concepts and Hydrodynamics			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued modeling and optimization techniques for Naval design of multi-hulls, optimal functional arrangements for both ship and submarine design, and optimization for semi-displacement craft. - Continued implementation of nationwide program to increase interest in naval engineering education. - Continued further examination of computational mechanics to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis and error control. - Continued research in propeller tip vortex cavitation and sheet-to-cloud cavitation. - Continued computational and experimental investigation into complex, three-dimensional flow separation problems. - Continued modeling and understanding of full-scale circulation control bow planes design. - Continued validation of Unsteady Reynolds Averaged Navier Strokes (URANS) prediction on maneuvering effects on ship motion in waves. - Continued modeling of hydro-acoustics of advanced materials propulsor. - Continued program to investigate renewable energy technologies for navy applications. - Continued computational and experimental investigations of wakes in stratified fluids. - Continued Large Eddy Simulation (LES) modeling of crashback of underwater vehicle with propulsor. - Continued measurement and modeling of unsteady high-speed craft hydrodynamics. - Continued high-fidelity fluid-structure interaction program. - Continued computational prediction and validation of damaged ship maneuvering. - Continued research efforts on multi objective optimization of hull shapes using hybrid hull concept to achieve high efficiency, reduced slamming loads and hydrodynamic/structural performance. - Continued development of understanding of shockwave propagation and failure mechanisms of high strain rate, sensitive polymers and their interaction in composites with structural and armor materials. Ship Signatures, Structures, and Materials - Continued the structural performance of hybrid ship hulls and hybrid joints subject to sea loads and weapons effects for application to high speed, low signature vessels. - Continued modeling of alternating current sources and propagation. - Continued Particle Image Velocimetry (PIV)/Laser Doppler Velocimetry (LDV) studies of multiphase bubble flows and interaction with elastic plates in a small, quiet water tunnel. - Continued LDV of scaling effects studies of unsteady elastic duct and propulsor interaction in a wind tunnel. - Continued pressure-shear experiments at ultra high loading rates of explosion resistant coating ERC in combination with light weight composites, including glass, acrylics, Poly(methyl methacrylate) (PMMA) and develop computational simulation capability for understanding the behavior and failure effect of ERC on the materials. - Continued computational methods for simulation of fragmentation, including tracking interactions of fragments and their interactions with composites of various materials (and fluid fragment interaction). - Continued effort on much higher strain rate loading and constitutive behavior of Explosion Resistant Coating (ERC) for strain			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
rates appropriate to ballistic events. - Continued work on cohesive elements for dynamic fracture under combined mode for application to failure in joints in ship structures under blast loading. - Continued work on hybrid ship (non-magnetic stainless steel/composite) hull concepts. - Continued further examination of computational mechanics in order to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis, and error control. - Continued concept for photonic band gap waveguide. - Continued methods to model the mechanisms of interaction between an elastic duct wall and fluid-flow in a duct with a propeller. - Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures. - Continued efforts in alternative hull for fast ships and hybrid ship hull structures. - Continued efforts in understanding of explosion resistant coating under extreme loads and its interaction with other armor and structural materials. - Continued investigation into methods to control airborne noise transmission using active control. - Continued development of metamaterial concepts for radio frequency (RF) signature control and photonic and acoustic applications. - Continued experimental facility for sea-slamming loads in fast ships, and considering hydro-elasticity and structural details in composites panels and scale effects. Measurements are used developing new theoretical models. - Continued study of droplet & volume scattering phenomena. - Continued the development of predictive models for infrared emission and reflection from breaking waves. - Continued development of computational electromagnetic tools for electromagnetic materials design & optimization. - Continued development of a methodology for highly reliable composite to metallic joints. - Continued fundamental efforts in multi-scale, time-varying, hull structural reliability models and processes for structural performance analysis. - Continued the development and understanding of elastomeric polymers for multi-functionality in protection systems/armor and structural acoustics, with superior properties against environmental effects and extreme temperature. - Continued development of advanced electro magnetic energy absorbing composite materials. - Continued performing measurements of sea-slamming loads in fast ships at various sea states and speeds for composite panels on the experimental facility and developed/verified theoretical/computational models considering hydro elasticity and structural details and scale effects. - Continued efforts to further the physics based understanding of structural acoustics for the next generation submarine. - Continued improvements for predictive capabilities of surface ship propulsion system and underwater acoustic signatures. Ship and Air Platform Machinery and Systems - Continued efforts to understand and control the generation and propagation of far-field jet noise.			

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Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued development of Pulsed Detonation Engine (PDE) Technology. - Continued development and understanding of control capabilities and distributed intelligence strategies for shipboard systems. - Continued propulsion system cost-reduction efforts through reduction of vibration, noise and thermal fluctuation at the source by controlling combustion. - Continued passive and active high speed noise control. - Continued studies of alternate propulsion systems for PDE and generated prediction models. - Continued investigation of thermal management approaches for cooling high power electronic devices. - Continued research on non-vapor, compression based refrigeration cycles. - Continued studies of advanced air-breathing propulsion concepts. - Continued study of advanced materials for PDE applications. - Continued efforts to expand the model based reasoning control algorithm approach to multiple heterogeneous systems. - Continued studies of complexity in heterogeneous distributed control systems. - Continued efforts to investigate a market based control approach to distributed control. - Continued efforts to perform physics based modeling of fluid actuation systems. Power Generation, Energy Conversion and Storage - Continued evaluation of stability and control of electrical power systems. - Continued analyzing synchronization of 19 diode lasers to produce intense beams. - Continued efforts in nanostructures, novel electrolytes, and electrode materials to enable new, 3D, power source architectures and to improve capacity of rechargeable lithium and lithium-ion batteries. - Continued exploration and development of materials for high energy density, passive power electronics (Capacitors). - Continued expanding the fundamental understanding of direct electrochemical oxidation and the use of logistic fuels in solid oxide fuel cells. - Continued development of phase change cooling approaches for high power electronic devices. - Continued efforts developing a science base for optimized combustion of alternative fuels. - Continued the investigation of the long-term durability effects of coating/substrate systems from combustion chemistries and products derived from current petroleum-based fuel and from petroleum-based/synthetic fuel blends that lead to predictive models. - Continued effort in energy and power management to include understanding and reliability of high power electronics. - Continued investigation into rare earth-free permanent magnet materials. - Continued modeling of positron confinement for ultra high-density energy storage and convened international positron confinement workshop. -Continued investigating thermodynamic cycle analogy for harvesting waste heat using multiferroic (pyromagnetic & pyroelectric) materials.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued research into thermionic energy conversion using inter-gap molecular species in a heat cell with low work function materials. - Continued research into cyber-physical, real-time distribution and control of power & energy networks, physics-based models,hardware-in-the-loop simulation. - Continued development of novel approaches to deposition of ultra high quality SiC epilayers needed to enable high-voltage, highfrequency,high-power wide bandgap semiconductor devices. - Continued study of fault tolerant electromechanical energy converter concepts for naval applications. - Continued research to understand new energy conversion methods (pyroelectrics, thermionics, combustion). - Continued basic research in next generation wide bandgap semiconductors. - Initiated experimental and computational investigation of dynamic response of marine gas turbines for on-demand and flexible power supply. - Initiated power and energy management science, particularly understanding new magnetic materials and sliding electrical contacts. Advancements in Naval Technology Innovations - Continued development of the Centers for Innovative Naval Technology (CINT), which will expand and apply the Center for Innovative Ship Design (CISD) approach to other Navy facilities to dramatically expand participation and the breadth of naval technologies covered.			
FY 2014 Plans: Air Vehicles - Continue all efforts of FY 2013, less those noted as completed above. - Initiate Sea-Based Aviation NNR research in Virtual Dynamic Interface, Advanced Manned/Unmanned Handling Qualities and Control for Naval Operations, Improved Fixed Wing Launch and Recovery High Lift Aerodynamics and Performance, Enhanced Fixed Wing V/STOL Operations, and Autonomous Deck Operations. Science of Autonomy - Continue all efforts of FY 2013, less those noted as completed above. - Initiate research in integrated design analysis/prognosis to optimize airframe structural properties and match material selection to operational requirements. - Initiate modeling of complex behaviors/interactions to predict risk, probability and mechanism of failure and forecast lifetime performance. Ship Concepts and Hydrodynamics - Continue all efforts of FY 2013, less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiate research into the extension of bubble-wake modeling to physical far-field regime.			
Ship Signatures, Structure, and Materials			
- Continue all efforts of FY 2013, less those noted as completed above.			
Ship and Air Platform Machinery and Systems			
- Continue all efforts of FY 2013, less those noted as completed above.			
Power Generation, Energy Conversion and Storage			
- Continue all efforts of FY 2013, less those noted as completed above.			
- Complete materials research in positron storage.			
- Complete insulation longevity prediction materials research.			
- Initiate fundamental research in novel, high temperature, superconducting (HTS) material synthesis.			
Advancements in Naval Technology Innovations			
- Continue all efforts of FY 2013, less those noted as completed above.			
FY 2015 Plans:			
Air Vehicles			
- Continue all efforts of FY 2014, less those noted as completed above.			
Science of Autonomy			
- Continue all efforts of FY 2014, less those noted as completed above.			
Ship Concepts and Hydrodynamics			
- Continue all efforts of FY 2014, less those noted as completed above.			
Ship and Air Platform Signatures, Structures, and Materials			
- Continue all efforts of FY 2014, less those noted as completed above.			
- Continue Sea-Based Aviation NNR structures and materials research in Structural Mode Characterization, High-Loading/ Lightweight Materials, Advanced Structural Concepts, Material Degradation/Corrosion, and Structural Protection and Maintenance.			
Ship and Air Platform Machinery and Systems			
- Continue all efforts of FY 2014, less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue Sea-Based Aviation NNR propulsion research in Propulsion Cycles, Subsystems, and Integration, Turbomachinery and Drive Systems with Enhanced Maintainability, Jet Noise Reduction, Hot Section Materials and Coatings, and Small UAV Propulsion. Power Generation, Energy Conversion and Storage - Continue all efforts of FY 2014, less those noted as completed above. - Complete investigation into rare earth-free permanent magnet materials. - Complete development of novel approaches to deposition of ultra high quality SiC epilayers needed to enable high-voltage, high-frequency, high-power wide bandgap semiconductor devices. - Complete power and energy management science, particularly understanding new magnetic materials and sliding electrical contacts. - Complete basic research in next generation wide bandgap semiconductors. Advancements in Naval Technology Innovations - Continue all efforts of FY 2014, less those noted as completed above.			
Title: ATMOSPHERE AND SPACE SCIENCES ***Description:*** Efforts include: Marine Meteorology and Prediction, and Space Sciences. Accomplishments and plans described below are examples for each effort category. ***FY 2013 Accomplishments:*** Marine Meteorology and Prediction - Continued analysis of results from major field projects on air-sea interaction and transition improvements into applied research to improve the treatment of fluxes in coupled atmosphere-ocean prediction systems. - Continued the development of next-generation ocean-atmosphere coupled models. - Continued effort to investigate and better understand the bulk exchanges, aerosol-cloud interaction, and physical processes that take place at the atmospheric boundary layer interface. - Continued theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. - Continued effort to gain a fundamental understanding of the flow-dependent limits of predictability by combining research in data assimilation and atmospheric instability. - Continued investigation into the near-earth environmental effects on electromagnetic propagation.	22.826	25.221	25.053

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued investigation of sub-grid-scale processes that influence marine boundary layer turbulence, aerosol production and removal, and marine stratocumulus cloud and drizzle formation and dissipation with the goal of improving the predictability of these phenomena in high-resolution mesoscale prediction systems. - Continued investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves. - Continued effort to assimilate WindSat wind vector, Ozone Mapping and Profiler Suite (OMPS) ozone profiles, and Global Positioning System (GPS) temperature and water vapor profile retrievals into NOGAPS (Navy Operational Prediction System). - Continued assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models. - Continued development of new soil moisture retrieval algorithm that addresses the basic modeling issues pertinent to soil moisture retrieval using passive microwave data from the WindSat instrument. - Continued demonstration and validated a new data assimilation capability in NOGAPS ALPHA to generate the first global atmospheric analysis fields that extend from the ground to the edge of space. - Continued effort to derive and test advanced nonlinear atmospheric data assimilation algorithms using variational and ensemble techniques that are firmly based on modern inverse problem theory. - Continued effort to understand the fundamental physics and dynamics that control cloud and aerosol variability in the marine boundary layer. - Completed investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves. - Initiated effort to improve understanding of sub-seasonal, seasonal and intra-seasonal oscillation in a fully coupled (air, sea, land, ice) Model with the goal of developing a seamless, high-resolution earth system prediction capability for extended range forecasts. - Initiated the effort to understand the impact of skewness on our ability to estimate meteorological variables and their uncertainty. - Initiated the effort to understand the predictability of weather in future extreme environments by quantifying how these changes impact forecast error growth and energy, non local errors and tropical cyclone prediction. - Initiated the study to understand the interplay of deep convective and boundary layer processes in tropical cyclone eye/eyewall dynamics and symmetric/asymmetric inner-core variability through a combination of numerical models, observation and improving upon existing theory. Space Sciences - Continued assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography. - Continued program to develop advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued monitoring of other-agency efforts for 'Naval Harvest' of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography. - Continued a focused program to develop a predictive, operational capability for the onset and evolution of equatorial spread-F that limits space-based communications and navigation capabilities. - Continued a program to use large high frequency/very high frequency (HF/VHF) arrays to investigate fine scale ionospheric phenomena with associated improvements in ionospheric modeling and the performance of current and future DoD capabilities impacted by ionospheric disturbances. - Continued program to extend magneto-hydrodynamic models of solar activity, and related effects on the near-Earth space environment, toward an improved predictive capability on communication and navigation systems, and other related effects on DoD operations. - Continued effort to develop better physical understanding of small-scale atmospheric wave dynamics in the middle and upper atmosphere. - Continued effort to develop understanding to forecast the sun's changing extreme ultraviolet (EUV) radiation and the responses of the upper atmosphere and ionosphere one-to-ten days in advance. - Continued effort to develop and validate numerical models of high-energy solar energetic particle (SEP) and solar gamma-ray (SGR) emissions. - Continued effort to develop a quantitative standard model for solar flares that satisfies ultra violet (UV)-X-ray observations; understand the origin, dynamics, and evolution of plasma in active region magnetic flux tubes. - Continued effort to develop the basis for an observational technique potentially enabling the first physics-based prediction of the severity of the largest energetic particle events generated by the Sun. - Continued investigation of the driving mechanisms, mode characteristics, and impact on space plasmas of electromagnetic waves relevant to radiation belt remediation and auroral ionospheric space weather. - Continued research on advanced EUV/X-ray optics and associated spectral modeling and data analysis, to improve the precision of solar irradiance monitoring and enable accurate irradiance forecasts. - Continued effort to assemble individual databases and model components of the Sun-Earth System. - Continued field project to increase understanding of air-sea exchange of enthalpy (heat and moisture) to improve high-resolution coupled atmosphere-wave-ocean TC prediction systems. - Continued effort to test solar active region heating models and determine the most important heating mechanisms, understanding of which is essential for accurate solar radiative output predictions. - Continued effort to develop spectroscopic techniques and derive required measurements to observe essential small scale solar coronal plasma processes, which are critical to understanding the solar atmosphere. - Completed effort to test solar active region heating models and determine the most important heating mechanisms, understanding of which is essential for accurate solar radiative output predictions. - Initiated effort to develop an accurate three-dimensional model of the solar wind in the inner heliosphere for use in space weather prediction codes, to improve forecasts of coronal mass ejection arrival time at earth.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiated effort to measure and model ionizing gamma radiation from terrestrial thunderstorms, towards quantifying the physical conditions under which thunderstorms become powerful sources of energetic particles and photons. - Initiated effort to quantify the evolution of probability density functions for orbiting objects in a crowded space environment, which will help inform orbital debris mitigation and avoidance strategies.			
FY 2014 Plans: Marine Meteorology and Prediction - Continue all efforts of FY 2013, less those noted as completed above. - Complete analysis of results from major field project on air-sea interaction and transition improvements into applied research to improve the treatment of fluxes in coupled atmosphere-ocean prediction systems. - Initiate investigation of tropical cyclone intensification and structure changes that occur in response to changes in upper level outflow, large scale environmental interactions and/or internal changes in convection using innovative new observing systems and satellite observations. Space Sciences - Continue all efforts of FY 2013, less those noted as completed above. - Complete effort to exploit the polarametric aspect of WindSat for non-ocean surface wind vector Meteorological and Oceanographic Command (METOC) retrievals. Effort this year focused on soil moisture and sea ice. - Complete assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography. - Complete effort to use large high frequency/very high frequency (HF/VHF) arrays to investigate fine scale ionospheric phenomena with associated improvements in ionospheric modeling and the performance of current and future DoD capabilities impacted by ionospheric disturbances. - Complete effort to develop and validate numerical models of high-energy solar energetic particle (SEP) and solar gamma-ray (SGR) emissions. - Complete effort to develop a quantitative standard model for solar flares that satisfies UV-X-ray observations; understand the origin, dynamics, and evolution of plasma in active region magnetic flux tubes. - Complete effort to develop the basis for an observational technique potentially enabling the first physics-based prediction of the severity of the largest energetic particle events generated by the Sun. - Complete research on advanced EUV/X-ray optics and associated spectral modeling and data analysis, to improve the precision of solar irradiance monitoring and enable accurate irradiance forecasts. - Complete field project to increase understanding of air-sea exchange of enthalpy (heat and moisture) to improve high-resolution coupled atmosphere-wave-ocean tropical cyclone prediction systems.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Complete effort to test solar active region heating models and determine the most important heating mechanisms, understanding of which is essential for accurate solar radiative output predictions. - Complete effort to develop spectroscopic techniques and derive required measurements to observe essential small scale solar coronal plasma processes, which are critical to understanding the solar atmosphere. - Initiate investigation into the coupling physics, dynamics, and chemistry from the lower atmosphere, earth surface, and ocean into the upper atmosphere and ionosphere, focusing on processes relevant to ionospheric specification and forecasting. ***FY 2015 Plans:*** Marine Meteorology and Prediction - Continue all efforts of FY 2014, less those noted as completed above. Space Sciences - Continue all efforts of FY 2014, less those noted as completed above.			
Title: COUNTER IMPROVISED EXPLOSIVE DEVICE (IED) SCIENCES	16.846	14.963	14.558
Description: The Basic Research Counter IED program seeks to develop innovative scientific concepts that will form the foundation for future technologies that may be developed and implemented to efficiently and effectively address the IED threat. The effort will emphasize fundamental scientific concepts that can be applied to the detection, neutralization, destruction and mitigation of the effects of these devices, to advance anticipation, and affect the occurrence or potential occurrence of IED events. The program also seeks to establish and nurture a multidisciplinary counter-IED Science and Technology community of Government, academic and industry researchers to accelerate the transition of new science and technology into fielded systems. Accomplishments and plans described below are examples for each effort category. Funding decrease in FY 2014 us the result of reassignment of funding for the Basic Research Challenge Program into the newly created Research Activity. ***FY 2013 Accomplishments:*** - Continued effort in the area of Prediction to develop theoretical and technical approaches that permit prediction and analysis of IED emplacement as well as the assembly of IEDs. This included recognition of emplacement patterns, human activity recognition from video and other sensing systems, human intelligence and social network analysis of terrorist networks, modeling and simulation of the full spectrum of IED activities, analysis of communications, and knowledge management systems to combine diverse data sources. - Continued effort in the area of Detection to develop concepts that would permit stand-off detection and localization of the explosive, the case materials, the environment in which the device is located, and other components of the IED.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued effort in the area of Neutralization to develop scientific concepts that may be applied to remotely render an IED ineffective without necessarily having to detect or destroy it. - Continued effort in the area of Destruction to develop scientific concepts that may be applied to quickly and remotely destroy IEDs without necessarily having to detect them. - Continued effort in the area of Mitigation to develop scientific concepts that may be applied to protect people and/or equipment from the destructive effects of an IED that may be detonated. - Continued creation of new spectroscopy for sensitive characterization of semiconductor nanostructures, ultrathin molecular films and chemical/biological threat materials and explosives. - Continued development of product that will provide the warfighter protection against blast pressure wave and complements efforts in ballistic/projectile protection and combat casualty care communities. - Continued development of a new chemical explosive detection concept based on pump/probe ultrashort pulse lasers. - Continued research on characterizing background noise in urban and riverine environments in support of IED signature detection. - Continued a Counter-IED Grand Challenge effort to pursue innovative device neutralization modalities, augmented by device detection technologies. - Continued development of high performance polymer materials for armor applications. - Continued effort to directly observe lattice deformations in explosives under shock impact. - Continued analytical study to detect an intruder in proximity to an underwater pipeline using structure-guided acoustic waves. - Continued increased emphasis on sociological and cultural aspects of defeating insurgent networks. - Continued increased emphasis on standoff wide area neutralization and pre-detonation of IEDs. - Continued increased emphasis on stronger lightweight armor including nanoparticle designs. - Continued increased emphasis on detection of physical and temporal device characteristics. - Continued effort to provide new representations and multi-physics algorithms that significantly extend the validity and efficiency of state-of-the-art Computational Fluid Dynamics capabilities and enable accurate computation of complex fluid dynamics. - Continued increased emphasis on challenges within the Riverine environment. - Continued increased emphasis on challenges in the temporal domain in various land environments. - Initiated an effort to integrate observable behaviors with social behavior models to provide inputs for predictions and validation. - Initiated a program to investigate nano-technologies applied to miniaturized remote molecular sensors, with an additional emphasis on low-fidelity detection of trace explosive vapor partial-pressures. - Initiated research into emerging very-broad-band spectroscopic capabilities to achieve a low-fidelity mosaic of partial pressure detections of explosives. - Initiated study of biomimetic nano composites. - Initiated study of energy transduction through soft armor.			
FY 2014 Plans:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all effort of FY 2013, less those noted as completed above. - Complete development of product that will provide the warfighter protection against blast pressure wave and complements efforts in ballistic/projectile protection and combat casualty care communities. - Complete effort in the area of Mitigation to develop scientific concepts that may be applied to protect people and/or equipment from the destructive effects of an IED that may be detonated. - Complete an effort to provide new representations and multi-physics algorithms that significantly extend the validity and efficiency of state-of-the- art Computational Fluid Dynamics capabilities and enable accurate computation of complex fluid dynamics. - Complete a Counter-IED Grand Challenge effort to pursue innovative device neutralization modalities, augmented by device detection technologies. - Complete an analytical study to detect an intruder in proximity to an underwater pipeline using structure-guided acoustic waves. - Complete development of high performance polymer materials for armor applications. - Initiate a Neutralize effort to investigate the identification of techniques to deflagrate or detonate explosives by creating hot spots or other localized effects that do not quench. - Initiate a Neutralize effort to investigate new energy conversion schemes and extraction mechanisms for high-powered microwave sources that have potential to dramatically reduce the size, weight, and power required. - Initiate a Neutralize effort to research compact wideband metamaterial multifunctional antennas. - Initiate a Mitigate effort to explore new chemistry techniques to optimize polymer fiber growth and hardening. - Initiate a Mitigate effort to develop in-situ analytical tools to observe nano to micro structure of materials during fabrication and treatment processes. ***FY 2015 Plans:*** - Continue all effort of FY 2014, less those noted as completed above. - Complete a Neutralize effort to investigate emitter recognition and related network behavioral analysis. - Complete a Mitigate effort to research multifunctional ballistic fibers with Custom Designed and Engineered Nanostructure. - Complete work on neural correlates of cross-culture adaptation - Complete work on distinguishing the optical signature of explosive molecules from background molecules. - Initiate research on lightweight flexible materials that can selectively absorb, dissipate, and convert high energy electromagnetic waves or blast waves. - Initiate research on compact and efficient high voltage pulsed switches that can rapidly charge and discharge at a high repetition rate. - Initiate an effort to detect a wider variety of homemade explosives			
Title: HUMAN SYSTEMS	18.800	21.213	17.180

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Description: Efforts include: Human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition. Accomplishments and plans described below are examples for each effort category. Funding decrease in FY 2015 is the result of changing S&T investment priorities within the Department of the Navy. ***FY 2013 Accomplishments:*** - Continued research of social networks for counterterrorism. - Continued expansion of the cognitive architectural modeling capability to increase coverage, including spatial reasoning, multitasking, and impact of physiological and stress variables. - Continued research of human cognition and performance to create more realistic simulations for training. - Continued program to combine cognitive architectures with computational neuroscience to better predict human performance. - Continued program on implantable electronics for performance enhancement. - Continued investment in natural language interaction capability for artificially intelligent training systems. - Continued research of neuro-control of high-lift bio-inspired Unmanned Underwater Vehicles and active vision and cognitive navigation skills in mobile robots. - Continued computational neuroscience for novel pattern recognition and sensory augmentation. - Continued research of human-robot interaction to support team collaboration. - Continued the output human performance usability models with actual human performance results obtained in usability testing on systems under development. These systems include future Naval Combat Systems and Homeland Security Operation Centers. - Continued investigation of human sensory performance for optimizing video and audio human-electronic device interfaces. - Continued research to create new social modeling tools for understanding the responses of adversaries, determining the best practices for containing and deterring the adversary, and developing effective course of action in non-Western environments for humanitarian and civilian-military operations. - Continued research of advanced biometrics such as biodynamic signatures to support spirals 2 and 3 of the Navy Identity Dominance System - Maritime Domain. - Continued efforts to extend the representational capabilities of cognitive architectures to accommodate aspects of social cognition and teamwork. - Continued efforts to develop an empirical understanding and prediction of the behaviors of individuals and social groups and networks, computational approaches to social network theory and the co-evolution of adversarial tactics and strategies, algorithms for exploring scenarios that take into account socio-cultural factors; political and economic factors; local attitudes, values, and social structure.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued research of human activity and intend recognition and dynamic biometrics for improved human system interfaces and force protection. - Continued research into probabilistic reasoning in computation cognitive architectures. - Continued research into computational social neuroscience to provide new models for manpower assignment and incentivization and new social models of cross-cultural interactions. - Continued research on models of social dynamics and culture in small scale societies. - Initiated research on brain-inspired intelligent systems to enable high-level interaction between warfighters and autonomous systems. - Initiated research to explore the development of algorithms to automate assessment of the information value of Command and Control (C2) related data for next generation C2 systems. - Initiated research to explore to dynamically provide decision support in support of rapid mission planning, re-planning and execution at command and combatant echelons. Research thrust to include dynamic mapping of decision space and decision-based, dynamic task allocation algorithms. - Initiated research to explore concepts of operations for the management of information in hybrid autonomous systems. - Initiated research on social neuroscience of Trust. - Initiated research on data collection and processing for health surveillance and medical assistance. ***FY 2014 Plans:*** - Continue all efforts of FY 2013. - Complete research into developing adaptive and individualized intelligent tutors for STEM training and education. - Complete socio-culture research of complex humanitarian operations - Initiate research on geography, health and disaster for next generation information systems for collaborative humanitarian assistance. - Initiate research to improve collaborative systems and trust in computer mediated environments. - Initiate socio-culture research of complex humanitarian operations. - Initiate development of intelligent, embedded assessment for Intelligent Tutoring System (ITS). - Initiate research on socially guided machine learning. This includes robotic teammates learning from human teachers both by demonstration and verbal instruction. - Initiate the early exploration of modeling the cognitive basis for human moral judgments. - Initiate research to explore the development of algorithms to automate assessment of the information value of Command and Control (C2) related data for next generation C2 systems. - Initiate research to explore concepts of operations for the management of information in hybrid autonomous systems. - Initiate research on geography, health and disaster for next generation information systems for collaborative humanitarian assistance. - Initiate research to improve collaborative systems and trust in computer mediated environments.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiate socio-culture research of complex humanitarian operations. - Initiate research into cost effectively adapting current intelligent tutoring technologies to wider dissemination across Navy schoolhouses. - Initiate/Complete socio-culture research of complex humanitarian operations. ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those noted as completed above. - Complete research of advanced biometrics such as biodynamic signatures to support spirals 2 and 3 of the Navy Identity Dominance System - Maritime Domain. - Initiate research to address visualization and synthesis from multiple data sources to support autonomous systems and small hybrid teams. - Initiate research on portable, intelligent, computer based expert decision aids for maintenance applications. - Initiate research on computational models for predicting human error on procedural tasks. - Initiate research on cognitive modeling for cybersecurity. - Initiate research seeking a unified theory of the overall decision process, including the role of judgment with the goal that the unified theory will link currently existing, but isolated, conceptual theories of decision making, judgment, sensing, and detection. - Initiate research into strategies for and utility of incorporating uncertainty into planning and asset allocation in Naval missions. - Initiate research on human performance sources of cyber vulnerabilities of unmanned vehicle (UxV) systems. - Initiate human systems integration research to reduce workload and increase operator situational awareness in command information center. - Initiate research to understand and dynamically model context in operational decision making. - Initiate research on statistical language translation for content analysis of threat behaviors and human security issues.			
Title: MATHEMATICS, COMPUTER, & INFORMATION SCIENCES ***Description:*** Efforts include: Mathematical foundation and computational theory and tools for design, communication, and control of intelligent autonomous systems; theory, algorithms and tools for decision support; decision theory, algorithms, and tools; heterogeneous information integration, management, and presentation; information assurance, secure and reliable information infrastructure for command and control; mathematical optimization for optimal resource allocation and usage; modeling and computation of complex physical phenomena; modeling and computation for electromagnetic and acoustic wave propagation and scattering; seamless, robust connectivity and networking. Accomplishments and plans described below are examples for each effort category. Funding decrease in FY 2015 is the result of changing S&T investment priorities within the Department of the Navy. ***FY 2013 Accomplishments:***	42.915	48.305	36.726

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued development of mathematical optimization framework and heuristic algorithms that serve as theoretical and computational basis for network design, resource allocation, and logistics. - Continued development of improved tactical and battlespace decision aids. - Continued to refine techniques for extracting maximum knowledge from multi-modal imagery, text, and multisource signal data. - Continued to investigate methods to deal with light dispersion on image formation underwater to enable precise navigation,station keeping, and mapping capabilities for unmanned underwater vehicles. - Continued efforts for enabling teams of autonomous systems to work together and work on representations for evolution of cooperative behaviors, including efforts in multi-modal interactions with autonomous systems. - Continued developing framework for dealing with effect of variable latencies in communication within teams of humans and autonomous systems. - Continued efforts on quantum computing and cryptography. - Continued efforts on model checking and automated theorem prover technologies. - Continued efforts in mathematical modeling of complex physical phenomena. - Continued efforts in mathematical techniques for inverse problems, including reliable approximate solutions in 3 dimensions(3D); adequate representation of the physics of the media and the scatterer; and improved resolution of structural and material properties. - Continued focused efforts in development of mathematical foundations for image understanding on a number of key challenges,such as multi-modal imagery representation and metrics, object recognition, scene analysis and understanding. - Continued development of mathematical, statistical, and computational framework leading to robust underlying approaches for automated information integration of disparate sources of data. - Continued research in cognitive radio and networking protocols. - Continued research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas. - Continued research in cross-layer wireless protocols for delay sensitive network traffic. - Continued multidisciplinary research efforts to focus on intelligent control systems, cooperative behavior modeling and response,UxV-human interactions and adaptive mission methodologies. - Continued development of an interaction model of how users characterize visual content and context to improve video surveillance. - Continued development of improved formal foundations, methods, and tools for compositional verification and construction of high assurance software systems. - Continued investigation of relational constructive induction, semi-supervised learning, and classifier ensembles to improve collective classification technology and operations based automated decision aids.- Completed efforts on Ferrite-based broadband circulators. - Continued research aiming to develop principled, trustworthy, yet practical and usable approaches to address the issue of software producibility and the development of complex software systems with ensured interoperability. - Continued research into anti-tamper and information assurance: research focused on protection techniques, architectures,			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
algorithms, protocols that allow for security and cyber situational awareness. - Continued research to develop mathematical and computational tools for compressive sensing. - Continued the development of theory and algorithms for quantum communications. - Continued efforts on Ferrite-based broadband circulators. - Continued efforts addressing the representation, computation, and analysis of information from large diverse data sets. - Continued research efforts to develop tools for proactive information assurance and cyber space security. - Continued multidisciplinary research efforts on reasoning for image understanding in uncertain environments. - Continued multidisciplinary research efforts to provide information assurance foundations for countering the Botnet threats. - Continued research efforts addressing computational complexity arising from network-enabled computing, such as cyber security, information integration, and intelligent autonomy of networked, cooperative systems. - Continued research efforts to develop methods and algorithms for computing with natural language. - Continued mathematical studies to understand the micro-physics of a liquid-solid-gas interaction in turbulent flow conditions. - Continued research efforts for mathematical development of physics-based computational and signal processing techniques for understanding and characterizing biological-acoustical coupling in acoustic wave propagation and scattering. - Continued effort to improve tactical networks by developing a theoretical performance model for wireless networks. - Continued effort to optimize quantum communication bandwidth in noisy environments by developing a new mathematical representation of quantum information. - Initiated research on mathematical and computational building blocks for machine reasoning and intelligence. - Initiated multidisciplinary research efforts on knowledge representation and reasoning for decentralized autonomy. - Initiated research efforts on algorithmic solutions and explicit measurement schemes for networks inference and monitoring. - Initiated research on novel techniques for interference mitigation. - Initiated efforts to develop computer sciences foundation for quantum information sciences leading to new ways of computing and communication. - Initiated research to improve teleoperation of robotic manipulators by developing a system trained by a human operator to perform complex manipulation tasks. - Initiated research to develop a theory of trust-based traffic security by creating models of trust, network structure and dynamics, and incentives and economics. - Initiated research to develop the foundation for new techniques that enable the adaptive characterization of evolving computer network traffic patterns.			
FY 2014 Plans: - Continue all efforts of FY 2013, less those noted as completed above. - Initiate research on distributed network synchronization.			
FY 2015 Plans: - Continue all efforts of FY 2014, less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Complete research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas.			
Title: MATERIALS/PROCESSES	57.975	57.403	55.675

Description: Efforts include: Structural Materials; functional materials; maintenance reduction; Environmental Sciences; and Manufacturing Science. Accomplishments and plans described below are examples for each effort category. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

Accomplishments and plans described below are examples for each effort category.

Funding decrease in FY 2015 is the result of changing S&T investment priorities within the Department of the Navy.

FY 2013 Accomplishments:
Structural Materials
- Continued development of first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels.
- Continued development of models and simulations to understand and predict high deformation rate blast behavior for engineered topological structures.
- Continued development of materials and fabrication science for fugitive phase processes for engineered topological structures for ship blast protection.
- Continued quantification of the corrosion effects on fatigue to be incorporated into the Unified Damage Model and validated in a few environmental cases on P-3 aircraft real loads data.
- Continued developing carbon nanotubes growth and mechanical behavior in advanced composites for next generation ship and aircraft structures.
- Continued development of theoretical basis for composite materials behavior based on x-ray computed microtomography.
- Continued development of understanding and constitutive models of dynamic behavior of naval steels.
- Continued evaluating environmental effects on marine composites and sandwich structures.
- Continued exploration of composition, processing and microstructural evolution in titanium alloys for marine structures.
- Continued exploration of multienergy processes for zero maintenance coatings.
- Continued investigation of a rapid annealing of surface layers and their effects.
- Continued the investigation of processing science (single crystals, coatings, thermal barrier coatings (TBC), heat treatment, etc) to materials performance for turbine engine components to develop relevant process protocols to optimize and control quality.
- Continued to advance the understanding of processing and deformation mechanisms in nanostructured ceramic composites and metal alloys to provide new high strength-high toughness materials for Naval platforms.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued to investigate the use of photorefractive crystals for the demodulation of a distributed fiber optic Bragg gratings structural health monitoring system. - Continued research on new hybrid composites that integrate polymers, structural fibers, carbon nanotubes, ceramics and metals, with improved blast, ballistic, fire resistance and mechanical characteristics with special emphasis at the interfacial aspects of the new materials. - Continued efforts to understand and predict salt chemistry effects on high temperature coatings and materials in naval gas turbine environments. - Continued understanding for development of modeling tools for enhancing dynamic response and projectile resistance for sandwich structures. - Continued the fatigue life prediction model analysis on high temperature engine materials. - Continued development of new methods for room temperature curing and processing of polymer composites with high temperature thermoxidative stability and fire resistance. - Continued assessment of the blast resistance of cellular structures as functions of soil characteristics. - Continued materials and fabrication science for fugitive phase processes for engineered topological structures for vehicle blast and fragmentation protection. - Continued exploration of fundamental mechanisms and initiate development of physics-based models of electrophoretic deposition of ceramic nanoparticles and subsequent sintering. - Continued physics based models for coupled phenomena in marine composite structures (thermo-mechanical loads, environmental effects, and fluid-structure interactions.) - Continued Computer-Aided Materials Design (CAMD) for synthesis and testing of various materials. - Continued structure and properties of liquid and glassy metals. - Continued scientific basis for the rational engineering design of Al-alloys for Naval applications. - Completed high temperature, low frictional sliding coefficient materials for elevated operating temperature gas turbine engine bearings. - Initiated establishment of mechanics of crack propagation in aluminum structures, and explore concepts for enhancing fracture resistance. - Initiated development of refractory solid metal carbide composites from metal / polymer precursors. Functional Materials - Continued research tools design efforts in electromagnetic and acoustic bandgap materials. - Continued study of new transduction mechanisms. - Continued development of the science and technology base for a highly efficient and stable flexible organic solar cell. - Continued investigation into the properties and fabrication of novel ceramics which have potential to combine hardness, strength, and high transmission in the long wave infrared (LWIR) spectral region. - Continued effort to synthesize beta-SiC power suitable for subsequent densification into transparent beta-SiC ceramic.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued meta-materials effort to develop negative index materials with dynamic frequency response. - Continued synthesis and property measurement of new sonar materials predicted by first principle methods. - Continued expansion of first-principles methods devised to calculate piezoelectric properties of materials for sonar transducers to calculate additional materials properties for other applications. - Continued design, processing, and measurements to fashion the new generation of high-strain, high coupling piezoelectric single crystals into high-performance acoustic transducers for naval sonar systems. - Continued basic research into material technology associated with the development of active and conventional armor. - Continued effort to characterize regenerative bacterial nanowires. - Continued effort to synthesize cyclic peptide ring modules and polymerize them into peptide nanotube polymers. - Continued efforts to utilize chemically modified virus proteins as a scaffold to assemble nanostructured metamaterials with unique optical properties including negative index of refraction. - Continued effort to develop surface electrons on diamond. - Continued efforts to develop oxide materials for power management, sensors, and information storage/processing. - Continued effort to use elastic pentamode metafluid materials for acoustic cloaking. - Continued effort to characterize the properties of chemically reactive flows subject to non-Kolmogorov or non-equilibrium turbulence, or that create these types of turbulence. - Continued effort to develop conjugation strategies that can allow the efficient attachment of multiple biological moieties to nanoparticles (NPs) in a controlled manner. - Continued examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used. - Completed effort to develop conjugation strategies that can allow the efficient attachment of multiple biological moieties to nanoparticles (NPs) in a controlled manner. - Initiated exploratory synthesis, electromechanical property evaluation and atomic level analysis of new quaternary piezocrystals in order to optimize materials properties for specific Navy SONAR applications. - Initiated development of advanced nanostructured magnetic materials for energy applications. - Initiated development of cladded single crystal fibers. Counter-IEDs - Initiated study of biomimetic nano composites. - Initiated study of energy transduction through soft armor. Sensors, Electronics & EW - Completed an effort to establish the physicochemical nature giving rise to the anomalously high electron conductivity of single-unit-layer conductive skins of RuO2 used to coat a wide array of dielectric substrates. - Completed research into novel super resolution algorithms using optical flow techniques.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Completed investigation of mathematical solutions and algorithms for resolving issues with sparse sensing radar. - Completed effort to demonstrate and develop one dimensional spin transport & manipulation in Si and Ge nanowires and to develop new lateral growth method for Ge NWs on Si(001). - Initiated study of active control of biomolecular binding on surfaces. - Initiated search for sustainable replacements for semiconductors and strong magnets. - Initiated study of sensing, selection and control of marine microbes. - Initiated effort to develop techniques for the atomic layer deposition of high-quality dielectric films on semiconductor surfaces with extremely low interface state densities. - Initiated effort to determine the feasibility and develop a greater understanding of defect science in SiC epitaxial layers on low offcut substrates suitable for power electronic applications. - Initiated fundamental investigation onto the synthesis and material properties of graphene, boron nitride and other two dimensional materials; identify potential exploitation avenues. - Initiated development of the method of moments solvers for millimeter wave region targets - Initiated development of phase-only pattern synthesis for transmit arrays. - Initiated development of a new theory of inference for statistical signal processing. Maintenance Reduction - Continued development of corrosion models. - Continued mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces. - Continued stainless steel carburization study to enhance corrosion performance. - Continued the concept study of multiscale corrosion modeling on naval ship materials. - Continued fundamental theoretical and experimental studies on nanoscale corrosion of metals and alloys. - Continued corrosion prediction using an integrated deterministic-based model. - Continued grain boundary engineering to improve corrosion resistance of marine grade aluminum alloys. - Continued modeling and simulation of corrosion phenomena. - Continued studies of surface microstructure optimization to enhance corrosion properties of navy marine alloys - Continued sensor development for monitoring microstructural changes on alloys under thermal and mechanical stresses. - Continued research focused on modeling and simulation for platform and system affordability, lifetime materials, shipboard wireless capability, automation to reduce manning. - Continued development of ab initio models of corrosion reactions. - Continued development of coatings capable of actively responding to environmental stresses. - Continued study of coating failure mechanism on coating-substrate interface. - Continued research on innovative concepts for effective radiation barrier coatings and ultra-low thermal conductivity barrier coatings.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued development of environmental corrosivity modeling. - Continued development of nanoscale modeling of corrosion kinetics. - Continued development of surface tolerant coatings. Environmental Science - Continued examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations. - Continued broad based program in anti-fouling and fouling release coatings including investigation of effect of new polymers,materials, processes, and novel testing methodologies for coating efficacy. - Continued effort to determine most promising foul-release approaches based on silicones to meet Navy durability requirements. - Continued effort to develop Reverse Osmosis (RO) pre-treatment strategies to allow water recycling on ships. - Continued efforts on treatment strategies of oily water containing synthetic lubricants. Manufacturing Science - Continued a multidisciplinary research task into furthering the sciences associated with advances in manufacturing processes. ***FY 2014 Plans:*** Structural Materials - Continue all efforts of FY 2013, less those noted as completed above. Functional Materials - Continue all efforts of FY 2013, less those noted as completed above. Maintenance Reduction - Continue all efforts of FY 2013, less those noted as completed above. Environmental Science - Continue all efforts of FY 2013, less those noted as completed above. Manufacturing Science - Continue all efforts of FY 2013, less those noted as completed above. ***FY 2015 Plans:*** Structural Materials - Continue all efforts of FY 2014, less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Complete first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels. - Complete scientific basis for the rational engineering design of Al-alloys for Naval applications. - Complete exploration of multienergy processes for zero maintenance coatings. Functional Materials - Continue all efforts of FY 2014, less those noted as completed above. - Complete study of new transduction mechanisms. Maintenance Reduction - Continue all efforts of FY 2014, less those noted as completed above. Environmental Science - Continue all efforts of FY 2014, less those noted as completed above. Manufacturing Science - Continue all efforts of FY 2014, less those noted as completed above.			
Title: MEDICAL/BIOLOGY ***Description:*** Efforts include: Bioinspired autonomous and surveillance systems, and bio-inspired processes, materials and sensors; synthetic biology for Naval applications; casualty care and management; casualty prevention; undersea medicine/ hyperbaric physiology; biorobotics; expeditionary operations training; stress physiology and regenerative medicine. These efforts are coordinated with the Army and Air Force through joint program reviews and meetings and are complementary, not duplicative. Accomplishments and plans described below are examples for each effort category. Funding decrease in FY 2015 is the result of changing S&T investment priorities within the Department of the Navy. ***FY 2013 Accomplishments:*** Medical Sciences - Continued work on stress physiology, hyperbaric physiology, and biological effects of Naval operational exposures. - Continued work in understanding the mechanisms of decompression illness and hyperbaric oxygen toxicity. - Continued research in casualty care and management and casualty prevention, including investigations of mechanisms of hemorrhagic shock, blast injury, tissue repair, and the biomedical effects of military operational exposures such as directed energy, hazardous chemicals, and sound.	18.863	20.611	18.225

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued research to explore systematic relationships between cognitive and physiological responses to laboratory tasks under operational conditions. - Continued research to explore mechanisms of "ultrasonic" hearing in divers. - Continued research to explore a novel opioid that will produce analgesia as effective as morphine, with minimal side effects. - Continued interventions to mitigate underwater sound/blast effects. - Continued research on improved trauma management in submarine Special Forces operators. - Continued research on physiological and genetic effects of long-term diving. - Continued research in genetic basis of psychological stress. - Continued research in mitigation of the effects of sleep deprivation. - Continued research in stress effects on the immune system. - Continued research with Army, in regenerative medicine (Armed Forces Institute for Regenerative Medicine (AFIRM) - Continued research to discriminate fatigue and stress performance effects. - Continued research on individual susceptibilities in extreme environments to include hypoxic and/or hypobaric conditions. - Initiated research to evaluate the effects of chronic stress on performance. - Initiated research to assess the effects of hyperbaric oxygen therapy on blast-induced histopathological changes. Biological Sciences - Continued efforts focused on microbe-materials interfacial interactions for detection of materials defects/failures, including corrosion, and for improved energy harvesting. - Continued efforts in "smart cell engineering" to design microbes that can sense and destroy other microbes through antibioticproduction, or can "sense" and qualify their surrounding environment and provide information back to the user. - Continued combinatorial chemical screens for bacterial communication pathway inhibitors as potential antibiotics or fouling control agents.ontinued research on biofouling with emphasis on barnacle adhesion studies using molecular biology tools. - Continued research on invertebrate larval settlement and metamorphosis in response to biofilms and various inhibitors of adhesion. - Continued work to identify plasma biomarkers of domoic acid toxicosis and leptospirosis in California sea lions, and develop a multiplexed assay to measure those plasma biomarkers. - Continued efforts to identify molecular biomarkers for battlefield injuries, and high-fidelity biosensors for detection in vivo. - Continued research into biomolecular 'logic controllers' for in vivo biosensor and in vivo drug delivery systems. - Continued research efforts focused on developing bio-inspired sensors, vehicles and systems for local Intelligence, Surveillance and Reconnaissance (ISR), Weapons of Mass Destruction (WMD) detection, personnel protection and affordability. Research elements include advances in microfabrication, biological materials, processing techniques, robustness and efficiency of systems. - Continued research on stem cells in marine mammals and their potential clinical role. - Continued development of a second set of molecular diagnostic tests for recently discovered viral pathogens of marine mammals.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued research in elucidation of mechanisms of fish electric sense and near field low frequency acoustic perception. - Continued research on bacterial/cellular controllers for nano/micro-systems - Continued efforts to investigate DNA-scaffold-directed assembly of protein nanoarrays for control over orientation and position of proteins, and investigate triggered isothermal assembly of DNA nanostructures. - Continued efforts in comparing commensal/pathogenic microbiomes in to Atlantic bottlenose dolphin and California sea lion, and for the dolphin diagnosed with chronic/active gastritis. - Initiated synthetic biology efforts for designing organisms with non-natural functions (e.g., light detection, electrical 'switch' capability, magnetic field production) - Initiated research to identify natural product inhibitors of bacterial folate biosynthesis for development as antibiotics. - Initiated studies to control the synthesis of patterned materials from the nano-scale to the micro-scale using bionanotechnology.			
FY 2014 Plans: Medical Sciences - Continue all efforts of FY 2013, less those noted as completed above. - Initiate research on individual susceptibilities on health and human performance in military environments to include heat, cold, enclosed spaces, pressure and acceleration. - Initiate research on the mechanisms of nitrogen narcosis/high pressure nervous syndrome - Initiate investigations of mechanisms of blast-induced neurotrauma at the cellular level. Biological Sciences - Continue all efforts of FY 2013, less those noted as completed above. - Complete development of a second set of molecular diagnostic tests for recently discovered viral pathogens of marine mammals. - Initiate research on characterizing/manipulating human gut microbiome to understand its role in response to behavioral and physical stressors. - Initiate development of new tools and techniques for the engineering and characterization of DNA nanostructures and the control of DNA-based nanodevices. - Initiate the investigation of the material properties of silk proteins in order to facilitate development of applications. - Initiate development of field portable sensing platforms for explosives detection.			
FY 2015 Plans: Medical Sciences - Continue all efforts of FY 2014, less those noted as completed above. - Initiate research in partnership with the Army to study regenerative medicine (Armed Forces Institute for Regenerative Medicine II (AFIRM II)). - Initiate research to investigate novel mechanisms to manage the mammalian circadian system for optimized health and performance.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Initiate research to develop strategies for nerve cell regeneration. Biological Sciences - Continue all efforts of FY 2014, less those noted as completed above. - Initiate research on tubeworm adhesion science using molecular biology tools.			
Title: OCEAN SCIENCES	79.043	89.619	79.351
Description: Efforts include: Littoral Geosciences and Optics; Marine Mammals and Biology; Physical Oceanography and Prediction; and Ocean Acoustics. Accomplishments and plans described below are examples for each effort category. Accomplishments and plans described below are examples for each effort category. Increase in Ocean Sciences from FY 2013 to FY 2014 is due to support at-sea, ocean science research and ship time in western Pacific, Indian, and Arctic Oceans. Funding decline in Ocean Sciences from FY 2014 to FY 2015 is the result of reduced investment in Basic Research within the Department of Defense. ***FY 2013 Accomplishments:*** Littoral Geosciences and Optics - Continued field programs to understand physical and biological processes responsible for the formation, maintenance, and breakdown of thin oceanographic layers which have a significant impact on undersea warfare sensors and weapons. - Continued efforts to investigate the effects of oceanic biota on the propagation and inversion of multifrequency acoustical energy. - Continued investigations of sources and properties of light scatter within the coastal ocean. - Continued to investigate the physical processes that control re-suspension of bottom sediments and the resulting impact on optical and acoustical propagation. - Continued investigations of oceanic processes within the surface boundary layer that control high-frequency variability in image propagation and distortion. - Continued to investigate and characterize the impact of riverine sources of optically-important matter on underwater visibility,navigation, and surveillance. - Continued field program to infer sea floor characteristics from observations of surface gravity waves. - Continued effort to understand the extent and intensity of seafloor gas hydrate accumulations and coastal bio-optical response to air-ocean forcing.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued programs to estimate optical properties of coastal ocean water from above-surface sensing, using in situ data for validation. - Continued studies to predict tidal flat evolution in coastal/riverine/estuarine systems. - Continued incorporation of improved understanding of tropospheric and stratospheric bulk exchanges, air-sea interface, boundary layer interface, coastal ocean dynamics, gas hydrate accumulation, and biological responses into atmospheric and ocean prediction models and tactical aids. - Continued development of prediction models for distributaries deltaic coastal environments. - Continued studies of tidal flat evolution in wave dominated environments. - Continued studies of dissipation of surface gravity waves by muddy seabed sediments. - Continued field, modeling and remote sensing studies of currents, waves, sediment transport and bathymetric evolution of river mouth and inlet environments. - Continued investigations of radar, hyperspectral and electro-optical remote sensing signatures in littoral environments. - Initiated development of a new method of data assimilation, adjointless 4D-Var through a combination of theoretical analysis and numerical simulations to develop the method and estimate its efficiency with respect to the traditional 4d-VAR scheme as well as to use it to generate a sensitivity analysis for targeted observations - Initiated the effort to identify and isolate the dynamical processes that control the structure and variability of the Kuroshio and Ryukyu Current using a combination of numerical model simulations and observations and, explore their interactions between the Ryukyu Island passages. - Initiated the development of a numerical model system (composite of new and existing process models and data bases) and compare with observations, as well as use it to simulate future scenarios to quantify importance of seafloor carbon to the global carbon cycle now, and in the future. Marine Mammals and Biology - Continued field trials of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals. - Continued new efforts on tracking of marine mammals using data fusion based on tags and remote sensing. - Continued new efforts to examine physiology of marine mammals in situ and to predict consequences of physiological and auditory stress to populations. Physical Oceanography and Prediction - Continued field studies/modeling to predict propagation and effect on acoustics of non-linear internal waves in the western Pacific. - Continued development of a ship wave radar driven wave model to allow high resolution studies of near surface ocean processes and to support Sea Basing. - Continued design evaluation for a persistent mobile sampling network based on autonomous undersea vehicle platform and			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
sensor technologies. - Continued field programs that demonstrate persistent monitoring and measurement of environmental structures using gliders. - Continued workshops to define science needs for Sea Basing. - Continued an integrated modeling and field experiment on determining custom self-learning wave databases and forecast systems/ship-movement and engineering systems for Sea Basing. - Continued an Estuarine-Littoral Processes Interaction field study in muddy and tidal flat dominated regimes including a data assimilative prediction capability. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas. - Continued studies to understand how to sample ocean processes with gliders and other autonomous and remote sensing systems to support tactical oceanography. - Continued to develop state of the art numerical model assimilation and initialization techniques, improved physical parameterizations, air-sea interactions, and fidelity for atmospheric and ocean prediction systems. - Continued development of expert system methods to characterize and predict Riverine/estuarine systems to support Naval Special Warfare, Marine Expeditionary Forces and new Riverine units. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued studies of ocean and wave response to typhoons and monsoons in the Western Pacific. - Continued studies of how to predict the 'full battle space environmental cube' using networked sensors and multiply coupled ocean/wave/atmosphere/acoustic prediction systems to provide sea base and fleet force protection. - Continued extensive 3-year field program on prediction of internal waves. - Continued extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics program. - Continued an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models. - Continued studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Continued the field and modeling experiments to determine the lateral dispersion and maxing parameterization needed to understand model turbulence and to model ocean circulation. - Continued an effort to understand the ageostrophic vorticity dynamics of the ocean with an emphasis on the processes leading to the generation of submesoscale variability and coastal frontogenesis. - Continued an effort to understand the dynamics that govern spiciness variability, its impact on ocean circulation, and the competing roles temperature and salinity have on ocean density and sound speed structure evolution.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued a field and modeling effort to understand and predict the generation and variability of western boundary currents in the Pacific Ocean. - Continued a field and modeling effort to understand the coupled physical processes that result in the propagation of the air-sea mode known as the Madden-Julian Oscillation in the Indian Ocean. - Continued a field and modeling program to investigate the structure and circulation of the South China Sea and oceanographic variability along the coast of Vietnam. - Continued studies of the coupled atmosphere-ocean-cryosphere-wave physics from the submesoscale to decadal climate scales to permit development of new global coupled modeling systems. - Continued studies of changes in the Arctic oceanography, meteorology and cryosphere and associated processes to allow permit development of new prediction models for the Arctic. - Continued arctic research to develop a new generation of ocean-ice-atmosphere dynamic prediction models, including process studies involving remote sensing and in-situ observations. - Completed an effort to understand the ageostrophic vorticity dynamics of the ocean with an emphasis on the processes leading to the generation of submesoscale variability and coastal frontogenesis. - Completed extensive 3-year field program on prediction of internal waves. - Completed extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics Program. - Completed workshops to define science needs for Sea Basing. - Completed an Estuarine-Littoral Processes Interaction field study in muddy and tidal flat dominated regimes including a data assimilative prediction capability. - Completed an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models. - Initiated collaborative studies with Vietnam to observe and model oceanographic processes along the Vietnamese shelf. - Initiated field experiments using autonomous vehicles to observe topographically-generated currents and turbulence around islands in the Western Pacific Ocean. - Initiated research efforts related to the development of an Earth System Prediction Capability to enable improvements in extended range environmental forecasts. Ocean Acoustics - Continued analysis of deep-water acoustic transmissions made in the North Pacific to understand the scattered sound field due to ocean volume variability and bathymetric features. - Continued a field and modeling effort to simultaneously study shallow-water medium fluctuations and develop time-reversal communications using adaptive channel equalizers. - Continued analysis and modeling to understand the physics of buried mine detection through broadband and synthetic aperture sonar.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued shallow-water, shelf-break measurements and analysis to characterize the effects of the ocean water column and seabed variability on low- and mid-frequency acoustic propagation and scattering. - Continued a field and modeling effort to establish the capabilities of underwater acoustic communications for FORCEnet and persistent undersea surveillance. - Continued the development and testing of geo-acoustic inversion and extrapolation methods. - Continued investigations into quantifying, predicting and exploiting uncertainty in acoustic prediction models. - Continued research to develop complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. - Continued research to quantify uncertainty in acoustic field computations for multi-scale ocean environments using novel approaches involving Bayesian prediction and polynomial chaos expansions to embed environmental uncertainty into multi-scale ocean dynamics and acoustic propagation. - Continued effort to understand synoptic scale ocean variability in the strategic Turkish Straits System including water mass exchange between basins and vertical mixing. - Continued data collection and analysis of deep water ambient noise with emphasis on the Philippine Sea. - Continued reverberation and clutter modeling studies. - Continued investigation of acoustic propagation in the Arctic.			
FY 2014 Plans: Littoral Geosciences and Optics - Continue all efforts of FY 2013, less those noted as completed above. - Complete studies of tidal flat evolution in wave dominated environments. - Complete studies of dissipation of surface gravity waves by muddy seabed sediments. - Complete field programs to understand physical and biological processes responsible for the formation, maintenance, and breakdown of thin oceanographic layers which have a significant impact on undersea warfare sensors and weapons. - Complete investigations of the physical processes that control re-suspension of bottom sediments and the resulting impact on optical and acoustical propagation. - Complete field program to infer sea floor characteristics from observations of surface gravity waves. - Complete investigations of oceanic processes within the surface boundary layer that control high-frequency variability in image propagation and distortion. - Initiate studies of Coupled Human-Landscape Interactions in Low-lying Coastal Environments. - Initiate studies of data-assimilative modeling for coupled nearshore-riverine systems. Marine Mammals and Biology - Continue all efforts of FY 2013, less those noted as completed above.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Physical Oceanography and Prediction - Continue all efforts of FY 2013, less those noted as completed above. Ocean Acoustics - Continue all efforts of FY 2013, less those noted as completed above. - Complete analysis and modeling to understand the physics of buried mine detection through broadband and synthetic aperture sonar. - Complete effort to understand synoptic scale ocean variability in the strategic Turkish Straits System including water mass exchange between basins and vertical mixing. - Initiate soft sediment geoacoustic inversion studies with an emphasis on the Gulf of Mexico. ***FY 2015 Plans:*** Littoral Geosciences and Optics - Continue all efforts of FY 2014, less those noted as completed above. - Initiate research efforts to observe, understand, and predict the many intertwined geophysical processes which are present on the inner shelf. Marine Mammals and Biology - Continue all efforts of FY 2014, less those noted as completed above. Physical Oceanography and Prediction - Continue all efforts of FY 2014, less those noted as completed above. - Initiate research efforts to observe, understand, and predict the evolution of the Marginal Ice Zone in the Arctic Ocean. - Initiate in situ, airborne, and remote sensing observational efforts to inform scientific studies of the physical environment in the Arctic region. - Initiate research on integrated Arctic System Models to enable improved forecasts of the operational environment on lead times from hours to months in the Arctic domain. - Initiate an investigation into the changing surface conditions of the Arctic Ocean, resulting from observed reductions in sea ice cover. Ocean Acoustics - Continue all efforts of FY 2014, less those noted as completed above.			
Title: SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	33.190	42.587	47.252

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Description: Science and Engineering Education and Career Development activities include DON participation in science fairs, summer research interns/fellows at Navy laboratories, graduate fellowships for individuals expected to become members of the engineering faculty at Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs), and curricular enrichment programs. It is centered around Naval S&T efforts supporting Science, Technology, Engineering and Math (STEM). Outreach includes the encouragement, promotion, planning, coordination and administration of Naval Science and Technology. It also includes international scientific exploration through ONR Global. The funding increases in FY 2013 thru FY 2015 are the results of significant emphasis on the Science, Technology, Engineering and Mathematics (STEM) initiative. ***FY 2013 Accomplishments:*** Science, Technology, Engineering and Math (STEM) - Continued awarding prizes at 400 regional high school science fairs and four national competitions For Inspiration and Recognition of Science and Technology (FIRST), Junior Science and Humanities Symposia (JSHS), and Association for Unmanned Vehicle Systems International (AUVSI). - Continued supporting high school summer interns at Navy laboratories Science and Engineering Apprentice Program (SEAP). - Continued supporting undergraduate/graduate students as summer research interns at Navy laboratories Naval Research Enterprise Internship Program (NREIP). - Continued providing graduate fellowship support to HBCU engineering faculty candidates. - Continued funding Young Investigator Program (YIP) research grants. - Continued inspiring, engaging, educating and employing exceptional candidates to sustain and enhance the naval research enterprise. - Continued funding for the following educational and outreach efforts: Youth Exploring Science (YES), American Society of Materials (ASM) Teacher Camp, Expanding Your Horizon (EYH), Forest Partners, and Sally Ride Science, plus SeaPerch, FIRST,and BotBall robotics efforts. - Continued support for SciGirls, Navy GEMS (Gains in the Education of Mathematics and Science), STEM Literacy for Navy recruits, Business-Higher Education Forum (BHEF), and the Gulf Coast Initiative. - Initiated new projects to further teacher development and Grades 13/14 STEM degree retention. International Outreach - ONR Global - Continued international outreach support through ONR Global that provides a conduit for new scientific areas on the international front and promotes foreign sources of research important to the Naval mission. (ONRG) ***FY 2014 Plans:*** Science, Technology, Engineering and Math (STEM)			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2013. - Initiate new effort on undergraduate retention in STEM majors at Minority Serving Institutions. - Initiate new effort for teacher training in STEM for schools in underserved communities. - Initiate new computer science programs for female undergraduates. - Initiated expansion of internships to underserved students. - Initiate Masters in Systems Engineering program at a minority institution in partnership with Assistant Secretary of the Navy (Research, Development and Acquisition). International Outreach - ONR Global - Continue all efforts of FY 2013. ***FY 2015 Plans:*** Science, Technology, Engineering and Math (STEM) - Continue all efforts of FY 2014. International Outreach - ONR Global - Continue all efforts of FY 2014. The ONRG International Science Program mission is to search the globe for emerging scientific research and advanced technologies to enable the Office of Naval Research and the Naval Research Enterprise to effectively address current needs of the Fleet/Forces, and investigate and assess revolutionary, high-payoff technologies for future naval missions and capabilities. This is accomplished through PHD-level Associate Director scientists located in Asia, Europe and South America collaborating with international organizations and researchers through grants in innovative basic research, and establishing quality, relevant connections between international science and technology (S&T) centers of excellence and DON, DOD, and other US Government organizations. The direct impact of this investment is to capitalize on international basic research during unprecedented and dynamic global interdependence, increasing the ability to solve DON S&T challenges through shared knowledge and technologies with partners during a time of budget constraints. Additionally, this investment builds global S&T awareness to reduce the risk of potential technological surprise, and supports theater security cooperation goals to sustain cooperative relationships with an expanding set of international partners to enhance global security.			
Title: SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW) ***Description:*** Efforts include the basic research portions of: Sensing, diagnostics, and detectors; navigation and timekeeping; nanoelectronics; wide band gap power devices; real-time targeting; Electro-Optical/Infra Red (EO/IR) electronics; EO/IR electronic warfare; EO/IR sensors for surface/aerospace surveillance; Radio Frequency (RF) sensors for surface/aerospace surveillance; solid state electronics; vacuum electronics; Integrated Topside (InTop) Innovative Naval Prototype (INP); and RF electronic warfare.	44.644	54.180	54.875

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Accomplishments and plans described below are examples for each effort category. The increase from FY 2013 to FY 2014 is due to increased research emphasis in Anti-Submarine Warfare Distributed Search, Functional Materials, Electro-Optical/Infra-Red sciences. FY 2015 funding decrease within the SEEW efforts conducted at the Naval Research Laboratory. ***FY 2013 Accomplishments:*** - Continued monolithic integration of multifunctional materials to enable passive devices and sensors into wide bandgap semiconductor circuits. - Continued investigation of physical basis for improved time and frequency standards using quantum-entangled ions and atoms. - Continued investigation of ultra high speed logic and multiple-quantum-well devices with a goal of >500 gigahertz (GHz) samplers, in support of mixed signal circuits for receiver analog-to-digital converters (ADC's). - Continued program to extend device performance and architectures to frequencies approaching terahertz (THz). - Continued program to incorporate Magnesium Diboride (MgB2) tunnel junctions into simple electronic logic structures. - Continued study to determine if the coupling between spins in quantum dots mediated by the virtual excitons is sufficiently strong for use in solid state implementations for quantum information. - Continued program on advanced epitaxial growth for novel Si-based detector applications. - Continued development of a blind adaptive beamforming approach for the High Frequency (HF) radar case and compare with both the conventional and traditional approaches. - Continued development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. - Continued development of electromagnetic ultra-near-field holography. - Continued development of sensitive miniature fluxgate magnetometers. - Continued project to lower thermal gradients between active circuit elements and heat sinks. - Continued projects to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging. - Continued a program to apply innovative mass nanofabrication techniques to previously developed nanodevice arrays. - Continued a program on the control of deleterious defects in silicon carbide (SiC). - Continued a program on the study of Quantum Dots and their application to coherent wave function control and quantum information. - Continued a program on the tailoring of the optical, structural and electronic properties of semiconductor quantum wires. - Continued a program to demonstrate non-volatile memory, based on spin-torque Magnetic Random Access Memory (MRAM), with switching speed > 1 GHz and write currents small enough (<1 mA) to be driven by superconducting Rapid Single Flux Quantum (RSFQ) logic.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued a program to determine if the newly invented Reciprocal Flux Quantum Logic in fact delivers 2x higher speeds with 5x fewer Josephson junctions and power, while using the same underlying devices so that single chip hybrid circuits between it and the dominant RSFQ logic are feasible. - Continued a program to investigate whether pattern dependent RF currents during plasma etching are responsible for observed variability in Josephson junction characteristics in complex circuits and, if so, define design rule changes to avoid the effects. - Continued demonstrations of tunable analog filters made in a digital Nb device foundry. - Continued development of techniques to observe directly the electrical properties of pair states in high temperature superconductors. - Continued work on optical manipulation of ultra-cold atoms. - Continued investigation of temporal-spatial noise shaping circuits and architectures for high power digital-to-analog conversion with objectives of doubling spectral bandwidth, reduction of element density (15%), and extension of multidimensional Nyquist limits to both linear and planar arrays. - Continued the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processor (DSP)applications to Transmit/Receive (T/R) arrays. - Continued research to improve mixed signal III-V device and circuit modeling with objectives of achieving a 30 dB dynamic range improvement for complex circuits containing over 100,000 devices. - Continued project to explore graphene based nanoelectronic devices. - Continued program in chip-scale quantum architectures. - Continued project to reduce heat transfer through electrical leads in cryogenic packaging. - Continued project to explore development of devices, sigma delta and time encoder circuits for near THz switching with objectives of enabling analog and digital conversion at millimeter wave frequencies. - Continued high-sensitivity magnetometry using quantum logic. - Continued materials studies of low temperature regenerator (high thermal capacity) materials and/or controlled flow microstructures with the goal of improving energy efficiency of cryocoolers. - Continued research into fundamental concepts and mathematics for digital array architectures. - Continued research to apply carbon nano-tube technology to acoustic sensing. - Continued research to investigate two-dimensional electron gases in perovskite oxide heterostructures. - Continued project to investigate self-assembled one-dimensional GaN channels in AlGaN/GaN structures. - Continued spin-based electronics research. - Continued graphene physics and bandgap engineering research. - Continued semiconducting nanowire synthesis and characterization research. - Continued research on strain engineering in graphene. - Continued work on spin properties of graphene. - Continued research on focused electron beam based angstrom-scale nano-patterning. - Continued research effort to determine the most appropriate tunnel barrier for MgB2 Josephson junctions.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued an effort to grow low defect density, high purity epitaxial 4H-SiC at high growth rates suitable for high power electronic device applications. - Continued design, construction, and testing of sonic crystals that can be tuned to have specific acoustic properties. - Continued effort to create a physics-based understanding of epitaxial oxides and insulators for use in applications for advanced electronics. - Continued investigation into stabilizing in-phase coherent state of coupled systems for coherent power generation. - Continued high output impedance solid state device technologies and materials. - Continued effort to fabricate functionalized micro-opto-mechanical systems for the measurement of micromechanical photothermal spectra of adsorbed chemical vapor analytes. - Continued research effort on chemical synthesis and bandgap tailoring in graphene nanoribbons. - Continued research on spin dynamics in Group IV semiconductors and related device concepts. - Continued research efforts on non-conventional nanofabrication that hold promise for sub-10nm resolution. - Continued studies of the physics origin of noise and behavioral fluctuations in superconducting circuits, especially analog to digital converters, and incorporate the understanding into computer aided circuit simulators. - Continued studies of the generation and recombination dynamics of non-equilibrium quasiparticles associated with digital switching events in superconducting logic. - Continued investigation of metamaterials with embedded active devices to better understand multidimensional signal processing from RF through THz frequencies. - Continued effort on nuclear optical frequency standard in thorium 229. - Continued studies of intraband transitions in wide bandgap quantum wells. - Continued studies of the use of non-linear optical (phonon-photon interactions) phenomena as a method of cooling to cryogenic temperatures. - Continued effort to investigate statistical representations of target and signal techniques. - Continued studies of chemical vapor deposition (CVD) of graphene on copper. - Continued research on duel-STM characterization of graphene film. - Continued research on defect engineering and characterization in graphene. - Continued studies of how to prevent flux trapping and diagnose its occurrence in complex superconducting circuits and to design real time expert measurement systems in general for testing of new designs defined in VHSIC (Very High Speed Integrated Circuits) Hardware Description Language (VHDL). - Continued MgB2 Josephson junction work with first tests of 10 device logic cells to determine likely clock speeds of this new materials technology. - Continued demonstrations of tunable analog filters made in a digital Nb device foundry. - Continued high output impedance solid state amplifier technologies. - Continued program of ultraprecise gravitational measurements using atom interferometers. - Continued research on graphene based high performance flexible electronics.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued research on DNA based carbon nanotube sorting and placement. - Continued investigation of electrical stress characterization and Gallium Nitride transistor stability. - Continued development of a path-integral-based theory of wave propagation in bounded, disordered media. - Continued research effort to provide a fundamental understanding of spin transport, scattering and manipulation in the Group IV semiconductors necessary for future technological development of spin as an alternate state variable. - Continued an effort to establish the physicochemical nature giving rise to the anomalously high electron conductivity of singleunitlayer conductive skins of RuO2 used to coat a wide array of dielectric substrates. - Continued research into novel super resolution algorithms using optical flow techniques. - Continued investigation of mathematical solutions and algorithms for resolving issues with sparse sensing radar. - Continued effort to develop multiple layered semiconductor quantum dots for infrared optical applications. - Continued effort to demonstrate and develop one dimensional spin transport and manipulation in Si and Ge nanowires and to develop new lateral growth method for Ge NWs on Si(001). - Continued research on characterization and control of graphene edge effects. - Continued research on electronic functionality in DNA nanostructures. - Continued research on chemical functionalization and self-assembly of graphene nanostructures. - Continued studies of how best to densitify superconducting circuits using new third generation Nb devices including what new layers devoted to resistors, filters, power distribution or wiring would provide the greatest system benefit. - Completed initial demonstrations of super-conducting tunable Nb filters. - Initiated research on correlated electron materials for high performance electronic devices. - Initiated effort to study novel oxide materials with high electron densities for high performance transistors. - Initiated research on synthesis of electronic Boron Nitride films. - Initiated research on defect characterization of single layer Boron Nitride. - Initiated studies of analog intelligent nanoelectronics computational architecture. - Initiated research on new class of superconductors or devices in which competition between superconducting and magnetic ordering is involved. - Initiated research on multi-THz electromagnetic devices lying within the intersection of high-speed electronic materials, photonic materials and active metamaterials. - Initiated research on semiconductor nanowire array based transistors operating in the quantum capacitance limit for highly linear RF electronic devices and photonic nanoresonators. ***FY 2014 Plans:*** - Continue all efforts of FY 2013, less those noted as completed above. - Complete project on strain engineering in graphene. - Complete effort on focused electron beam based angstrom-scale nano-patterning. - Complete effort to observe directly the electrical properties of pair states in high temperature superconductors.			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Complete a program investigating pattern dependent RF currents during plasma etching with design rule definitions that include provision for specific dummy structures to fill empty space and avoid these delirious effects. - Complete effort to lower thermal gradients between active circuit elements and heat sinks (with 5x reduction). - Initiate research on 2D materials other than graphene. - Initiate research on spin properties in topological insulators. - Initiate research on chemical synthesis of carbon nanostructures. - Initiate research towards detecting and manipulating Majorana fermions in condensed matter systems. - Initiate studies of topological insulator materials and novel device concepts exploiting properties of transport in their protected electronic state. - Initiate efforts to improve the sensitivity of superconducting quantizers, mechanisms to achieve >20 GHz in-building wireless (IBW) in analog to digital converters, and explore origins of non-linearities in quantizers. - Initiate studies of whether superconducting qubits can act as controllable sources of microwave entangled photons and whether these plausibly have application to quantum radar. ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those noted as completed above. - Complete efforts on alternative tunnel barriers for Niobium (Nb) electrode Josephson junctions for third generation digital devices. - Initiate effort to maintain the ten (10) femto-second jitter produced by high speed long Josephson junction (LJJ) clocks as these pulses propagate to their point of use in coherently sampling multiple ADC and devise a Josephson junction based way of phase locking a LJJ clock to an external master clock. - Initiate non-equilibrium k-space transport studies. - Initiate research on micro plasma based materials, devices, and circuits.			
Title: WEAPONS ***Description:*** Efforts include: Undersea Weaponry; Energetic Materials and Propulsion; Expeditionary Operations (communications, materials for forensic sensing, landmine detection, human sensory enhancements, lightweight power sources and information efficiency); Directed Energy; Counter Directed Energy and Applied Electromagnetics. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. Accomplishments and plans described below are examples for each effort category. Funding decrease in FY 2014 is a result of reassignment of funding for the Basic Research Challenge Program into the newly created Research Activity.	26.292	17.919	17.936

Exhibit R-2A, RDT&E Project Justification: PB 2015 Navy		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
FY 2013 Accomplishments: Undersea Weaponry - Continued conducting basic research related to critical S&T (including vehicle control, maneuverability, and stability) associated with the development of High-Speed Supercavitating Vehicles (HSSV). - Continued expansion of the Navy Undersea Research Program (NURP) Program to provide a further infusion of educated and career minded scientists and engineers in support of the National Naval Responsibility (NNR) for Undersea Weapons Research. - Continued computer code refinements and investigation of supercavitating vehicle dynamics and instability. - Continued evaluation of viable synthesis methodologies and characterization of candidate explosive ingredients suitable for undersea weapons applications. - Continued development of diagnostic capabilities to accurately determine aluminum combustion characteristics in oxidizing environments. - Continued an Otto Fuel II characterization study for undersea weapons. - Continued studies of low probability of intercept sonar, metalized explosives, lattice deformation of crystalline explosives, high thermal conductivity nanocomposites for vehicle arrays, microplasma fuels reforming and biomimetric propulsion mechanisms for underwater vehicles exploiting flutter instability. - Continued development of concept for weaponized Unmanned Undersea Vehicles (UUVs) based on game theoretic approach. - Continued validation of hydroacoustics models and test and evaluate acoustic array signal processing algorithms. - Continued study on propulsion and its interaction with supercavitating cavity, and control surfaces. - Continued acoustic concepts formulation and modeling for low-noise bio-inspired propulsion systems. - Continued concept development on inversion of swarm dynamics for underwater tactical applications. - Continued new coating concepts for corrosion and anti-fouling protection of UUVs. - Continued high energy density power system research for under water vehicles. Energetic Materials and Propulsion - Continued development of a fundamental understanding of initiation mechanisms of explosive crystals subjected to shock stimulus. - Continued exploring the use of quantum mechanics and molecular dynamics to provide fundamental properties for energetic materials to predict initiation/detonation criteria for insensitive munitions applications. - Continued investigation of JP-10 combustion-based Proton-Exchange-Membrane (PEM) fuel cells. - Continued investigation of multi-tube multi-nozzle Pulse Detonation Engines (PDEs) and multi-tube common nozzle PDEs. - Continued investigation of nanometallic-hydrocarbon hybrid catalytic combustion for increased energy release rates. - Continued investigation of novel initiation techniques, including optimized injection parameters, and integrated single tube operation for PDEs.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continued Advanced Energetics research in reactive, explosive, and propulsive energetic materials, including high energy ingredient synthesis & characterization, and fundamentals of initiation and decomposition mechanisms, to tailor energy release processes in order to achieve substantial performance gains and/or enhanced survivability in harsh environments. - Continued to develop fundamental understanding of nitramine and perchlorate decomposition mechanisms for propellant applications. - Continued to develop organometallic-based highly energetic ingredients. - Continued efforts to explore alternative fuel concepts for Naval applications to include hydrogen, synthetic diesel, and biodiesel. - Continued development of multi-parameter sensor for multi-phase combustion flows (UAV and underwater PDEs). - Continued implementation of new & nanostructured materials design concepts for direct energy conversion and waste energy conversion. - Continued investigation of integrated pulse detonation engine-airframe for autonomous vehicles, and pulse detonation for passive weapons (noise, jamming). - Continued studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C). - Continued hydroacoustics models and experiments to reduce the self noise on cavitator acoustic array. - Continued acoustic signal processing algorithms for HSSV guidance and control. - Continued development of new concepts for underwater power generation. - Continued development of non-lethal undersea warheads for Overseas Contingency Operations. - Continued development of PDE for underwater applications. - Continued new thrust on the design, synthesis and characterization of high energy dense oxidizers. - Continued structure property relationship studies on advanced propellant systems and high blast energetic compositions. - Continued synthesis and characterization of cluster complexes between reactive metals and energetic oxidizers and explosives. - Initiated research and development for hypersonic propulsion system technologies for increased range and speed, improved stealth and maneuverability, reduced emissions and signatures, lower noise, wider operational envelopes and turn-down ratio. - Initiated research into coulombic explosives via unique electronic and structural properties of atomic clusters not observed in bulk. - Initiated development of a new methodology coordinating both theoretical and synthetic chemistry to maximize molecular design and predicted molecule stabilities. This will facilitate insight into the next generation of energetic materials. - Initiated research to develop ability to synthesize and quantitatively predict energetic material performance from first principles of quantum chemistry. - Initiated research and development on aircraft, fuels and rocket propulsion system technologies for: increased range and speed, improved stealth and maneuverability, reduced emissions and signatures. - Initiated an investigation that focuses both theoretical and synthetic processes to maximize molecular design and crystal morphology for new insensitive munition (IM)-compliant commodity energetic material ingredients.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Expeditionary Operations - Continued investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells. - Initiated basic materials research to explore and improve high strain and stress rate performance of high performance fibers,armor inserts, and structural materials. - Continued basic research into automated reasoning and data fusion for distributed surveillance. - Continued fundamental chemistry and materials science research to advance water purification technologies. - Continued basic research to advance electrochemical energy conversion and storage. - Initiated a Vehicle Autonomy effort focused on unmanned and autonomous systems to displace the operator from hazardous conditions/environments, lighten the load of individual Marines, and provide greater warfighting capability. Directed Energy - Continued research thrust in directed energy weapons. - Continued directed energy development in the areas of advanced optical components and coatings for high energy lasers, high power injector and photocathode development, beam control and tracking research, terahertz source development and applications, femtosecond laser application studies, and the modeling and simulation of high power laser operation. - Continued basic research into mechanisms and concepts supporting the defeat of and protection against speed of light weapons for light tactical aerial vehicles and unmanned systems to include research into atmospheric propagation and extinction to support increased understanding of operational impacts which may affect utility of directed energy systems. - Continued research into advanced theoretical research and modeling of superconducting laser elements as used in advanced high energy accelerators. Counter Directed Energy - Identified the most promising physics, science, and mathematic solutions to protect naval assets against directed energy threats. - Established the basic science and technology issues relevant to the propagation of directed energy in the atmosphere and its interaction with sensors, electronics and structural materials. - Initiated assessment of theoretical constructs for directed energy (DE) systems detection and geolocation. - Initiated investigation into the susceptibility of critical naval electronic components to electromagnetic radiation. - Initiated development of courseware for Counter Directed Energy (CDEW) for use at the U.S. Naval Academy and the Naval Postgraduate School. - Initiate performance of laboratory experimentation on laser and High Power Microwave protection methods for future naval aviation systems and platforms. - Initiate development of suitable metamaterial samples which provide electromagnetic shunting and conduct laboratory testing with laser and microwave systems. - Initiate testing of unmanned systems DE protection methods.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Applied Electromagnetics: - Continued program to conduct basic research and theoretical analysis in electromagnetic phenomena in the spectrum from microwaves to visible light. Areas of research will be in microwave directed energy, optical directed energy (lasers), terahertz sources, and related nanometer-scale electronics and sensors.			
FY 2014 Plans: Undersea Weaponry - Continue all efforts of FY 2012, less those noted as completed above. - Complete efforts related to aluminum combustion characterization, Otto Fuel characterization, low probability of intercept sonar, nanocomposites for sonar arrays, fuel reforming and biomimetric propulsion, game theoretic weapon analysis, swarm dynamics, anti-fouling vehicle technology and countermeasure detection and classification. - Initiate basic research related to cavity stability, vehicle control, maneuverability, stability associated with the development of high-speed, supercavitating vehicles. - Initiate new, and continue on-going, research in fuzing phenomenology, reactive materials, high oxygen constituents and insensitive munitions and use of these technologies in advanced warhead concepts. Energetic Materials and Propulsion - Continue all efforts of FY 2013, less those noted as completed above. Expeditionary Operations - Continue all efforts of FY 2013, less those noted as completed above. - Initiate a new effort to research peer-to-peer mixed initiative planning to allow unmanned autonomous systems to collaborate and improve their common operating picture without having to have a human in-the-loop. - Initiate Distributed Trust Models effort to determine USMC S&T gaps hindering dominance in cyberspace. Directed Energy - Complete all efforts in FY 2013, no further Basic Research in the area of Directed Energy. Counter Directed Energy - Continue all efforts of FY 2013, less those noted as completed above. Applied Electromagnetics: - Continue all efforts of FY 2013, less those noted as completed above.			
FY 2015 Plans: Undersea Weaponry			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
- Continue all efforts of FY 2014, less those noted as completed above. - Complete efforts in high-oxygen constituents and insensitive munitions. Energetic Materials and Propulsion - Continue all efforts of FY 2014, less those noted as completed above. Expeditionary Operations - Continue all efforts of FY 2014, less those noted as completed above. - Initiate development of collection strategies based on cutset sensor topologies in order to provide enhanced situational awareness with sparse sampling. Counter Directed Energy - Continue all efforts of FY 2014, less those noted as completed above. Applied Electromagnetics - Continue all efforts of FY 2014, less those noted as completed above.			
Title: BASIC RESEARCH CHALLENGE ***Description:*** The ONR Basic Research Challenge (BRC) program was established in 2008 to competitively select and fund promising research programs in new areas not addressed by the current basic research program. In the past, the Basic Research Challenge Program has been integrated into the legacy R2 Activities to illustrate its alignment with the mainstream Naval research disciplines, but with this update BRC is being identified as its own R2 Activity to call attention to the significance it provides to new areas of Naval importance. The program stimulates new, high-risk basic research projects in multidisciplinary and departmental collaborative efforts, and funds topics that foster leading edge science and attract new principal investigators and organizations. Basic Research Challenge awards are for a period of four years. Topics are submitted by ONR program officers and are selected for BRC awards by ONR's director of research. Basic Research Challenge award topics are then issued as a broad agency announcement. In FY 2014 the BRC is being identified under its own Research Activity to highlight its more prominent role in stimulating competitive multidisciplinary research between ONR departments. BRC research by its nature will likely cross the traditional Research Activity boundaries and produce standout results worthy of specific focused attention. Funding decrease in FY 2015 due to normalization of annual investment following initial emphasis in program research. ***FY 2013 Accomplishments:***	-	28.720	21.107

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
N/A ***FY 2014 Plans:*** - Continued research into the science of autonomy. - Continued research into de-centralized on-line optimization. - Continued research into carbon molecular electronics. - Continued research into co-prime sensor array signal processing: a new framework for reduced complexity sensing. - Continued research into understanding and characterizing intuition for more effective small unit decision making training technologies. - Continued research into couplings of ocean to space of ionospheric drivers from below novel electronic devices based on coupled phase transitions. - Continued research into biologically inspired flow field computation for sensing and control of ground vehicles. - Continued research into reduced order representations for design: development of optimized algorithms for multi-physics based models. - Continued research into multi-scale nonlinear mechanisms and effects associated with coupling weak energy into composite explosive compounds. - Continued research into integration of advanced analysis with materials research. - Continued research into towards active control of noise from hot supersonic jets. - Completed research into biologically inspired intelligent metamaterials. - Completed research into computing with natural language. - Completed research into the microphysics of a liquid solid gas interaction. - Completed research into acoustical uncertainty due to marine mammals and fish. - Initiated competition for new BRC awards to address selected high priority Naval S&T areas, transformational initiatives, and grand challenges, including strategically important DoN research areas. Approximately four high priority research topics will be identified to solicit proposals. ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those completed in that year.			
Accomplishments/Planned Programs Subtotals	424.830	484.387	443.697

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Defense Basic Research seeks to improve the quality of defense research conducted predominantly through universities and government laboratories. It also supports the education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in an academic environment. Initial research focus is generally conducted in an unfettered environment because of the nature of basic research, but as more is learned and applications emerge, individual research projects take on a more applied focus. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. Example metrics include a biporous wick structure for thermal management of power electric modules capable of removing 900 watts per square centimeter which was recently developed by an academia/industry team. 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.

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COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
9999: *Congressional Adds*	-	8.250	4.000	-	-	-	-	-	-	-	-	12.250

The FY 2015 OCO Request will be submitted at a later date.

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014
Congressional Add: Nanotechnology Research (Cong)	8.250	4.000
FY 2013 Accomplishments: ONR issued a Special Notice in the autumn of 2012 to basic research efforts to advance the understanding of nanoscale materials and the processing thereof. All awards were completed by April 2013, and work is progressing. Planned for the FY13 Congressional Add, ONR will issue a second Special Notice in the 4th Qtr FY2013 to solicit basic research proposals. Proposal selection and awards will be completed by June 2014. ***FY 2014 Plans:*** N/A		
Congressional Adds Subtotals	8.250	4.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.