Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Navy										DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601153N: *Defense Research Sciences*							
COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
Total Program Element	423.623	429.767	446.123	-	446.123	459.221	482.591	503.415	525.618	Continuing	Continuing
0000: *Defense Research Sciences*	396.907	429.767	446.123	-	446.123	459.221	482.591	503.415	525.618	Continuing	Continuing
4027: *Naval Innovative Science and Engineering*	9.628	-	-	-	-	-	-	-	-	0.000	9.628
9999: *Congressional Adds*	17.088	-	-	-	-	-	-	-	-	0.000	17.088

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 (Feb 2009). 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); Countermeasures and Counterweapons; 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 four 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.

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B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	429.107	429.767	443.593	-	443.593
Current President's Budget	423.623	429.767	446.123	-	446.123
Total Adjustments	-5.484	-	2.530	-	2.530
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	-3.694	-			
• SBIR/STTR Transfer	-8.350	-			
• Program Adjustments	-	-	2.172	-	2.172
• Section 219 Reprogramming	6.573	-	-	-	-
• Rate/Misc Adjustments	-	-	0.358	-	0.358
• Congressional General Reductions Adjustments	-0.013	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2010	FY 2011
Project: 9999: *Congressional Adds*		
Congressional Add: *Magnetic and Elec Fields in Ocean Env*	1.992	-
Congressional Add: *Energetics S&T Workforce Development*	3.485	-
Congressional Add: *Human Neural Cell-Based Biosensor*	1.095	-
Congressional Add: *Next Generation Manufacturing Processes and Systems*	1.195	-
Congressional Add: *ONAMI Initiatives*	3.824	-
Congressional Add: *Shock and Vibration Modeling of Marine Composites*	1.912	-
Congressional Add: *Texas Microfactory*	1.593	-
Congressional Add: *Next Gen Renew Energy Sources*	1.992	-
Congressional Add Subtotals for Project: 9999	17.088	-
Congressional Add Totals for all Projects	17.088	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Navy	DATE: February 2011
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Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
0000: *Defense Research Sciences*	396.907	429.767	446.123	-	446.123	459.221	482.591	503.415	525.618	Continuing	Continuing

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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 four NNRs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: AIR, GROUND AND SEA VEHICLES	50.044	56.511	58.318
Description: Efforts include: 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 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; and power generation, energy conversion, and storage. The funding increase in FY 2011 and out reflects increased investment in mobility research. ***FY 2010 Accomplishments:*** Air Vehicles			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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 ship board operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications. - Continued research in computational simulation of rotorcraft operations in shipboard environment. - Continued investigation of advanced structural concepts providing a high degree of crew protection during crashes. - Initiated research into new analytical methods for high-fidelity prediction of rotorcraft performance, loads, and vibration. - Initiated university and Navy Lab research in basic rotorcraft science with emphasis on enabling concepts for variable geometry/ variable rotor-speed aircraft. Ship Concepts and Hydrodynamics - 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 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 hydroacoustics 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. - Initiated measurement and modeling of unsteady high-speed craft hydrodynamics. - Initiated high-fidelity fluid-structure interaction program. 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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 effort on much higher strain rate loading and constitutive behavior of Explosion Resistant Coating (ERC) for strain 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 (no-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 advanced multispectral InfraRed (IR) materials. - Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures. - Continued development of mmWave material characterization system. - 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 basic research challenge on elastomeric polymer by design to protect the warfighter against traumatic brain injury by diverting the blast induced shock waves from the head.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed development of photonic crystal waveguide and radiating systems. - Initiated 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. Ship and Air Platform Machinery and Systems - Continued efforts to understand and control the generation and propagation of far-field jet noise. - 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 Pulsed Detonation Engine (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 research into new functional materials and new concepts to efficiently convert thermal, photonic, or vibrational energy to electric energy from primary or secondary sources. - Continued development of phase change cooling approaches for high power electronic devices. - Continued efforts developing science base for optimized combustion of alternative fuels.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued research on the scientific basis of nanostructure enhancement of semiconductor and functional materials performance for power generation and thermal management. - 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. ***FY 2011 Plans:*** Air Vehicles - Continue all efforts of FY 2010. Science of Autonomy This new sub-activity will begin in FY 2011 and include on-going efforts that were not mentioned specifically in previous years. - Continue multi-disciplinary research in the science of autonomy including multi-vehicle collaboration, intelligence, and human interaction. - Continue research in scalable and robust distributed collaboration among autonomous systems. - Continue research in human/unmanned system collaboration. - Continue research in autonomous perception and intelligent decision-making. - Continue research in intelligent architectures for autonomous systems. Ship Concepts and Hydrodynamics - Continue all efforts of FY 2010. - Initiate computational prediction and validation of damaged ship maneuvering. Ship Signatures, Structures, and Materials - Continue all efforts of FY 2010, less those noted as completed above. - Complete development of advanced multispectral IR materials. - Complete development of mmWave material characterization system. - Complete validation of infrared ship signature models. - Initiate development of advanced electro magnetic energy absorbing composite materials. - Initiate and perform measurements of sea-slamming loads in fast ships at various sea states and speeds for composites panels on the experimental facility and develop/verify theoretical/computational models considering hydro elasticity and structural details and scale effects.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Ship and Air Platform Machinery and Systems - Continue all efforts of FY 2010. Power Generation, Energy Conversion and Storage - Continue all efforts of FY 2010. ***FY 2012 Plans:*** Air Vehicles - Continue all efforts of FY 2011. Science of Autonomy - Continue all efforts of FY 2011. Ship Concepts and Hydrodynamics - Continue all efforts of FY 2011. - Initiate research efforts on multi objective optimization of hull shapes using hybrid hull concept to achieve high efficiency, reduced slamming loads and hydrodynamic / structural performance. - Initiate development of understanding of shockwave propagation and failure mechanisms of high strain rate sensitive polymers and their interaction in composite with structural and armor materials. Ship Signatures, Structures, and Materials - Continue all efforts of FY 2011, less those noted as completed above. - Initiate efforts to further the physics based understanding of structural acoustics for the next generation submarine. - Initiate improvements for predictive capabilities of surface ship propulsion system and underwater acoustic signatures. - Initiate efforts to generate a greater physics based understanding of Electric Drive and its impact on platform acoustic signatures. - Initiate development of advanced electro magnetic energy absorbing composite materials. - Initiate exploration of chiral metamaterials for advanced infrared property control. - Initiate polymer chemistry and structural study of low dielectric and impedance matched composite materials. Ship and Air Platform Machinery and Systems - Continue all efforts of FY 2011.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Power Generation, Energy Conversion and Storage - Continue all efforts of FY11. - Complete research into new functional materials and new concepts to efficiently convert thermal, photonic, or vibrational energy to electric energy from primary or secondary sources. - Complete research on the scientific basis of nanostructure enhancement of semiconductor and functional materials performance for power generation and thermal management. - Initiate investigation into rare earth-free permanent magnet materials. - Initiate modeling of positron confinement for ultra high-density energy storage and convene international positron confinement workshop. - Initiate investigating thermodynamic cycle analogy for harvesting waste heat using multiferroic (pyromagnetic & pyroelectric) materials. - Initiate research into thermionic energy conversion using inter-gap molecular species in a heat cell with low work function materials. - Initiate research into cyber-physical, real-time distribution and control of power & energy networks, physics-based models, hardware-in-the-loop simulation. - Initiate 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. - Initiate study of fault tolerant electromechanical energy converter concepts for naval applications. - Initiate experimental and computational investigation of dynamic response of marine gas turbines for on-demand and flexible power supply. - Initiate research to understand new energy conversion methods (pyroelectrics, thermionics, combustion). - Initiate power and energy management science particularly understanding new magnetic materials and sliding electrical contacts). - Initiate basic research in next generation wide bandgap semiconductors.			
Title: ATMOSPHERE AND SPACE SCIENCES ***Description:*** Efforts include: Marine Meteorology and Prediction, Space Sciences and the Basic Research Challenge, which is a competitive investment based on proposed scientific activities. Accomplishments and plans described below are examples for each effort category. ***FY 2010 Accomplishments:*** Marine Meteorology and Prediction	29.509	29.938	30.239

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - 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 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. - Completed theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. - Completed assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed effort to derive sea foam coverage from WindSat and to use this information in microphysical aerosol models to derive marine optical properties. - Initiated 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. Space Sciences - Continued 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. - 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. - 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 magnetohydrodynamic 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 of how multi-scale interactions impact the predictability of tropical cyclones and their downstream effects. - 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 UV-X-ray observations; understand the origin, dynamics, and evolution of plasma in active region magnetic flux tubes.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed the development of 3D magnetohydrodynamic code for simulations of solar filament eruptions leading to flare and coronal mass ejection (CME) activity. - 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 in the feasibility of using Thompson scattering to directly and globally image the near-Earth electron density distributions and their variations driven by the solar wind to enable space environment forecasting and comprehensive space domain awareness for the Navy and DoD. - 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. - Initiated effort to assemble individual databases and model components of the Sun-Earth System. ***FY 2011 Plans:*** Marine Meteorology and Prediction - Continue all efforts of 2010, less those noted as completed above. Space Sciences - Continue all efforts of 2010, less those noted as completed above. ***FY 2012 Plans:*** Marine Meteorology and Prediction - Continue all efforts of 2011. - Complete 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. Space Sciences - Continue all efforts of 2011. 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 effort to develop understanding of how multi-scale interactions impact the predictability of tropical cyclones and their downstream effects.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Complete investigation in the feasibility of using Thompson scattering to directly and globally image the near-Earth electron density distributions and their variations driven by the solar wind to enable space environment forecasting and comprehensive space domain awareness for the Navy and DoD.			
Title: COUNTER IMPROVISED EXPLOSIVE DEVICE (IED) SCIENCES	21.503	22.526	22.581
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. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. ***FY 2010 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. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - Completed flame suppression mechanism investigation of additives to fine water mist to provide the scientific basis to guide search for suitable fine water mist based fire suppression strategies for DoD platforms, and to mitigate explosive blast effects. - Completed computational fluid dynamics (CFD) CT-Analyst technology study that provides a sensitive operational-quality capability to backtrack airborne detections of the chemical signatures and taggants of explosives instantly to their source. - Completed reactive flow dynamics study of multiphase reactive flow modeling and simulation that can be applied to investigate mitigation strategies to counter the IED threat. - Completed investigation and development of nonlinear methods to more effectively describe and analyze hyperspectral and multi-sensor data to improve characterization using nonlinear (manifold) methods. - Completed development of nonlinear methods to significantly improve the differentiation of targets from background scenes in multivariate data sets of hyperspectral imagery. - Completed development of high-power mid-Infrared (IR) lasers for IR countermeasures, explosives detection (ED), biological detection, remote chemical sensing, etc. - Completed effort to develop a chemically strengthened visible infrared (Vis-IR) composite window made from Spinel ceramic and germanate glass. - Initiated a Counter-IED Grand Challenge effort to pursue innovative device neutralization modalities, augmented by device detection technologies. - Initiated development of high performance polymer materials for armor applications. - Initiated effort to directly observe lattice deformations in explosives under shock impact. - Initiated analytical study to detect an intruder in proximity to an underwater pipeline using structure-guided acoustic waves. - Initiated increased emphasis on sociological and cultural aspects of defeating insurgent networks. - Initiated increased emphasis on standoff wide area neutralization and pre-detonation of IEDs. - Initiated increased emphasis on stronger lightweight armor including nanoparticle designs. - Initiated increased emphasis on detection of physical and temporal device characteristics. ***FY 2011 Plans:*** - Continue all efforts of FY 2010, less those noted as completed above. ***FY 2012 Plans:*** - Continue all effort of FY 2011. - Initiate increased emphasis on challenges within the Riverine environment. - Initiate increased emphasis on challenges in the temporal domain in various land environments.			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate increased emphasis on an integrated anticipate/affect, detection, neutralization, and mitigation specific to the suicide bomber threat.			
Title: HUMAN SYSTEMS	15.911	17.289	17.511
Description: Efforts include: Human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition. ***FY 2010 Accomplishments:*** - Continued research of social networks for counterterrorism. - Continued expansion of the cognitive architectural modeling capability to increase coverage, including spatial reasoning, multi-tasking, 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 research of hierarchical, cellular, and hybrid organization structures for command and control. - Continued schema theory applications to multi-echelon command decision making. - Continued investment in natural language interaction capability for artificially intelligent training systems. - Continued research of neuro-control of high-lift bioinspired Unmanned Underwater Vehicles and active vision and cognitive navigation skills in mobile robots. - Continued computational neuroscience for novel pattern recognition and sensory augmentation. - Continued social-science based computational toolsets for terror network analysis at U.S. Pacific Command's Joint Intelligence Center and on the USS TARAWA (LHA-1) to support Expeditionary Strike Group One in Overseas Contingency Operations. - Continued investigations to support new missions for Expeditionary Strike Groups in three areas: 1) analysis and diagnosis of Command and Control Organizational structures; 2) effects-based operations and development of reach-back capability for course of actions analysis; and 3) decision support systems for management of Battle Rhythm. - Continued research of human-robot interaction to support team collaboration. - Continued computational and agent-base modeling and experimentation to explore options for Effects-Based Operations. - Continued models of operational decision making for component commanders of an Expeditionary Strike Group with special emphasis on elaboration and planning knowledge. - Continued research of integrated parallel optimization models of adaptive function and responsibility reallocation between commanders/staff and reconfiguration of the command, control, and communication organizational structures. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - Initiated research of human activity and intend recognition and dynamic biometrics for improved human system interfaces and force protection. - Initiated research into probabilistic reasoning in computation cognitive architectures. ***FY 2011 Plans:*** - Continue all efforts of FY 2010. - Initiate research into computational social neuroscience to provide new models for manpower assignment and incentivization and new social models of cross-cultural interactions. ***FY 2012 Plans:*** - Continue all efforts of FY 2011. - Initiate cognitive and neuroscience research on event representation and episodic memory for efficient storage and automatic recall of episodes from massive data stores of audio-visual data. - Initiate research on models of social dynamics and culture in small scale societies.			
Title: 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	30.170	34.572	35.714

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
scattering; seamless, robust connectivity and networking; and expeditionary operations Command, Control, Communications, Computers Intelligence Surveillance and Reconnaissance (C4ISR). The funding increase in FY 2011 and out reflects increased investment in information sciences. ***FY 2010 Accomplishments:*** - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - 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, 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. - Completed efforts on Ferrite-based broadband circulators. - Completed development of the mathematical framework and algorithms for a new Multi-Scale timekeeping and Synchronization (MSTS) technique as an enabling technology for synchronous operation of disparate battlespace systems. - Initiated efforts addressing the representation, computation, and analysis of information from large diverse data sets. - Initiated research efforts to develop tools for proactive information assurance and cyber space security. - Initiated multidisciplinary research efforts on reasoning for image understanding in uncertain environments. - Initiated multidisciplinary research efforts to provide information assurance foundations for countering the Botnet threats. ***FY 2011 Plans:*** - Continue all efforts of FY 2010, less those noted as completed above. - Initiate research efforts addressing computational complexity arising from network-enabled computing, such as cyber security, information integration, and intelligent autonomy of networked, cooperative systems. - Initiate research efforts to develop methods and algorithms for computing with natural language. - Initiate mathematical studies to understand the micro-physics of a liquid-solid-gas interaction in turbulent flow conditions. - Initiate 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. ***FY 2012 Plans:*** - Continue all efforts of FY 2011. - Complete efforts on switched mode techniques for overcome radiation efficiency limit in electrically small antennas. - Complete efforts on Ferrite-based broadband circulators. - Initiate research on mathematical and computational building blocks for machine reasoning and intelligence. - Initiate multidisciplinary research efforts on knowledge representation and reasoning for decentralized autonomy.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate research efforts on algorithmic solutions and explicit measurement schemes for networks inference and monitoring.			
Title: MATERIALS/PROCESSES	58.123	64.021	64.537
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. The funding increase in FY 2011 and out reflects increased investment in materials and processes research.			
FY 2010 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 validate 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 first lubrication-by-design experiments. - Continued high temperature, low frictional sliding coefficient materials for elevated operating temperature gas turbine engine bearings. - Continued investigation of a rapid annealing of surface layers and their effects.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued multi-scale (atomic to microscopic) physics/chemistry-modeling of friction, wear, and lubrication for the rational design of high performance bearings, gears, seals, and lubricants. - 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. - Continued to develop the science of sliding contact and lubrication using physical and chemical first principles. - 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. - Initiated exploration of fundamental mechanisms and initiate development of physics-based models of electrophoretic deposition of ceramic nanoparticles and subsequent sintering. - Initiated physics based models for coupled phenomena in marine composite structures (thermo-mechanical loads, environmental effects, and fluid-structure interactions.) 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 examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued exploration and prediction of new sonar materials based on first principle methods. - Continued extension of first principle calculations of sonar materials tensor piezoelectric and dielectric properties to complex solid solutions to provide the basic understanding and predictive capability for ultra high strain materials. - 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. - 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. - Completed first principle methods to calculate second and third rank tensor properties of sonar materials such as lead zirconate titanate and lead magnesium niobate. - Completed development of methods for the intentional, controlled, impurity doping of semiconductor nanocrystal wires. - Initiated efforts to develop oxide materials for power management, sensors, and information storage/processing. Maintenance Reduction - Continued development of corrosion models. - Continued mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces. - Continued mechanism-based modeling of H-assisted cracking in ultra high strength steels. - Continued stainless steel carburization study to enhance corrosion performance. - Continued studies on understanding and modeling sea water corrosion effects of thermal cycling of AA 5XXX series. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - Initiated development of ab initio models of corrosion reactions. - Initiated development of coatings capable of actively responding to environmental stresses. - Initiated study of coating failure mechanism on coating-substrate interface. - Initiated research on innovative concepts for effective radiation barrier coatings and ultra-low thermal conductivity barrier 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 2011 Plans: Structural Materials - Continue all efforts of FY 2010. - Complete multi-energy processing approaches for the room temperature cure of polymeric materials with high temperature thermoxidative stability and fire resistance. - Terminate effort to develop the science of sliding contact and lubrication using physical and chemical first principles. - Terminate effort for multi-scale (atomic to microscopic) physics/chemistry-modeling of friction, wear, and lubrication for the rational design of high performance bearings, gears, seals, and lubricants. - Terminate effort for first lubrication-by-design experiments. - Initiate Computer-Aided Materials Design (CAMD) for synthesis and testing of various materials.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Functional Materials - Continue all efforts of FY 2010, less those noted as completed above. - Initiate efforts to synthesize and characterize new materials with enhanced properties predicted by first principles methods. Maintenance Reduction - Continue all efforts of FY 2010. - Complete studies on mechanism based modeling of hydrogen assisted cracking in high strength alloys for marine applications. - Complete studies on understanding and modeling sea water corrosion effects of thermal cycling of AA 5XXX series. - Initiate development of environmental corrosivity modeling. - Initiate development of nanoscale modeling of corrosion kinetics. - Initiate development of surface tolerant coatings. Environmental Science - Continue all efforts of FY 2010. Manufacturing Science - Continue all efforts of FY 2010.			
FY 2012 Plans: Structural Materials - Continue all efforts of FY 2011, less those noted as completed above. - Complete high temperature, low frictional sliding coefficient materials for elevated operating temperature gas turbine engine bearings. - Initiate structure and properties of liquid and glassy metals. - Initiate scientific basis for the rational engineering design of Al-alloys for Naval applications. Functional Materials - Continue all efforts of FY 2011. - Complete development of methods for the intentional, controlled, impurity doping of semiconductor nanocrystal wires. - Complete efforts to synthesize and characterize new materials with enhanced properties predicted by first principles methods. - Complete exploration and prediction of new sonar materials based on first principle methods.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Complete extension of first principle calculations of sonar materials tensor piezoelectric and dielectric properties to complex solid solutions to provide the basic understanding and predictive capability for ultra high strain materials. Maintenance Reduction - Continue all efforts of FY 2011, less those noted as completed above. Environmental Science - Continue all efforts of FY 2011. Manufacturing Science - Continue all efforts of FY 2011.			
Title: MEDICAL/BIOLOGY	16.365	19.345	20.298
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; and stress physiology. These efforts are coordinated with the Army and Air Force through joint program reviews and are complementary, not duplicative. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. The funding increase in FY 2011 and out reflects increased investment in bio-inspired sciences. ***FY 2010 Accomplishments:*** Medical Sciences - Continued work on stress physiology, hyperbaric physiology, and biological effects of Naval operational exposures (e.g. directed energy). - Continued work in understanding the mechanisms of decompression illness and hyperbaric oxygen toxicity. - Continued work on genomics/genetics of infectious organisms of military relevance and signal of transduction. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued research to explore systematic relationships between cognitive and physiological responses to laboratory tasks under operational conditions. - Continued research in the mechanism/effects of underwater thermal stress. - Continued research in understanding skull bones injury and healing dynamics. - Continued research to discriminate fatigue and stress performance effects. - Initiated research on long-term effects of exposure to submarine environments. - Initiated research to explore mechanisms of "ultrasonic" hearing in divers. - Initiated research to explore a novel opiod that will produce analgesia as effective as morphine, with minimal side effects. Biological Sciences - Continued efforts focused on microbe-materials interfacial interactions for detection of materials defects/failures, including corrosion, and for improved energy harvesting. - Continued work on microbial synthesis of energetic materials. - Continued research on biofouling with emphasis on barnacle adhesion studies using molecular biology tools. - Continued efforts focused on microbe-materials interfacial interactions to detect materials defects/failures. - Continued research to understand physiological effects of sound exposure on marine mammals from Navy sound sources other than sonar. - Continued efforts in "smart cell engineering" to design microbes that can sense and destroy other microbes through antibiotic production, 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. - Continued efforts to engineer plants to produce high value naval materials. - Continued efforts utilizing metagenomic screens to identify novel bacterial activities related to nitration or synthesis of high-N heterocycles. - Continued efforts to develop ultra-fast methodology for selecting DNA biosensor molecules. - Continued research to generate label-free assays for biosensing at biointerfaces. - Continued research to identify inhibitors of lateral DNA transfer in bacteria. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued research on engineered cells for infection detection and treatment in wounds. - Continued research efforts focused on developing bio-inspired sensors, vehicles and systems for local ISR, 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. - Initiated efforts to ascertain potential human health and environmental risks of novel nanomaterial-based ammunition primers. - Initiated research on stem cells in marine mammals and their potential clinical role. - Initiated development of a second set of molecular diagnostic tests for recently discovered viral pathogens of marine mammals. - Initiated research in elucidation of mechanisms of fish electric sense and near field low frequency acoustic perception. - Initiated research in mitigation of the effects of sleep deprivation. - Initiated research in stress effects on immune system. - Initiated research in cellular effects of high frequency EM fields.			
FY 2011 Plans: Medical Sciences - Continue all efforts of FY 2010. - Initiate interventions to mitigate underwater sound/blast effects. - Initiate research on improved trauma management in submarine Special Forces operators. - Initiate research on physiological and genetic effects of long-term diving. - Initiate research on heterotopic ossifications; injuries to bone material in soft tissue. - Initiate research in genetic basis of psychological stress. Biological Sciences - Continue all efforts of FY 2010. - Complete efforts to ascertain potential human health and environmental risks of novel nanomaterial-based ammunition primers - Complete work on microbial synthesis of energetic materials. - Complete efforts to engineer plants to produce energetic materials. - Complete efforts to develop ultra-fast methodology for selecting DNA biosensor molecules. - Complete research to generate label-free assays for biosensing at biointerfaces. - Complete research to identify inhibitors of lateral DNA transfer in bacteria. - Initiate synthetic biology and microbiological bioenergy efforts. - Initiate research in self-assembly of proteins in water. - Initiate research on bacterial/cellular controllers for nano/micro-systems			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate 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. - Initiate efforts in comparing commensal/pathogenic microbiomes in to Atlantic bottlenose dolphin and California sea lion, and for the dolphin diagnosed with chronic/active gastritis. ***FY 2012 Plans:*** Medical Sciences Continue all efforts of FY 2011. - Initiate research on individual susceptibilities in extreme environments to include hypoxic and/or hypobaric conditions. - Initiate research on individual susceptibility to chronic hyperbaric oxygen exposure. Biological Sciences - Continue all efforts of FY 2011, less those noted as completed above. - Initiate research on characterizing/manipulating human gut microbiome to understand and/or add specific functions (i.e., stress mitigation, N2 bubble mitigation, and digestion of non-traditional 'foods').			
Title: OCEAN SCIENCES ***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. This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. The funding increase in FY 2011 and out reflects increased investment in ocean science research. ***FY 2010 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.	75.409	81.941	86.008

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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 biooptical response to air-ocean forcing. - Continued programs to estimate optical properties of coastal ocean water from above-surface sensing, using insitu 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. - Completed study of 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. - Completed field, laboratory, and numerical studies of seafloor sand ripple genesis, evolution, and destruction and their effect on acoustical penetration of the sea floor. - Initiated studies of dissipation of surface gravity waves by muddy seabed sediments. 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. - Initiated 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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 extensive internal wave field program off the New Jersey Shelf; field work coincided with and complemented 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 design evaluation for a persistent mobile sampling network based on autonomous undersea vehicle platform and sensor technologies. - Continued extensive 3-year field program on prediction of internal waves. - Continued first field test of the Optimal Deployment DRI (ODDAS) in the South China Sea. - Continued 5-year program on the analysis of coherent structures in rivers and estuaries in support of the prediction and characterization of denied areas. - Continued a field and modeling program to predict mesoscale structures and rapidly-varying currents in the Philippine Archipelago using Synthetic Aperture Radar (SAR), Hyperspectral and other remote data together with new data assimilation methods. - Continued field programs that demonstrate persistent monitoring and measurement of environmental structures using gliders. - Continued workshops to define science needs for Sea Basing. - Continued a Coupled Oceanographic-Acoustics modeling and field program to demonstrate the use of a fully coupled system in optimizing tactical reduction of uncertainty. - 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 the field experiment in Monterey Bay to examine the role of unresolved processes in model parameterizations. - 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - Completed the pilot test of the novel data Synthetic Aperture Radar (SAR) and Hyper-spectral assimilation forecast system developed under Philippine experiment. 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 field experiments and modeling efforts to examine the performance of Acoustic Vector Sensors. - 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. - 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 to research effect of solitons and internal wave bores on acoustic propagation and buoyancy. - 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 assessment of "time-reversal" propagation techniques for mitigation of environmental variability. - Continued effort to understand synoptic scale ocean variability in the strategic Turkish Straits System including water mass exchange between basins and vertical mixing. - Continued field work on adaptive beam-forming using mobile, autonomous sensors. - Continued deep-water acoustic transmission measurements with emphasis on the Northern Philippine Sea.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continued research effect of solitons and internal wave bores on acoustic propagation and buoyancy. - Completed development of algorithms for accurate acoustic predictions in dispersive, turbulent, turbid water. - Completed development of source waveform design for rough littoral seafloors. - Completed effort to develop a methodology for expressing the semantics of physics-based environmental models to support automated computer applications. - Completed effort to understand how mudflat sediments respond to dynamic processes. - Completed research to enhance understanding of the vibrational response of elastic structures to flow induced excitation while developing a first-principles model for the induced structural acoustic response and reradiated acoustic field. - Initiated data collection and analysis of deep water ambient noise with emphasis on the Philippine Sea. ***FY 2011 Plans:*** Littoral Geosciences and Optics - Continue all efforts of FY 2010, less those noted as completed above. Marine Mammals and Biology - Continue all efforts of FY 2010. Physical Oceanography and Prediction - Continue all efforts of FY 2010, less those noted as completed above. - Complete extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics program. - Complete an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models. - Complete a field and modeling program to predict mesoscale structures and rapidly-varying currents in the Philippine Archipelago using Synthetic Aperture Radar (SAR), hyper-spectral and other remote data together with new data assimilation methods. - Complete a coupled oceanographic acoustics modeling and field program to demonstrate the use of a fully coupled system in optimizing tactical reduction of uncertainty. - Complete extensive 3-year field program on prediction of internal waves, acoustics in internal wave fields, transmission loss, and dissipation in areas of internal wave breaking. - Complete first field test of the Optimal Deployment DRI (ODDAS) in the South China Sea. - Complete 5-year program on the analysis of coherent structures in rivers and estuaries in support of the prediction and characterization of denied areas.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Complete the field experiment in Monterey Bay to examine the role of unresolved processes in model parameterizations. - Initiate studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography. - Initiate the field and modeling experiments to determine the lateral dispersion and maxing parameterization needed to understand model turbulence and to model ocean circulation. Ocean Acoustics - Continue all efforts of FY 2010, less those noted as completed above. - Complete field experiments and modeling efforts to examine the performance of acoustic vector sensors. - Complete field work on adaptive beam-forming using mobile, autonomous sensors. - Complete research effect of solitons and internal wave bores on acoustic propagation and buoyancy. - Complete assessment of "time-reversal" propagation techniques for mitigation of environmental variability. - Complete field work on adaptive beam-forming using mobile, autonomous sensors. - Initiate reverberation and clutter modeling studies. ***FY 2012 Plans:*** Littoral Geosciences and Optics - Continue all efforts of FY 2011. - Initiate Field, modeling and remote sensing studies of currents, waves, sediment transport and bathymetric evolution of river mouth and inlet environments. - Initiate Investigations of radar, hyperspectral and electro-optical remote sensing signatures in littoral environments. Marine Mammals and Biology - Continue all efforts of FY 2011. Physical Oceanography and Prediction - Continue all efforts of FY 2011, less those noted as completed above. - Initiate a field and modeling effort to understand and predict the generation and variability of western boundary currents in the Pacific Ocean. - Initiate 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. - Initiate field experiments to study the generation of sub-mesoscale features in the ocean due to topographic interactions with islands, coasts, and coral reefs.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate a field and modeling program to investigate the structure and circulation of the South China Sea and oceanographic variability along the coast of Vietnam. - Initiate 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. - Initiate studies of changes in the Arctic oceanography, meteorology and cryosphere and associated processes to allow permit development of new prediction models for the Arctic. - Initiate arctic research to develop a new generation of ocean-ice-atmosphere dynamic prediction models, including process studies involving remote sensing and in-situ observations. Ocean Acoustics - Continue all efforts of FY 2011, less those noted as completed above - Complete field work on adaptive beam-forming using mobile, autonomous sensors. - Complete deep-water acoustic transmission measurements with emphasis on the Northern Philippine Sea. - Initiate investigation of acoustic propagation in the Arctic.			
Title: SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	31.186	29.328	32.150
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. Outreach includes the encouragement, promotion, planning, coordination and administration of Naval Science and Technology. ***FY 2010 Accomplishments:*** - Continued awarding prizes at 400 regional high school science fairs and three national competitions. - Continued supporting high school summer interns at Navy laboratories. - Continued supporting undergraduate/graduate students as summer research interns at Navy laboratories. - Continued providing graduate fellowship support to HBCU engineering faculty candidates. - Continued funding Young Investigator research grants. - Continued encouraging, promoting, planning, coordinating and administering naval Science and Technology programs. ***FY 2011 Plans:*** - Continue all efforts of FY 2010. ***FY 2012 Plans:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Continue all efforts of FY 2011.			
Title: SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW)	50.036	53.604	53.939
Description: Efforts include the basic research portions of: Sensing, diagnostics, and detectors; navigation and timekeeping; nano-electronics; 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. ***FY 2010 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.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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. - 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- 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 - Completed research effort to investigate target and signal characteristics based on non-Archimedean geometry. - Completed the 6.1 portion of study of RQL digital superconducting logic with the conclusion its performance warrants 6.2 development. - Completed research effort to investigate target and signal characteristics based on non-Archimedean geometry. - Completed the study of RQL digital superconducting logic. - Initiated research effort to determine the most appropriate tunnel barrier for MgB2 Josephson junctions. - Initiated an effort to grow low defect density, high purity epitaxial 4H-SiC at high growth rates suitable for high power electronic device applications. - Initiated design, construction, and testing of sonic crystals that can be tuned to have specific acoustic properties. - Initiated effort to create a physics-based understanding of epitaxial oxides and insulators for use in applications for advanced electronics. - Initiated investigation into stabilizing in-phase coherent state of coupled systems for coherent power generation. - Initiated high output impedance solid state device technologies and materials. - Initiated effort to fabricate functionalized micro-opto-mechanical systems for the measurement of micromechanical photothermal spectra of adsorbed chemical vapor analytes. - Initiated research effort on chemical synthesis and bandgap tailoring in graphene nanoribbons. - Initiated research on spin dynamics in Group IV semiconductors and related device concepts. - Initiated research efforts on non-conventional nanofabrication that hold promise for sub-10nm resolution. - Initiated 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. - Initiated studies of the generation and recombination dynamics of non-equilibrium quasiparticles associated with digital switching events in superconducting logic. - Initiated investigation of metamaterials with embedded active devices to better understand multidimensional signal processing from RF through THz frequencies. - Initiated effort on nuclear optical frequency standard in thorium 229. - Initiated studies of intraband transitions in wide bandgap quantum wells. - Initiated studies of the use of non-linear optical (phonon-photon interactions) phenomena as a method of cooling to cryogenic temperatures.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiated effort to investigate statistical representations of target and signal techniques. - Initiated studies of chemical vapor deposition (CVD) of graphene on copper - Initiated research on duel-STM characterization of graphene film - Initiated research on defect engineering and characterization in graphene. - Initiated 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). ***FY 2011 Plans:*** - Continue all efforts of FY 2010, less those noted as completed above. - Initiate high output impedance solid state amplifier technologies. - Initiate program of ultraprecise gravitational measurements using atom interferometry. - Initiate research on graphene based high performance flexible electronics - Initiate research on DNA based carbon nanotube sorting and placement - Continue MgB2 Josephson junction work with first tests of 10 device logic cells to determine likely clock speeds of this new materials technology. - Complete first demonstrations of miniature but low loss HF and Ka band filters constructed as objects manufactured by whole wafer techniques in a mixed analog and digital Nb process technology. - Initiate investigation of electrical stress characterization and Gallium Nitride transistor stability. ***FY 2012 Plans:*** - Continue all efforts of FY 2011, less those noted as completed above. - Initiate research on characterization and control of graphene edge effects - Initiate research on electronic functionality in DNA nanostructures - Initiate research on chemical functionalization and self-assembly of graphene nanostructures - Initiate 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.			
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.	18.651	20.692	24.828

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base. The increase in FY 2011 is due to funding related to the completion of an advanced energetics research effort. The increase in FY 2012 is due to increased basic research in support of the EM Railgun. ***FY 2010 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 University Laboratory Initiative (ULI) 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 the novel signal processing approach for detection and classification of countermeasures. - Continued development of concept for weaponized Unmanned Undersea Vehicles (UUVs) based on gametheoretic approach. - Continued validation of hydroacoustic 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. - Completed a proof of concept demonstration of a potential electro-optical technology enhancement capability for undersea warhead fuzing systems. - Completed isolation and characterization of the tetranitroborate anion as a candidate ingredient suitable for undersea warheads applications.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed development of an acoustic propagation model for rapid and accurate calculations for undersea weaponry applications. 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. - 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. - Initiated new thrust on the design, synthesis and characterization of high energy dense oxidizers.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiated structure property relationship studies on advanced propellant systems and high blast energetic compositions. - Initiated synthesis and characterization of cluster complexes between reactive metals and energetic oxidizers and explosives. Expeditionary Operations - Continued investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells. - Continued research in quantum optics, nano-microscale self assembly and molecular recognition for active forensic sensing. 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. - 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. - Completed investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells. - Initiated research into advanced theoretical research and modeling of superconducting laser elements as used in advanced high energy accelerators. Applied Electromagnetics: - Continued 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 2011 Plans: Undersea Weaponry - Continue all efforts of FY 2010, less those noted as completed above. - Complete the novel signal processing approach for detection and classification of countermeasures. Energetic Materials and Propulsion - Continue all efforts of FY 2010.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Expeditionary Operations - Continue all efforts of FY 2010. Directed Energy - Continue all efforts of FY 2010. Counter Directed Energy - Identify the most promising physics, science, and mathematic solutions to protect naval assets against directed energy threats - Establish 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. Applied Electromagnetics: - Continue all efforts of FY 2010. - Initiate 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 2012 Plans: Undersea Weaponry - Continue all efforts of FY 2011. - Initiate high energy density power system research for under water vehicles. Energetic Materials and Propulsion - Continue all efforts of FY 2011. Expeditionary Operations - Continue all efforts of FY 2011. - Complete basic research in quantum optics, nano-microscale self assembly and molecular recognition for active forensic sensing. - Initiate basic materials research to explore and improve high strain and stress rate performance of high performance fibers, armor inserts, and structural materials. - Initiate basic research into automated reasoning and data fusion for distributed surveillance.			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601153N: *Defense Research Sciences*	PROJECT 0000: *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate basic research into the optimization of individual physical performance, cognitive performance, and resilience to stress. - Initiate fundamental chemistry and materials science research to advance water purification technologies. - Initiate basic research to advance electrochemical energy conversion and storage. Directed Energy - Continue all efforts of FY 2011. Counter Directed Energy - Continue all efforts of FY 2011. Applied Electromagnetics: - Continue all efforts of FY 2011.			
Accomplishments/Planned Programs Subtotals	396.907	429.767	446.123

C. Other Program Funding Summary ($ in Millions)

N/A

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.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601153N: *Defense Research Sciences*	PROJECT 4027: *Naval Innovative Science and Engineering*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
4027: *Naval Innovative Science and Engineering*	9.628	-	-	-	-	-	-	-	-	0.000	9.628

A. Mission Description and Budget Item Justification

Funding supports research and development efforts as directed under Section 219 of the fiscal year 2009 Duncan Hunter National Defense Authorization Act.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Naval Innovative Science and Engineering	9.628	-	-
Description: Funding supports research and development efforts as directed under Section 219 of the fiscal year 2009 Duncan Hunter National Defense Authorization Act. ***FY 2010 Accomplishments:*** Section 219 (Naval Innovative Science and Engineering) included in the FY 2009 Duncan Hunter National Defense Authorization Act, established mechanisms whereby the director of a naval laboratory may utilize up to three percent of all funds available to the laboratory to sponsor individual projects for: 1. Innovative basic and applied research that is conducted at the laboratory and supports military missions; 2. Development programs that support the transition of technologies developed by the defense laboratory into operational use; 3. Development activities that improve the capacity of the defense laboratory to recruit and retain personnel with needed scientific and engineering expertise; and 4. The revitalization and recapitalization of the laboratories.			
Accomplishments/Planned Programs Subtotals	9.628	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

The overall metrics of Section 219 is to increase retention and recruitment; number of advanced degrees, patent awards, and technical papers; successful technology transition to the warfighter; and laboratory ability to conduct innovative research.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601153N: *Defense Research Sciences*	PROJECT 9999: *Congressional Adds*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
9999: *Congressional Adds*	17.088	-	-	-	-	-	-	-	-	0.000	17.088

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011
Congressional Add: Magnetic and Elec Fields in Ocean Env ***FY 2010 Accomplishments:*** This effort supported investigation of physical oceanographic and magnetic relationships via measurable physical and magnetic properties to determine how magnetic and electric fields respond to physical forcing under various oceanic conditions on a narrow continental shelf (deep water close to shore) off the east coast of the United States.	1.992	-
Congressional Add: Energetics S&T Workforce Development ***FY 2010 Accomplishments:*** This effort conducted applied research in the areas of energetic material synthesis, energetic systems engineering, traumatic brain injury, and autonomous technology.	3.485	-
Congressional Add: Human Neural Cell-Based Biosensor ***FY 2010 Accomplishments:*** This effort developed a monolayer culture of adherent human neural progenitor cells that can be reliably and quantitatively differentiated into primary cultures of human neurons.	1.095	-
Congressional Add: Next Generation Manufacturing Processes and Systems ***FY 2010 Accomplishments:*** This effort established a research and education program in flexible rapid response manufacturing which enhanced the manpower, technology and knowledge base for quick response, high technology precision manufacturing.	1.195	-
Congressional Add: ONAMI Initiatives ***FY 2010 Accomplishments:*** This effort provided basic research to explore novel measurement techniques and metrology tools to build and characterize nanostructures and devices. New nanometrology tools to image and measure the structure and composition of nanomaterial heterostructures and interfaces were studied and built, and techniques for evaluation of nanoscale devices for logic and biosensing applications were explored.	3.824	-
Congressional Add: Shock and Vibration Modeling of Marine Composites	1.912	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601153N: *Defense Research Sciences*	**PROJECT** 9999: *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011
FY 2010 Accomplishments: This effort investigated and developed new composite materials, analytical tools and processing methods that can be used on all types of naval vessels. In particular, research was conducted into shock and vibration modeling of marine composites.		
Congressional Add: Texas Microfactory ***FY 2010 Accomplishments:*** This effort supported Texas Microfactory research.	1.593	-
Congressional Add: Next Gen Renew Energy Sources ***FY 2010 Accomplishments:*** This effort funded basic research to support development of prototypes of next generation renewable energy systems for naval applications.	1.992	-
Congressional Adds Subtotals	17.088	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.