FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
DEFENSE RESEARCH SCIENCES	379,581	383,217	407,271	423,633	432,367	450,161	471,544

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 (Jan 2007). 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). It is managed by the Office of Naval Research (ONR) through Program Officers at ONR Headquarters, and the base program of the corporate Naval Research Laboratory (NRL).

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps capabilities", where "Innovation is a process that couples Discovery and Invention (D&I) with Exploitation and Delivery". DON basic research is the core of D&I. It includes 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).

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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, and in which ONR is and likely will remain the principal US research sponsor. There are currently four NNR.

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

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	384,126	374,052	353,753
Congressional Action	1,000	14,900	0
Congressional Undistributed Reductions/Rescissions	0	-2,517	0
Execution Adjustments	950	0	0
Federal Technology Transfer	-21	0	0
Pay Raise Adjustments	0	0	21
Program Adjustments	0	0	53,531
Rate Adjustments	0	0	-34
SBIR Assessment	-6,474	-3,218	0
FY 2009 President's Budget Submission	379,581	383,217	407,271

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: As directed by the Secretary of Defense, a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

Schedule:

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:

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Defense Basic Research seeks to improve the quality of defense research conducted predominantly through universities and government laboratories such as the Naval Research Laboratory. 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.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
AIR, GROUND AND SEA VEHICLES	40,066	43,015	50,476

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; and logistics. In FY 2008, Power Generation, Energy Conversion, and Storage sub-activity efforts are transferred from the Materials and Processes Activity into this Activity. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 Accomplishments:

Air Vehicles
- Continued investigations into controlled initiation and recovery from aggressive non-linear aero-maneuvers conducted by unmanned air vehicles.
- Focused 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.

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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 experiments and modeling for rough-wall boundary layer noise.
- Continued the Research Tools Development Consortia Program under the University Research – Engineering Design Consortia.
- Continued modeling of multi-phase flow.
- 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 experimental waterjet hydrodynamics and cavitation.
- Completed development of modeling of highly unsteady separated flow around ducted propulsor using Large-Eddy Simulation (LES).
- Completed development of unsteady field pressure measurement technique using Particle Image Velocimetry (PIV).
- Completed numerical modeling of propeller effects on bubble growth.
- Completed numerical modeling of vortical flow/propeller interaction.
- Initiated propeller tip vortex cavitation and sheet-to-cloud cavitation.
- Initiated and completed validation of six degrees of freedom (6DOF) Reynolds-Averaged Navier-Stokes (RANS) for surface ship motions (without capsize).
- Initiated validation of prediction of ship wave breaking and bubbly flow at full scale.
- Initiated Unsteady Reynolds-Averaged Navier Stokes (URANS) prediction of maneuvering effects on ship motion in waves including validation.

Ship Signatures, Structures, and Materials
- Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures.
- Continued the structural performance of hybrid ship hulls and hybrid joints subject to sea loads and weapons effects for application to high speed, low signature vessels.
- Continued studies of the structural acoustics of anisotropic propulsion ducts.
- Continued modeling of alternating current sources and propagation.
- Continued PIV/Laser Doppler Velocimetry (LDV) studies of multiphase bubble flows and interaction with elastic plates in a small quiet water tunnel.

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- 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.
- Completed hull complexity acoustic measurements at small-scale using 3D acoustic holography.
- Completed evaluation of mechanical behavior of elastomeric coatings under ballistic and extreme dynamic loading.
- Initiated methods to model the mechanisms of interaction between an elastic duct wall and fluid-flow in a duct with a propeller.
- Initiated study to extend near-field acoustic holography measurement techniques to large-scale measurements in cluttered noisy environments.

Ship and Air Platform Machinery and Systems
- Continued evaluation of stability and control of electrical power 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.
- Initiated propulsion system cost-reduction efforts through reduction of vibration, noise and thermal fluctuation at the source by controlling combustion.
- Initiated passive and active high speed noise control.
- Initiated studies of alternate propulsion systems for Pulsed Detonation Engine (PDE) and generate prediction models.

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FY 2008 Plans:

Air Vehicles
- Continue all efforts of FY 2007.

Ship Concepts and Hydrodynamics
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete experiments for rough-wall boundary layer noise.
- Complete modeling of multi-phase flow.
- Complete potential-flow modeling of waterjet propeller cavitation.
- Complete RANS predictions of surface ship motion for high speeds.
- Complete validation of prediction of ship wave breaking and bubbly flow at full scale.
- Initiate computational and experimental investigation into complex three-dimensional flow separation problems.
- Initiate measurement and modeling of small wave effects on wave breaking and bubble generation.

Ship Signatures, Structures, and Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete study to extend near-field acoustic holography measurement techniques to large-scale measurements in cluttered noisy environments.
- Complete studies of the structural acoustics of anisotropic propulsion ducts.
- Initiate investigation into methods to control airborne noise transmission using active control.
- Initiate development of metamaterial concepts for radio frequency (RF) signature control and photonic and acoustic applications.

Ship and Air Platform Machinery and Systems
- Continue all efforts of FY 2007.

Power Generation, Energy Conversion and Storage (transferred from Materials and Processes R-2 Activity)
- Continue evaluation of stability and control of electrical power systems.
- Continue analyzing synchronization of 19 diode lasers to produce intense beams.
- Continue efforts in nanostructures, novel electrolytes, and electrode materials to enable new 3D power source architectures to improve capacity of rechargeable lithium and lithium-ion batteries.

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- Continue exploration and development of materials for high energy density passive power electronics (Capacitors).
- Continue expanding the fundamental understanding of direct electrochemical oxidation and the use of logistic fuels in solid oxide fuel cells.
- Continue research tools design efforts in Chemical Dynamics and High Temperature Probes.
- Continue development of phase change cooling approaches for high power electronic devices.
- Continue development of multi-scale thermal modeling approaches.
- Continue development of non-vapor compression based refrigeration cycles.
- Continue research on the scientific basis of nanostructure enhancement of semiconductor and functional materials performance for power generation and thermal management.
- Continue research into new functional materials and new concepts to efficiently convert thermal, photonic, or vibrational energy to electric energy thermoelectric materials from primary or secondary sources.

FY 2009 Plans:

Air Vehicles
- Continue all efforts of FY 2008.

Ship Concepts and Hydrodynamics
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete measurement and modeling of small wave effects on wave breaking and bubble generation.
- Initiate validation of URANS prediction on maneuvering effects on ship motion in waves.
- Initiate modeling of hydroacoustics of advanced materials propulsor.
- Initiate program to investigate renewable energy technologies for navy applications.
- Initiate computational and experimental investigations of wakes in stratified fluids.
- Initiate LES modeling of crashback of underwater vehicle with propulsor.

Ship Signatures, Structures, and Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete methods to model the mechanisms of interaction between and elastic duct wall and fluid flow in a duct with a propeller.
- Complete PIV/LDV studies of multiphase bubble flows and interaction with elastic plates in a small quiet water tunnel.
- Initiate study of droplet & volume scattering phenomena.

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- Initiate the development of predictive models for infrared emission and reflection from breaking waves.
- Initiate development of computational electromagnetic (CEM) tools for electromagnetic materials design & optimization.
- Initiate development of a methodology for highly reliable composite to metallic joints.
- Initiate fundamental efforts in multi-scale, time-varying, hull structural reliability models and processes for structural performance analysis.

Ship and Air Platform Machinery and Systems
- Continue all efforts of FY 2008.
- Initiate studies of advanced air-breathing propulsion concepts.
- Initiate study of advanced materials for Pulsed Detonation Engine (PDE) Applications.
- Initiate a review of shipboard electrical system monitoring and control technology and identify and evaluate algorithms and techniques to resolve identified or predicted performance gaps.

Power Generation, Energy Conversion and Storage
- Continue all efforts of FY 2008.
- Complete development of multi-scale thermal modeling approaches.
- Initiate 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.

	FY 2007	FY 2008	FY 2009
ATMOSPHERE AND SPACE SCIENCES	22,516	19,867	30,742

Efforts include: Marine Meteorology and Prediction and Space Sciences. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments; and efforts to plan a field program supporting numerical weather

forecasting/prediction for WESTPAC, which would provide strategic information for military efforts in the geographical areas of Korea and Taiwan.

FY 2007 Accomplishments:

Marine Meteorology and Prediction
- Continued analysis of results from major field projects on air-sea interaction and transition improvements into applied research to improve the treatment of fluxes in coupled atmosphere-ocean prediction systems.
- Continued the development of next-generation ocean-atmosphere coupled models.
- Continued effort to investigate and better understand the bulk exchanges, aerosol-cloud interaction, and physical processes that take place at the atmospheric boundary layer interface. (Includes NRL investment/performance in this effort.)
- Continued theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. (Includes NRL investment/performance in this effort.)
- Continued effort to gain a fundamental understanding of the flow-dependent limits of predictability by combining research in data assimilation and atmospheric instability. (Includes NRL investment/performance in this effort.)
- Continued investigation into the near-earth environmental effects on electromagnetic propagation. (NRL)
- 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 investigation of the effects of radioactively important aerosols on cloud dynamics and thermal structure of the lower atmosphere for the purpose of improving the treatment of these processes in numerical weather prediction models.
- 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). (NRL)
- Continued effort to derive sea foam coverage from WindSat and to use this information in microphysical aerosol models to derive marine optical properties. (NRL)
- Completed solar heliospheric-ionospheric investigations of effects of selected solar activities on ionospheric disturbances. (NRL)

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- Initiated assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models.

Space Sciences
- Continued calibration/validation of meteorological satellite wind (WindSat) polarimetric passive microwave data, and developed the version 1 of the WindSat wind vector retrieval algorithm. WindSat wind vectors have been released to the science community for evaluation. (NRL)
- 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. (NRL)
- Continued the development of 3D magnetohydrodynamic code for simulations of solar filament eruptions leading to flare and coronal mass ejection (CME) activity. (NRL)
- Continued studies of the major October-November 2003 solar activity events and the associated effects on the near-Earth space environment. (NRL)
- Continued effort to improve understanding of tropospheric and stratospheric bulk exchanges through observations and modeling. Effort this year focused on finding individual thunderstorm cells spawned by forest fires (pyro-cumulonimbus clouds) which have injected material into the stratosphere. (NRL)
- Continued assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.
- Continued development and evaluation of techniques for remote sensing of upper atmosphere phenomena including neutral density, winds and bulk exchange cycles. (NRL)
- Initiated program to develop advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability.
- Initiated 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.
- Initiated 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. (NRL)
- Initiated 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. (NRL)

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FY 2008 Plans:

Marine Meteorology and Prediction
- Continue all efforts of FY 2007, less those noted as completed above.

Space Sciences
- Continue all efforts of FY 2007.
- Initiate 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.
- Initiate effort to develop better physical understanding of small-scale atmospheric wave dynamics in the middle and upper atmosphere.(NRL)
- Initiate effort to develop understanding of how multi-scale interactions impact the predictability of tropical cyclones and their downstream effects.(NRL)
- Initiate 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.(NRL)
- Initiate effort to develop and validate numerical models of high-energy solar energetic particle (SEP)and solar gamma-ray (SGR) emissions. (NRL)
- Initiate 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. (NRL)

FY 2009 Plans:

Marine Meteorology and Prediction
- Continue all efforts of FY 2008.

Space Sciences
- Continue all efforts of FY 2008.

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	FY 2007	FY 2008	FY 2009
COUNTER IMPROVISED EXPLOSIVE DEVICE (IED) SCIENCES	14,800	24,169	24,418

The ONR 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 and to advance prediction of the occurrence or potential occurrence of IED events. The program also seeks to establish and nurture a multi-disciplinary counter-IED Science and Technology community of Government, academic and industry researchers to accelerate the transition of new science and technology into fielded systems. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

Increase from FY 2007 to FY 2008 reflects increased emphasis in Counter IED program. FY 2007 reflected the impact of a specific Congressional Reduction against this PE.

FY 2007 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.

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- 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 computational fluid dynamics (CFD) CT-Analyst technology that provides a sensitive operational-quality capability to backtrack airborne detections of the chemical signatures and taggants of explosives instantly to their source. (NRL)
- Continued reactive flow dynamics study of multiphase reactive flow modeling and simulation that can be applied to investigate mitigation strategies to counter the IED threat. (NRL)
- Continued laboratory-on-a-chip studies of molecular dynamics and recognition including complex, integrated separations performed on a rapid timescale for DoD target analytes such as toxic industrial chemicals and chemical warfare agents which may be used in IEDs. (NRL)
- Continued 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. (NRL)
- Continued investigating neutron-sensitive glass materials for remote radiation sensing to develop novel approaches for detection of radiological threats: special nuclear materials, dirty bombs, IEDs. (NRL)
- Continued the study of radar for active detection of suicide bombers. (NRL)
- Continued exploration into advanced microarchitectures for bioprocessing and sensing to develop and characterize cellular microarrays expressing G-protein coupled receptors (GPCRs) and other proteins as targets for environmental detection. (NRL)
- Continued the study of molecular motions & physical properties under stress to develop better elastomers for applications of flexible materials (blast resistant coatings, sonar domes, appliqués). (NRL)
- Continued studies of the fundamental issues in processing of quartz-crystal microbalance arrays directed to making micro-arrays of quartz crystals, each working at different frequencies. (NRL)
- Continued investigation and development of nonlinear methods to more effectively describe and analyze hyperspectral and multi-sensor data to improve characterization using nonlinear (manifold) methods. (NRL)
- Continued activities to devise and demonstrate chemical templates for assembling/ positioning nanoclusters and nanowire leads with nanometer precision to better understand the chemical & biochemical assembly of nanocluster-based electronics/sensors. Investigated ultra-fine electroless deposition for forming electrical leads. Explored early applications to single-electron devices and high-sensitivity sensors. (NRL)
- Continued study of metal nanoparticles for insensitive munitions (IM) with high energy density and low sensitivity to hazardous conditions, operational environment and countermeasures. (NRL)
- Continued development of rapid identification of biological aerosols, a novel method that allows specific biological aerosols to be identified within a background of others and that can fulfill the criteria of continuous sampling, real time performance, use of a small amount of consumables, and portability. (NRL)

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- Continued a systems biology approach for the interrogation of marine microorganisms to describe and predict the functioning of an entire marine bacterial system in response to certain stimuli which will provide the ability to comprehensively model and manipulate microbiological systems for the development of next generation sensors for biological, chemical and explosive agent detection. (NRL)
- Continued synthetic nanopores for single molecule identification to demonstrate a novel synthetic-nanopore-based strategy for real-time, label-free, single molecule detection of chemical and biological threats. (NRL)
- Initiated development of high-power mid-Infrared (IR) lasers for IR countermeasures, explosives detection (ED), biological detection, remote chemical sensing, etc. (NRL)
- Initiated creation of new spectroscopy for sensitive characterization of semiconductor nanostructures, ultra-thin molecular films and chemical/biological threat materials and explosives. (NRL)
- Initiated 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. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Initiate effort to develop a chemically strengthened Visible infrared (Vis-IR) composite window made from Spinel ceramic and germanate glass.(NRL)
- Initiate development of nonlinear methods to significantly improve the differentiation of targets from background scenes in multivariate data sets of hyperspectral imagery.(NRL)
- Initiate development of a new chemical explosive detection concepts based on pump/probe UltrashortPulse Lasers(NRL)
- Initiate research on characterizing background noise in urban and riverine environments in support of IED signature detection.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate increased emphasis on standoff wide area neutralization and pre-detonation of IEDs
- Initiate increased emphasis on stronger lightweight armor including nanoparticle designs
- Initiate increased emphasis on sociological and cultural aspects of defeating insurgent networks.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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	FY 2007	FY 2008	FY 2009
HUMAN SYSTEMS	7,655	8,532	9,785

Efforts include: human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 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, etc.
- Continued research on 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 PACOM'S Joint Intelligence Center and on the USS TARAWA (LHA-1) to support Expeditionary Strike Group One in the Global War on Terrorism.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- 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.
- Completed studies of the interaction of auditory and visual displays.
- Completed development of novel multidisciplinary approaches to human-activity inference from video imagery to enable force protection and counterterrorism.
- Completed expansions to cognitive models to include spatial reasoning.
- Initiated computational and agent-base modeling and experimentation to explore options for Effects-Based Operations.
- Initiated models of operational decision making for component commanders of an Expeditionary Strike Group with special emphasis on elaboration and planning knowledge.
- Initiated 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.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete research on adaptive command and control architectures in support of the Navy's new Maritime Strategy.
- Initiate systematic program of perceptual research to fill in information that cognitive architectural modeling has revealed to be missing from the research literature.
- Initiate 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.
- Initiate investigation of human sensory performance for optimizing video and audio human-electronic device interfaces.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate 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.
- Initiate research on advanced biometrics such as biodynamic signatures to support spiral 2 and 3 of Navy Identity Dominance System Maritime Domain.
- Initiate efforts to extend the representational capabilities of cognitive architectures to accommodate aspects of social cognition and teamwork.
- Initiate 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.
- Initiate research focused towards cognitive and neural sciences, virtual/immersive environment simulators, decision models for improved warfighter performance.

	FY 2007	FY 2008	FY 2009
INFORMATION SCIENCES	20,938	23,176	31,298

Efforts include: Mathematical foundation and computational theory and tools for design, communication, and control of intelligent autonomous systems; decision theory, algorithms, and tools; heterogeneous information integration, management, and presentation; information assurance, secure and reliable information infrastructure for Command and Control; mathematical optimization for optimal resource allocation and usage; modeling and computation of complex physical phenomena; modeling and computation for electromagnetic and acoustic wave propagation and scattering; seamless, robust connectivity and networking; and expeditionary operations Command, Control, Communications, Computers Intelligence Surveillance and Reconnaissance (C4ISR). Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments; and an increased level of investment and effort for information technology for software systems.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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FY 2007 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 multi-source 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 development of mathematical foundations for image enhancement, feature extraction, feature-based/texture-based compression, denoising, and segmentation; data representation and metrics, content-based indexing and retrieval; reconstruction, interpolation, and registration; and scene analysis and image understanding.
- Continued efforts on quantum computing and cryptography.
- Continued efforts on model checking and automated theorem prover technologies.
- Continued efforts on biometric technologies for authentication.
- Continued efforts in physics-based modeling of natural 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 development of computational framework for integrating information of disparate sources.
- Continued development of a systematic approach that will serve as a theoretical and computation basis for automated image understanding and automatic object recognition.
- Continued development of technology for maximizing information delivery in tactical networks via encoding information under speech. (NRL)
- Continued development of technology for improving behavior of coordinated teams of autonomous systems. (NRL)
- Continued development of technology to re-engineer legacy code. (NRL)
- Continued development of technology to improve analysis of distributed systems. (NRL)

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- Completed the development of technology to improve tactical wireless ad hoc networks via development of cross-layer design approaches. (NRL)
- Initiated development of mathematical, statistical, and computational framework leading to robust underlying approaches for automated information integration of disparate sources of data.
- Initiated development of technology for assessing effectiveness of automatic translation programs. (NRL)
- Initiated development of technology for analyzing functionality of executable software code. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of technology to improve analysis of distributed systems. (NRL)
- Initiate the development of a theory of traffic security in communication networks. (NRL)
- Initiate research in methods to visually represent and explore large, diverse, dynamic data sets. (NRL)
- Initiate the 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. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete development of technology for assessing effectiveness of automatic translation programs. (NRL)
- Complete development of technology for analyzing functionality of executable software code. (NRL)
- Initiate research in cognitive radio and networking protocols.
- Initiate research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas.
- Initiate research in cross-layer wireless protocols for delay sensitive network traffic.
- Initiate development of computational methods for software producibility of complex software systems.
- Initiate research into Anti-Tamper Approaches, Complex Software Systems, and Information Assurance: research focused on protection techniques, architectures, algorithms, protocols that allow for security and cyber situational awareness.
- Initiate multidisciplinary research efforts to focus on intelligent control systems, cooperative behavior modeling and response, UxV-human interactions and adaptive mission methodologies.
- Increase basic research into the extraction of information from large data sets.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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	FY 2007	FY 2008	FY 2009
MATERIALS/PROCESSES	59,548	57,555	59,948

Efforts include: Structural materials; functional materials; maintenance reduction; and Environmental Sciences. Power Generation, Energy Conversion, and Storage sub-activity efforts previously reported in this Activity are transferred to the Air, Ground and Sea Vehicles Activity in FY 2008. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. 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.

FY 2007 Accomplishments:

Structural Materials
- Continued development of physics-based models of thermal and materials flow during friction stir welding of steels, including the development of residual stresses that will lead to distortion.
- 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 understanding and constitutive models of dynamic behavior of naval steels.
- Continued development of theoretical basis for composite materials behavior based on x-ray computed micro-tomography.
- Continued investigation of continuous growth of single and multi-wall nanotubes for next generation polymer matrix composite materials.
- 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 development of nanocomposites for enhancing mechanical properties of marine composites.
- Continued evaluation of new high temperature resin for potential Unmanned Combat Air System (UCAS) high temperature composite applications.
- Continued research tools design efforts in dynamic three dimensional control of structures.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Continued exploration of high strain rate superplasticity in advanced nanostructured ceramic composites to provide the basis for the development of such materials for Naval applications.
- 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 investigation of the role of hydrogen and nitrogen on mechanical properties of titanium alloys. (NRL)
- Continued studies on microstructure, mechanical, fatigue crack growth, and corrosion properties of friction stir welded Aluminum 5456. (NRL)
- Continued research on first-principles and experimental data to develop iron-nickel (Fe-Ni) atomistic potentials which will be used in the study of austenitic steels, currently we can show that Ni segregates on high Sigma grain boundaries. (NRL)
- Continued investigation of joining dissimilar ceramics and sintering of light metal composites. (NRL)
- Continued exploration into the processing and microstructures of novel titanium alloys that may be enabled by new co-reduction of mixed metallic oxide processes.
- Continued exploration of microstructural evolution during solid-state joining and localized processing of weldments in titanium alloys for improved toughness and fatigue resistance.
- Continued development of progressive damage models for blast effects on composite marine structures.
- Continued research in the area of fusing carbon nanotubes together to produce 3D networks of single and/or multiwall carbon nanotubes for structural applications.
- Continued research into the area of transforming bio-fibrillose material into carbon nanotubes.
- Continued effort to support DARPA development of ceramic nanocomposite infrared (IR) windows and domes for high speed missile applications utilizing the understanding of processing, mechanical and optical properties of ceramic nanocomposites gained from ongoing ONR research.
- Continued investigation of continuous growth of single and multiwall nanotubes for next generation polymer matrix composite materials.
- Completed development of hybrid composites incorporating glass fibers and high strength steel fibers for joining application.
- Completed research into dynamic slamming load effects on marine composites.
- Completed the development of understanding of deformation mechanisms in nanometer scale aluminum.
- Completed efforts to understand links between complex reaction paths and atomic diffusion in the formation of environmental and diffusion barrier coatings for high temperature thermal and environmental barrier coatings.
- Completed analysis of dynamic response for marine composites and sandwich structures.
- Completed loads analysis of physics-based models for fatigue damage in naval alloys.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiated investigation of a rapid annealing of surface layers and their effects. (NRL)
- Initiated 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.

Functional Materials
- 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 research tools design efforts in electromagnetic and acoustic bandgap materials.
- Continued development of a theoretical model that describes coherent multiexciton generation by one photon in PbSe and PbS nanocrystals for new solar cells. (NRL)
- Continued studies on the electron doped cuprate superconductors (Nd2-xCexCuO4 and Pr2-xCexCuO4) by temperature dependent polarized electronic Raman spectroscopy across a wide region of the doping (Cerium) phase diagram. (NRL)
- Continued a project for the determination of a critical structural phase transition in a new class of superconducting materials. (NRL)
- Continued a theoretical study on a variety of novel superconductors where superconductivity coexists with magnetism or spin fluctuations. (NRL)
- Continued construction of a unique facility for exploring static electrical contact phenomena consisting of a servohydraulic load frame with an insulated load train. This equipment will enable studies on transmission of electrical current across dissimilar metal interfaces at extreme pressures and current densities beyond those investigated before. (NRL)
- Continued studies on dielectric breakdown strength of ferroelectric glass-ceramics to show that it is an order of magnitude higher than conventional ceramic dielectrics while maintaining high dielectric constant. (NRL)
- Continued exploration and prediction of new sonar materials based on first principle methods.
- Continued study of new transduction mechanisms.
- Continued examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used. (NRL)
- Continued investigation of radically new hierarchical polymer lenses that mimic the focusing of an eye. (NRL)
- Continued single molecule binding detection using optical trap. (NRL)
- Continued effort to fabricate extended 2D left handed materials (LHM) structures. (NRL)

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Completed development of first principle methods to calculate second and third rank tensor properties of sonar materials such as lead zirconate titanate and lead magnesium niobate.
- Completed the piezo electric fracture analysis with experimental and model for verification.
- Initiated synthesis and property measurement of new sonar materials predicted by first principle methods.
- Initiated development of compact, multifunctional and biologically active conjugates that are composed of luminescent quantum dots and functional peptides. (NRL)
- Initiated 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. (NRL)
- Initiated development of the science and technology base for a highly efficient and stable flexible organic solar cell. (NRL)

Maintenance Reduction
- 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 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 development of corrosion models.
- Continued mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces.
- Continued to identify stress corrosion control methods for friction stir welded high-strength aluminum alloys using advanced thermal treatments, chemical modifications, and surface mechanical processes to tailor compressive stresses.
- Continued mechanism-based modeling of H-assisted cracking in ultra high strength steels.
- 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 stainless steel carburization study to enhance corrosion performance.
- Continued testing of a statistically relevant number of combinatorial specimens to rank defects, microstructure and their interactions for fatigue crack initiation and growth. (NRL)
- Completed exploration of advanced coatings with multifunctional corrosion/fouling properties.
- Completed exploration of theoretical concepts for corrosion control.

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Completed development of a Giant Magnetoresistance (GMR) array Nondestructive Evaluation (NDE) system for detection of hidden cracks in Navy aircraft.

Power Generation, Energy Conversion and Storage
- 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 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 identification of new approaches to efficiently convert thermal, electrical and optical energy from primary sources (optical-photovoltaics).
- Continued research tools design efforts in Chemical Dynamics and High Temperature Probes.
- Continued development of phase change cooling approaches for high power electronic devices.
- Continued development of multi-scale thermal modeling approaches.
- Continued development of non-vapor compression based refrigeration cycles.
- Completed efforts in fundamental understanding of novel solid polymer electrolytes.
- Completed work on developing the scientific basis of nanostructure enhancement of direct energy conversion materials performance for power generation.
- Completed expanding research into new thin-film and bulk materials and processes for converting thermal to electric energy such as identifying new high figure of merit thermoelectric materials.
- Initiated efforts developing science base for optimized combustion of alternative fuels.

Environmental Sciences
- Continued examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations.
- Continued assessment of the fate and effects of chemical and biological contaminants in marine/estuarine environments.
- 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 research tools design efforts in Sampling and Analytical Methodologies.

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Completed efforts to increase strength in silicone based polymers for anti-fouling/friction reduction coatings.
- Completed research on ultra-filtration membranes for bioreactors.
- Initiated effort to develop Reverse Osmosis (RO) pre-treatment strategies to allow water recycling on ships.

FY 2008 Plans:

Structural Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of physics-based models of thermal and materials flow during friction stir welding of high-strength low-alloy (HSLA-65) grade steel.
- Complete research into the area of transforming bio-fibrillose material into carbon nanotubes.
- Complete evaluation of new high temperature resin for potential Unmanned Combat Air System (UCAS) high temperature composite applications.
- Initiate 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.
- Initiate efforts to understand and predict salt chemistry effects on high temperature coatings and materials in naval gas turbine environments.
- Initiate understanding for development of modeling tools for enhancing dynamic response and projectile resistance for sandwich structures.
- Initiate efforts to understand the thermomechanical links during complex chemical reaction paths and atomic diffusion during the degradation of high temperature thermal and environmental barrier coatings.
- Initiate the exploration of naval titanium alloys designed a priori for both performance and friction stir weldability.

Functional Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete investigation of radically new hierarchical polymer lenses that mimic the focusing of an eye. (NRL)
- Initiate high temperature, low frictional sliding coefficient coating materials for gas turbine bearing at high operating temperatures.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate exploration of innovative technologies such as capacitive micro-machined acoustic transducers for naval sonar systems.
- Initiate study of standoff detection of explosive materials and devices. (NRL)
- Initiate development of methods for the intentional, controlled, impurity doping of semiconductor nanocrystal wires.(NRL)
- Initiate effort to synthesize beta-SiC power suitable for subsequent densification into transparent beta-SiC ceramic.(NRL)
- Initiate meta-materials effort to develop negative index materials with dynamic frequency response.(NRL)

Maintenance Reduction
- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate the concept study of multiscale corrosion modeling on naval ship materials.
- Initiate fundamental theoretical and experimental studies on nanoscale corrosion of metals and alloys.
- Initiate corrosion prediction using an integrated deterministic-based model.

Power Generation, Energy Conversion and Storage (Transferred to Air, Ground and Sea Vehicles R-2 Activity).

Environmental Science
- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate efforts on treatment strategies of oily water containing synthetic lubricants.

FY 2009 Plans:

Structural Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete development of physics-based models of thermal and materials flow during friction stir welding of steels, including the development of residual stresses that will lead to distortion.
- Complete research tools design efforts in dynamic three dimensional control of structures.
- Complete research tools design efforts in chemical dynamics.
- Complete development of progressive damage models for blast effects on composite marine structures.
- Initiate alloy modeling for advanced material optimization for high temperature gas turbine applications.
- Initiate development of understanding and constitutive models of competing and complementary microstructural factors influencing both dynamic behavior and weldability of high strength steels and naval titanium alloys.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate expansion of first-principles methods devised to calculate piezoelectric properties of materials for sonar transducers to calculate additional materials properties for other applications.
- Initiate multi-energy processing approaches for the room temperature cure of polymeric materials with high temperature thermoxidative stability and fire resistance.
- Initiate the fatigue life prediction model analysis on high temperature engine materials.
- Initiate fundamental research on catalytic activation via tuned lasers for optimized fuel generation.
- Initiate development of new methods for room temperature curing and processing of polymer composites with high temperature oxidative stability and fire resistance.
- Initiate investigation of advanced materials contributions to blast and projectile resistance of cellular structures.
- Initiate assessment of the blast resistance of cellular structures as functions of soil characteristics.

Functional Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate 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.
- Initiate basic research into material technology associated with the development of active and conventional armor.

Maintenance Reduction
- Continue all efforts of FY 2008.
- Complete identification of stress corrosion control methods for friction stir welded high-strength aluminum alloys using advanced thermal treatments, chemical modifications, and surface mechanical processes to tailor compressive stresses.
- Initiate the investigation of processing science (single crystals, coatings, thermal barrier coatings (TBC), heat treatment, etc) to materials performance to develop relevant process protocols to optimize and control quality.
- Initiate research on innovative concepts for effective radiation barrier coatings and ultra-low thermal conductivity barrier coatings.
- Initiate studies of the interfacial reactions between coatings and evolving substrates (Mo-Si-B, CMCs) involving first principal calculations leading to predictive living models at temperatures from 2400F to 3600F.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate the investigation of the influence of environments (thermal, oxidation, corrosion, temperature gradients, and contaminants) on oxide growth rates, stress generation, coating adherence, durability, and lifing for aircraft and ship applications.
- Initiate grain boundary engineering to improve corrosion resistance of marine grade aluminum alloys.
- Initiate studies of surface microstructure optimization to enhance corrosion properties of navy marine alloys
- Initiate sensor development for monitoring microstructural changes on alloys under thermal and mechanical stresses.
- Initiate research focused on modeling and simulation for platform and system affordability, lifetime materials, shipboard wireless capability, automation to reduce manning.

Environmental Science
- Continue all efforts of FY 2008.
- Complete assessment of the fate and effects of chemical and biological contaminants in marine/estuarine environments.
- Complete research tools design efforts in Sampling and Analytical Methodologies.

Manufacturing Science
- Initiate a multidisciplinary research task into furthering the sciences associated with advances in manufacturing processes

	FY 2007	FY 2008	FY 2009
MEDICAL/BIOLOGY	13,459	14,838	14,787

Efforts include: biosensors, biomaterials, bioprocesses; marine mammals; casualty care and management; healthy and fit force; casualty prevention; undersea medicine/hyperbaric physiology; biorobotics; expeditionary operations training and education; and chemical-biological defense. These efforts are coordinated with the Army and Air Force through joint program reviews and are complementary, not duplicative. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

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This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 Accomplishments:

Medical Sciences
- Continued research to understand individual variability in stress response.
- Continued non-lethal weapons bioeffects research.
- 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, healthy and fit force, 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.
- Continued research in Genetic Polymorphisms, the stress response and their Interaction with the Immune System.
- Initiated research to explore systematic relationships between cognitive and physiological responses to laboratory tasks under operational conditions.

Biological Sciences
- Continued studies of effects of man-made sound on marine mammal hearing and behavior.
- Continued research to understand physiological effects of Naval sonar exposures on marine mammals.
- Continued work to power naval ocean instruments with sediment biofuel cells and to elucidate the microbial processes that drive energy harvesting in these systems.
- Continued research on biofouling with emphasis on barnacle adhesion studies using molecular biology tools.
- Continued genetic analysis and genomics to facilitate efforts to understand anaerobic microbial transformation of polycyclic aromatic hydrocarbons and polychlorinated biphenyls in estuarine sediments, and eelgrass-mediated degradation under aerobic conditions.
- Continued work on microbial synthesis of energetic materials.
- Continued efforts to develop next-generation and supramolecular antibiotics.
- Continued research of toxicity and enzymatic pathways of biodegradation of Royal Demolition Explosive (RDX), High Melting Point Explosive (HMX) and Dinitrotoluene (DNT) in marine benthos.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Continued dolphin microarray and gene-based studies to facilitate immunobiology studies of stress response.
- Continued efforts focused on microbe-materials interfacial interactions to detect materials defects/failures.
- Continued research on biofouling microbial community succession and invertebrate larval settlement in response to biofilms.
- Continued biogeochemical research of Mississippi Sound sediments: Hurricane Katrina effects and recovery.
- Continued research to understand physiological effects of sound exposure on marine mammals from Navy sound sources other than sonar.
- Initiated 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.
- Initiated efforts in biomolecular materials, to include 2D self-assembled bioorganic/inorganic arrays as functional materials; biomimetic adhesives for underwater use; bioelectrochemistry and electrode studies associated with microbial fuel cells; self-assembling nano-sculpted surfaces polymers for biofouling studies; stochastic protein-quantum dot nanoswitches.
- Initiated combinatorial chemical screens for bacterial communication pathway inhibitors as potential antibiotics or fouling-control agents.

FY 2008 Plans:

Medical Sciences
- Continue all efforts of FY 2007.
- Initiate research in the mechanism/effects of underwater thermal stress.

Biological Sciences
- Continue all efforts of FY 2007.
- Complete efforts directed at genomics-enabled anaerobic transformation of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in estuarine sediments.
- Complete efforts focused on eelgrass-mediated degradation of PAHs and PCBs.
- Complete efforts to develop next-generation and supramolecular antibiotics.
- Initiate efforts to engineer plants to produce high value naval materials.
- Initiate efforts utilizing metagenomic screens to identify novel bacterial activities related to nitration or synthesis of high-N heterocycles.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

FY 2009 Plans:

Medical Sciences
- Continue all efforts of FY 2008.

Biological Sciences
- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate increased emphasis in efforts focused on microbe-materials interfacial interactions for detection of materials defects/failures, including corrosion, and for improved energy harvesting.
- Initiate increased emphasis in research on invertebrate larval settlement and metamorphosis in response to biofilms and various inhibitors of adhesion.
- Initiate increased advanced medical research for battlefield trauma.
- Complete research on biofouling microbial community succession.
- Complete dolphin miroarray and gene-based studies to facilitate immunobiology studies of stress response.
- Complete efforts on biomimetic adhesives for underwater use.
- Complete biogeochemical research of Mississippi Sound sediments: Hurricane Katrina effects and recovery.
- Complete research on toxicity and enzymatic pathways of biodegradation of Royal Demolition Explosive (RDX), High Melting Point Explosive (HMX) and Dinitrotoluene (DNT) in marine benthos.
- Initiate research on molecular biomimetics for naval applications.
- Initiate efforts to identify molecular biomarkers for battlefield injuries, and high-fidelity biosensors for detection in vivo.
- Initiate research into biomolecular 'logic controllers' for in vivo biosensor and in vivo drug delivery systems
- Initiate research on engineered cells for infection detection and treatment in wounds
- Initiate 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.
- Initiate research to identify inhibitors of lateral DNA transfer in bacteria
- Initiate research to explore novel dressings that mitigate burn pain and will control infection.
- Initiate 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.

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	FY 2007	FY 2008	FY 2009
OCEAN SCIENCES	80,836	84,710	88,840

Efforts include: Littoral Geosciences, Optics, and Biology; Marine Mammals; Physical Oceanography and Prediction; and Ocean Acoustics. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. 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.

FY 2007 Accomplishments:

Littoral Geosciences, Optics, and Biology
- 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 field, laboratory, and numerical studies of seafloor sand ripple genesis, evolution, and destruction and their effect on acoustical penetration of the sea floor.
- Continued efforts to investigate the effects of oceanic biota on the propagation and inversion of multi-frequency acoustical energy.
- Continued investigations of sources and properties of light scatter within the coastal ocean.
- Continued to investigate the physical processes that control re-suspension of bottom sediments and the resulting impact on optical and acoustical propagation.
- Continued investigations of oceanic processes within the surface boundary layer that control high-frequency variability in image propagation and distortion.
- Continued to investigate and characterize the impact of riverine sources of optically-important matter on underwater visibility, navigation, and surveillance.
- Continued field program to infer sea floor characteristics from observations of surface gravity waves.
- Continued effort to improve accuracy of the "5-cm gravimetric geoid" and precise geodesy. (NRL)
- Continued effort to use time sequencing NRL PHILLS (Portable Hyperspectral Imager for Low-light Spectroscopy) images of the same scene to derive dynamical properties of the ocean surface. (NRL)

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- Continued effort to investigate the use of combining Light Detection and Ranging and passive hyperspectral sensing to derive bottom characteristics and water column optical properties over water and terrestrial vegetation and trafficability maps over land. (NRL)
- Continued effort to understand and predict coastal dynamics in environments where significant sediment heterogeneity occurs, impacting on hydrodynamic and morphodynamic processes, including six week, April-May, field efforts off Cassino Beach, Brazil, subject to sudden, large muddy beach deposits. (NRL)
- Continued effort to understand the extent and intensity of seafloor gas hydrate accumulations and coastal bio-optical response to air-ocean forcing. (Includes NRL investment/performance in this effort.)
- Continued programs to estimate optical properties of coastal ocean water from above-surface sensing, using in-situ data for validation.
- Initiated studies to predict tidal flat evolution in coastal/riverine/estuarine systems.
- Initiated 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. (Includes NRL investment/performance in this effort.)

Marine Mammals
- 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.
- Completed study of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals.

Physical Oceanography and Prediction
- Continued field studies/modeling to predict propagation and effect on acoustics of non-linear internal waves in the western Pacific.
- Continued studies to understand how to sample ocean processes with gliders and other autonomous and remote sensing systems to support tactical oceanography.
- 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 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. (Includes NRL investment/performance in this effort.)

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- Continued extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics Program.
- Continued an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models.
- Continued 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; Spring FY 05 field work in the South China Sea collected unique data sets on extremely large internal waves, acoustics in internal wave fields, transmission loss, and dissipation in areas of internal wave breaking.
- 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 effort to understand the bio-optical response to dynamical forcing processes and how to assimilate optical properties into a physical ocean model for predictive purposes. (NRL)
- 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 the field experiment in Monterey Bay to examine the role of unresolved processes in model parameterizations.
- Continued the development of breaking wave detection techniques using Hilbert transformation of the space-time series of surface waves and the capability of establishing empirical functions connecting wave breaking properties to the generation and entrainment of bubble clouds. (NRL)
- Initiated a Coupled Oceanographic-Acoustics modeling and field program to demonstrate the use of a fully coupled system in optimizing tactical reduction of uncertainty.
- Initiated an integrated modeling and field experiment on determining custom self-learning wave databases and forecast systems/ship-movement and engineering systems for Sea Basing.
- Initiated the pilot test of the novel data (synthetic aperture radar and Hyper-spectral) assimilation forecast system developed under Philippine experiment.
- Initiated an Estuarine-Littoral Processes Interaction field study in muddy and tidal flat dominated regimes including a data assimilative prediction capability.

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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 though 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. (Includes NRL investment/performance in this effort.)
- Continued studies of adaptive beam-forming using mobile, autonomous sensors.
- Continued development of realistic seismo-acoustic model for sediment geology. (NRL)
- Continued investigation of acoustically induced magnetic fields using modern experimental equipment and numerical techniques. (NRL)
- Continued development of source waveform design for rough littoral seafloors. (NRL)
- Continued development of "time-reversal" characterization of bubble field dynamics. (NRL)
- Completed development of the Nonlinear Progressive Wave Equation model. (NRL)
- Completed investigations of analogs of condensed matter physics phenomena in ocean acoustics. (NRL)
- Initiated 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. (NRL)
- Initiated 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. (NRL)
- Initiated 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. (NRL)

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- Initiated assessment of "time-reversal" propagation techniques for mitigation of environmental variability.
- Initiated field work on adaptive beam-forming using mobile, autonomous sensors.

FY 2008 Plans:

Littoral Geosciences, Optics, and Biology
- Continue all efforts of FY 2007.
- Initiate development of prediction models for distributary deltaic coastal environments.

Marine Mammals
- Continue all efforts of FY 2007, less those noted as completed above.

Physical Oceanography and Prediction
- Continue all efforts of FY 2007.
- Enhance studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas.
- Enhance studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography.
- Initiate development of expert system methods to characterize and predict Riverine/estuarine systems to support Naval Special Warfare, Marine Expeditionary Forces and new Riverine units.

Ocean Acoustics
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of realistic seismo-acoustic model for sediment geology. (NRL)
- Complete investigation of acoustically induced magnetic fields using modern experimental equipment and numerical techniques. (NRL)
- Complete development of source waveform design for rough littoral seafloors. (NRL)
- Complete development of ""time-reversal"" characterization of bubble field dynamics. (NRL)
- Initiate effort to understand synoptic scale ocean variability in the strategic Turkish Straits System including water mass exchange between basins and vertical mixing. (NRL)
- Initiate effort to develop a methodology for expressing the semantics of physics-based environmental models to support automated computer applications. (NRL)
- Initiate development of algorithms for accurate acoustic predictions in dispersive, turbulent, turbid water. (NRL)

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- Initiate effort to understand how mudflat sediments respond to dynamic processes. (NRL)

FY 2009 Plans:

Littoral Geosciences, Optics, and Biology
- Continue all efforts of FY 2008.
- Initiate studies of tidal flat evolution in wave dominated environments.

Marine Mammals
- Continue all efforts of FY 2008.

Physical Oceanography and Prediction
- Continue all efforts of FY 2008.
- Complete studies of internal wave propagation in the South China Sea.
- Initiate studies of ocean and wave response to typhoons and monsoons in the Western Pacific.
- Initiate 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.

Ocean Acoustics
- Continue all efforts of FY 2008, less those noted as completed above.
- Enhance deep-water acoustic transmission measurements with emphasis on the Northern Philippine Sea.
- Complete development of complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. (NRL)
- Complete development of enhanced 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. (NRL)

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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	FY 2007	FY 2008	FY 2009
SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	40,820	36,404	33,699

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 2007 Accomplishments:

- Continued awarding prizes at 400 regional high school science fairs and three national competitions.
- Continued supporting 203 high school summer interns at Navy laboratories.
- Continued supporting 230 undergraduate/graduate students as summer research interns at Navy laboratories.
- Continued providing graduate fellowship support to nine HBCU engineering faculty candidates.
- Continued funding Young Investigator research grants including 7 new three-year research grants.
- Continued the encouragement, promotion, planning, coordination and administration of naval Science and Technology.

FY 2008 Plans:

- Continue all efforts of FY 2007.

FY 2009 Plans:

- Continue all efforts of FY 2008.

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	FY 2007	FY 2008	FY 2009
SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW)	40,085	42,974	49,474

Efforts include: 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 Innovative Naval Prototype (ITS INP); and RF electronic warfare. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

Change from FY 2007 to FY 2008 reflects a increased level of investment and effort for networked sensors (+$3M), nanoelectronics (+$1M), and solid state electronics (+$1M) increased . Most other areas within this activity underwent minor shifts in emphasis that are reflected in the distribution of funds. These year-to-year continuations do not remain perfectly flat, but rather fluctuate depending on the required investment profile necessary to achieve the program's objectives and schedule.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 Accomplishments:

- Continued the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processor (DSP) applications to T/R arrays.
- Continued monolithic integration of multifunctional materials to enable passive devices and sensors into wide bandgap semiconductor circuits.
- 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 project to develop linear higher power microwave wide bandgap semiconductor bipolar transistors based on distributed polarization effect (graded composition) base growth and processing technology.

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- Continued effort to increase power conversion efficiency in an organic plastic solar cell based on Carbon 60 and a transparent hole transporter, and a conducting polymer electrode with achievement of > 4%
- Continued the analysis and characterization of micro-motion Doppler modulation.
- Continued investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
- Continued investigation of physical basis for improved time and frequency standards using quantum-entangled ions and atoms.
- Continued project to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging, with a first step being the integration of Cellular Nonlinear Network (CNN) fast image processor with multi-spectral focal plane array sensors.
- Continued development of sensitive miniature fluxgate magnetometers.
- Continued studies to optimize power and efficiency of compact, high power, electron beam pumped Argon-Xenon (Ar-Xe) laser for Navy directed energy weapons (DEW). (NRL)
- Continued to analyze effects of maritime and urban aerosols on thermal blooming of high energy laser beams. (NRL)
- Continued investigation of super-resolution signal processing techniques for closely spaced and unresolved targets in Doppler, range and direction of arrival spaces for a variety of radars.
- Continued non-cooperative target identification from multiple aspects.
- Continued investigation of ultra high speed logic and multiple-quantum-well devices with a goal of >500 giga-hertz (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 tera hertz (THz).
- Continued program to incorporate Magnesium Diboride (MgB2) tunnel junctions into simple electronic logic structures.
- Continued development of stabilized optical sources and low-noise photodetectors for the fabrication of an ultrastable microwave-frequency source. (NRL)
- Continued development of a blind adaptive beamforming approach for the HF radar case and compare with both the conventional and traditional approaches. (NRL)
- Continued research to improve integrated nanomechanical device arrays to include scaling down resonator architecture and quantifying properties which establish phononic crystal properties. (NRL)
- Continued research to develop electromagnetic ultra-near-field holography. (NRL)
- 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. (NRL)

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- Continued development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. (NRL)
- Continued program on advanced epitaxial growth for novel Si-based detector applications. (NRL)
- Completed advanced height finding and detection algorithms for high frequency radar.
- Completed exploitation of atom condensates to reach physical limit of frequency precision and control.
- Completed investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
- Completed investigations of the modification of metal surfaces by nitriding and other processes to maximize hardness, wear and corrosion resistance for Navy gun barrel applications using the large area plasma processing system (LAPPS). (NRL)
- Completed analysis and characterize observed micro-motion features and components obtained in experiments. Create a framework for analysis of Doppler modulations. (NRL)
- Completed material and structural improvements in type-II superlattice IR photodiodes operating in the long wavelength and very long wavelength IR ranges. (NRL)
- Completed development of multi-time and length scale step modeling of heat propagation in bare and packaged wide bandgap power amplifiers, experimental verification of the models, and testing of the role of temperature in observed history effects, non-linearity, and device failure mechanisms.
- Initiated study of the feasibility of a solid state implementation of a quantum computer. (NRL)
- Initiated research of a novel extension of the Generalized Radon Transform to establish appropriate wavenumber representations for arbitrarily oriented wave guides, surfaces, and structures. (NRL)
- Initiated development of a general mathematical framework for developing advanced infrared countermeasures and analyzing/optimizing their effectiveness. (NRL)
- Initiated work on optical manipulation of ultra-cold atoms. (NRL)
- Initiated a program on the study of Quantum Dots and their application to coherent wavefunction control and quantum information. (NRL)
- Initiated a program on the control of deleterious defects in silicon carbide (SiC). (NRL)
- Initiated a program on the tailoring of the optical, structural and electronic properties of semiconductor quantum wires. (NRL)
- Initiated a program to apply innovative mass nanofabrication techniques to previously developed nanodevice arrays.
- Initiated a program to demonstrate non-volatile memory, based on spin-torque MRAM, with switching speed > 1 GHz and write currents small enough (<1 mA) to be driven by superconducting Rapid Single Flux Quantum (RSFQ) logic.

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- Initiated 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.
- Initiated 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.
- Initiated demonstrations of tunable analog filters made in a digital Nb device foundry.
- Initiated development of techniques to observe directly the electrical properties of pair states in high temperature superconductors.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Transition Cellular Nonlinear Network (CNN) fast image processor with multi-spectral focal plane array sensors to 6.2 research.
- Complete the analysis and characterization of micro-motion Doppler modulation.
- Complete the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processing (DSP) applications to T/R arrays.
- Complete 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.
- Complete project to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging.
- Complete investigation of super-resolution signal processing techniques for closely spaced and unresolved targets in Doppler, range and direction of arrival spaces for a variety of radars.
- Complete development of sensitive miniature fluxgate magnetometers.
- Complete development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. (NRL)
- Complete development of a blind adaptive beamforming approach for the HF radar case and compare with both the conventional and traditional approaches. (NRL)
- Complete analyzing effects of maritime and urban aerosols on thermal blooming of high energy laser beams. (NRL)
- Complete the initial study of the coherent control of wavefunctions in quantum dots. (NRL)

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- Complete the demonstration of control of the concentrations of the defects that limit the minority carrier lifetime in SiC. (NRL)
- Complete the growth of semiconductor quantum wires with controlled doping and heterostructure interfaces. (NRL)
- Complete improvements to integrated nanomechanical device arrays to include scaling down resonator architecture and quantifying properties which establish phononic crystal properties. (NRL)
- Complete development of electromagnetic ultra-near-field holography. (NRL)
- Initiate investigation of temporal-spatial noise shaping circuits and architectures for analog-to-digital conversion.
- Initiate research effort to investigate target and signal characteristics based on non-Archimedean geometry.
- Initiate research effort to investigate multiple input multiple output (MIMO) signal analysis and characterization with application to wide area surveillance.
- Initiate 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.
- Initiate investigation of impedance properties and harmonic noise canceling for highly efficient digital and mixed signal amplifiers which operate in an electronically scanned array environment.
- Initiate project to explore semiconductor nanowire transport phenomena, doping and heterostructure characterization.
- Initiate carbon nanotube based electron device exploration.
- Initiate investigation of optical techniques to coherently manipulate, control, and guide ultra-cold atoms, studying their dynamics and interactions experimentally and theoretically. (NRL)
- Initiate growth of graphene using Molecular Beam Epitaxy (MBE) and metalorganic chemical vapor deposition (MOCVD) methods. (NRL)
- Initiate extraction of signal-network patterns from mammalian cells to use as unique identifiers of toxin, viral, or bacterial stimuli. (NRL)
- Initiate development of a novel Domain Decomposition (DD) technique to analyze performance of large electromagnetic surface critical to future Navy radar systems. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.

BUDGET ACTIVITY: 01
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- Complete non-cooperative target identification from multiple aspects.
- Complete wide band gap semiconductor materials growth and characterization research
- Complete development of a general mathematical framework for developing advanced infrared countermeasures and analyzing/optimizing their effectiveness. (NRL)
- Complete the demonstration of single and two-qubit operations of spins in quantum dots. (NRL)
- Complete the study of defects involved in limiting the minority carrier lifetime in SiC. (NRL)
- Complete the study of the use of InAs, Ga2O3 quantum wires for optical, structural and electronic applications. (NRL)
- Initiate thermal management technology research for power electrical and power RF devices, circuits, integrated circuits (ICs), systems and platforms utilizing low temperature grown conformal diamond heat-spreader/sinking technologies
- Initiate program of investigation of Transductors, Transpacitors and Transponents utilizing hetero-structural, hetero-functional and graded multi-functional thin film systems.
- Initiate magneto-electric component investigation for electrically tuned magnetic RF components based on Terfenol and Terfenol semiconductor hetero-junction device concepts
- Initiate quantitative study of system performance expected from using various superconductive RF components in several naval surveillance systems.
- Initiate materials studies of low temperature regenerator (high thermal capacity) materials and/or controlled flow microstructures.
- Initiate project to explore graphene based nanoelectronic devices.
- Initiate atomic scale spin manipulation effort.
- Initiate project to reduce heat transfer through electrical leads in cryogenic packaging.
- Initiate 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.
- Initiate high-sensitivity magnetometry using quantum logic.

	FY 2007	FY 2008	FY 2009
WEAPONS	11,043	13,172	13,804

Efforts include: Undersea Weaponry; Energetic Materials and Propulsion; Expeditionary Operations; and Directed Energy. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

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This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 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.

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, optimize injection parameters, and demonstrate 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.

BUDGET ACTIVITY: 01
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- 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).
- Completed transition portion of the HSSV ventilation requirements, control, and maneuvering approaches to the Defense Advanced Research Projects Agency (DARPA) Underwater Express Program.
- Initiated studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C).
- Initiated hydroacoustics models and experiments to reduce the self noise on cavitator acoustic array.
- Initiated acoustic signal processing algorithms for HSSV guidance and control.
- Initiated development of new concepts for underwater power generation.
- Initiated development of non-lethal undersea warheads for Global War on Terror (GWOT).

Energetic Materials and Propulsion
- Initiated development of PDE for underwater applications.

Expeditionary Operations
- Continued investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells.
- Completed investigation of modeling and exploiting the nonlinear seismic interactions between buried land mines and their surrounding soil for purposes of landmine detection.
- Initiated research in quantum optics, nano-microscale self assembly and molecular recognition for active forensic sensing

Directed Energy
- Continued research thrust in Directed Energy weapons.

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FY 2008 Plans:

Undersea Weaponry
- Continue all efforts of FY 2007.
- Complete computational fluid mechanics computer codes for supercavitating vehicles.
- Complete studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C).

Energetic Materials and Propulsion
- Continue all efforts of FY 2007.

Expeditionary Operations
- Continue all efforts of FY 2007, less those noted as completed above.

Directed Energy
- Continue all efforts of FY 2007.
- Initiate 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.

FY 2009 Plans:

Undersea Weaponry
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete efforts in nonlinear control laws, gas ventilation, and vehicle stability associated with the development of high-speed supercavitating vehicles (HSSV).
- Complete hydroacoustics models and experiments to reduce the self noise on cavitator acoustic array.
- Initiate validation of hydroacoustic models and test and evaluate acoustic array signal processing algorithms.
- Initiate study on propulsion and its interaction with supercavitating cavity, and control surfaces.
- Initiate efforts to assess and expand electro-optical technology to enhance undersea warhead fuzing systems.
- Initiate acoustic concepts formulation and modeling for low-noise propulsion systems.

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Energetic Materials and Propulsion
- Continue all efforts of FY 2008.

Expeditionary Operations
- Continue all efforts of FY 2008.

Directed Energy
- Continue all efforts of FY 2008.
- Initiate multi-disciplinary efforts to include coherent beamforming, beam correction, turbulence effects on propagation, materials for high energy systems and sources.
- Initiate basic research in support of Electromagnetic railgun projectile.
- Initiate basic research into mechanisms supporting the defeat of speed of light weapons.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
BIO-INSPIRED MATERIALS - APPLICATIONS IN CATALYSIS, MAGNETICS, ELECTRONICS & MEDICINE	3,288	0

FY 2007 Accomplishments:

Completed studies of magnetic nanobiomaterial confinement to yield increased magnetic moment and modified surface anisotropy effects. Completed studies of nanoprotein cage platforms to rapidly detect and treat microbial biofilms, including marine biofilms. Conducted studies of efficient biological or bio-inspired catalysts coupled to specifically engineered semi-conductors to allow production of hydrogen gas from light.

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	FY 2007	FY 2008
CARBON NANOTUBE-BASED RADIATION-HARD NON-VOLATIVE RAM	5,877	0

FY 2007 Accomplishments:

Conducted research and testing of carbon nanotube based rad-hard non-volatile memory (NRAM). Demonstrated NRAM array operating at 5V and approaching Mbit in density. NRL conducted rad-hard qualification testing of small (16bit) NRAM arrays at MRad level.

	FY 2007	FY 2008
DOD AGILE MANUFACTURING CTR FOR CASTINGS TECHNOLOGY (AMCAST)	971	0

FY 2007 Accomplishments:

Completed efforts to develop the Rapid Cast Technology to produce high value metal castings on-demand for Navy and DoD applications. This technology involved using a rapid prototyping technique to fabricate sand molds and cores for rapid casting of metallic parts and components. The capability will become a part of the Naval Undersea Warfare Center - Keyport's efforts to integrate new repair and fabrication technologies for Fleet maintenance applications.

	FY 2007	FY 2008
ENERGETICS TECHNOLOGY CENTER/S&T WORKFORCE	4,982	2,384

FY 2007 Accomplishments:

Initiated research focus on design, processing, and implementation of micro/nano scale energetic systems, both for performance and reduced sensitivity applications. Initiated revitalization of workforce initiative.

FY 2008 Plans:

This effort supports energetics technology center/S&T workforce.

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	FY 2007	FY 2008
EVALUATING ELF SIGNALS IN MARITIME ENVIRONMENT	996	1,590

FY 2007 Accomplishments:

Initiated development and experimental evaluation of mathematical models of extremely low frequency (ELF) electromagnetic field propagation from underwater electric and magnetic sources. These models are important to the US Navy as applied to mine warfare, submarine detection and survivability, underwater communications, special operations and homeland security.

FY 2008 Plans:

This effort supports evaluating ELF signals in maritime environment.

	FY 2007	FY 2008
MARITIME DOMAIN AWARENESS	1,594	0

FY 2007 Accomplishments:

Completed efforts to provide analytical tools on automated information system information pertaining to maritime events performing motion based pattern analysis techniques. This effort focused on tracking large numbers of sea vessels and understanding those ships' normal behavior, detecting changes in their behavior and deriving threat intentions based upon deviations from known non hostile threat behaviors.

	FY 2007	FY 2008
MOBILE AD HOC DATA COMMUNICATIONS FOR UNMANNED SYSTEMS	1,262	795

FY 2007 Accomplishments:

Initiated development of several new technologies that support highly mobile network architectures in a tactical environment, including:

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(1)development of a simulation environment to model many network nodes without having to physically deploy large networks, as well as enhancements to these protocols to continue to improve system performance;
(2) development of a new form-factor for the current network processor that is compatible with a production Explosive Ordnance Disposal (EOD) robot to support evaluation for fielding; and
(3) development of a small form-factor video codec capable of real-time video coding and decoding.

FY 2008 Plans:

Continue development of a portable implementation of a system capable of performing both OBX and MSA. Perform limited testing of a prototype system, including baseboard waveform processor, power and frequency-adjusting adjunct devices, and high-mobility networking radio. These new approaches will allow the Explosive Ordinance Disposal community, and other warfighters, the capability to operate networks with substantially improved performance and system throughput. These new approaches are expected to allow for the operation of many robots in the same operating theater, where the current system can only support a limited number of simultaneously active robots.

	FY 2007	FY 2008
NAVY SCIENCE & TECHNOLOGY OUTREACH	0	795

FY 2008 Plans:

This effort is a collaborative K-12 technology-oriented mentoring program established between the Department of the Navy and the State of Virginia. The program seeks to generate and sustain the interest and excitement of adolescents in careers in science, technology, engineering and mathematics disciplines using a proactive mentoring environment incorporating school teachers, Navy R&D Center scientists and engineers working with Virginia middle school students. The goal of the program is to increase the number of students earning university degrees in science, mathematics, engineering, and technology and to foster the development of the next generation of technologists for our Naval Research and Development Centers. In addition to their teachers, mentors from Navy science and engineering staff work with school children in their classrooms. This program exposes participants to the excitement and challenge of careers in science, technology or engineering while providing school teachers with important interactions with the naval community. The program has provided students with important interactions with career role models from among the Navy and academic communities. These interactions are strengthening peer, family, school and community support for technical collaborations and better ensure long term inclusiveness of women and minorities in science and technology

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programs. As a result of this program we expect to see an increase in the number of students taking college-prep mathematics and science courses as well as an increase in the number of students receiving degrees in engineering, mathematics and the physical sciences.

	FY 2007	FY 2008
NAVY USE OF UNOLS SHIPS	4,383	0

FY 2007 Accomplishments:

Completed tasks to provide additional vessel infrastructure and mission equipment upgrades and augmentations to benefit the overall capabilities of the vessels. This will enable such activities as overhaul of Z drive propulsion motors; replacement of over-the-side handling equipment with new, motion-compensated systems to improve safety of operations in rough seas; and further improvements in ship habitability. In addition, a portion of the funding was used to augment selected scientific cruises to maximize the return on initial base funding investments for at-sea experiments and research projects data collection.

	FY 2007	FY 2008
ONAMI NANOELECTRONICS AND NANOMETROLOGY INITIATIVE	2,491	1,987

FY 2007 Accomplishments:

This effort explored novel measurement techniques to characterize nanostructures and devices, new nanometrology tools to image and measure the structure and composition of nanoscale objects and interfaces, and techniques for evaluation of nanoscale devices for logic and biosensing. The work is detailed in a report that was submitted to ONR in November, 2007.

FY 2008 Plans:

This effort will focus on nanometrology research through collaborations with NIST and nanoelectronics research that is coordinated with the semiconductor industry through the Nanoelectronics Research Initiative (NRI).

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	FY 2007	FY 2008
ROTATIONAL MOLDED DOUBLE WALL FOR UN-MANNED PATROL BOAT	0	2,981

FY 2008 Plans:

Initiate research into developing manufacturing processes for unmanned patrol boats using a rotational molded double wall processes. These craft are integral to our transformational efforts to become more reliant on unmanned and autonomous vehicles, especially in the littorals.

	FY 2007	FY 2008
STANDOFF BIO-CHEMICAL AGENT DETECTION	971	795

FY 2007 Accomplishments:

This effort initiated research to continue on the recent successes of Texas A&M University (TAMU) researchers in the detection of anthrax and trace amounts of chemicals in the air. These breakthroughs are very relevant to national defense and homeland security.

FY 2008 Plans:

This effort supports standoff bio-chemical agent detection.

	FY 2007	FY 2008
TEXAS MICROFACTORY	0	3,478

FY 2008 Plans:

Initiate the development of a cost effective automated assembly and packaging system for microsystems in small lots by augmenting current equipment to include laser, electrical discharge machining and mechanical micromachining tools and top down nanomanufacturing tools. Demonstrate manufacturability techniques for steerable projectiles using 2D actuator arrays and microrobotic swarms to enhance the situational awareness of

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the Warfighter. Novel micromanufacturing platforms based on modular and multiscale architectures will enable the prototyping of new processes and products.

	FY 2007	FY 2008
TOTAL FORCE EDUCATION INITIATIVES	1,000	0

FY 2007 Accomplishments:

Completed effort with the Naval Post Graduate School (NPGS) for tuition assistance ships, PhD student support and student research.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601103N University Research Initiatives
PE 0601152N In-House Laboratory Independent Research

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences
PE 0601101E Defense Research Sciences
PE 0601102F Defense Research Sciences

D. ACQUISITION STRATEGY: