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HOUSE ARMED SERVICES COMMITTEE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
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BEFORE THE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
HOUSE ARMED SERVICES COMMITTEE
ON
THE FISCAL YEAR 2012 BUDGET REQUEST

MARCH 1, 2011

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Introduction

It is an honor to appear before you to report on Science and Technology (S&T) efforts within the Department of the Navy and discuss how the President's FY 2012 Budget supports the Navy and Marine Corps. The President's FY 2012 Budget requests $2 billion for Naval S&T.

The Naval S&T objective is to support a Navy and Marine Corps capable of prevailing in any threat environment. The Office of Naval Research (ONR) continues to work directly with the Secretary of the Navy (SECNAV), Chief of Naval Operations (CNO) and Commandant of the Marine Corps (CMC) to address critical challenges by: 1) focusing on S&T areas that provide the biggest payoff for the future, 2) encouraging innovative thinking and business processes, and 3) continuing to assess results and improve transition of S&T into acquisition programs.

We are efficient at what we do, and well-guided in future spending to strike a balance between responsive near term technology insertion and unfettered, innovative long-term basic research. It is the latter category that holds greatest potential for true game-changers such as the Global Positioning System (GPS), Autonomous Vehicles, the Free Electron Laser (FEL), and the Electromagnetic Railgun. There are many Navy S&T products in the Fleet/Force today with many more on the way. Among our greatest challenges are meeting SECNAV's Science, Technology, Engineering and Mathematics (STEM) goals, shaping and building an even higher quality S&T workforce, and recapitalizing the Naval Research Laboratory (NRL) infrastructure.

Our first task is to support the SECNAV's priorities: 1) taking care of Sailors, Marines, Civilians and their families, 2) treating Navy energy requirements and solutions as issues of national security, 3) creating acquisition excellence, and 4) optimizing unmanned systems. The next step involves both CNO priorities and CMC guidance. We have to build the future force, maintain warfighting readiness, and develop and support the entire Navy/Marine Corps family, uniformed and civilian. Where Marines are concerned, this involves training and equipping them for Afghanistan, rebalancing the Marine Corps (USMC) of the future through better education and training, and never forgetting to keep faith with service personnel and families. Each of these objectives demands the application of S&T resources. In addition to our focus on areas that provide the big payoff, innovative thinking, and improving our ability to transition S&T, we must improve strategic communication and engagement with stakeholders. We are getting better at this every day, but can never afford to rest on our laurels.

Science and Technology Strategic Plan

The Naval Science and Technology Strategic Plan was developed to guide our S&T investments. The Naval S&T Strategic Plan is regularly reviewed by Navy and USMC leadership to reaffirm alignment of Naval S&T with current Naval missions and future capability needs. It ensures S&T has long-term focus, meets near-term requirements, and makes our course clear to decision makers, S&T partners, customers and performers.

The S&T Plan identifies thirteen focus areas where S&T investment will have high payoff supporting Navy and USMC requirements: 1) Power & Energy, 2) Maritime Domain Awareness, 3) Operational Environments, 4) Asymmetric and Irregular Warfare, 5) Information

Superiority and Communication, 6) Power Projection, 7) Assure Access and Hold at Risk, 8) Distributed Operations, 9) Naval Warfighter Performance, 10) Survivability and Self-Defense, 11) Platform Mobility, 12) Fleet/Force Sustainment, and 13) Total Ownership Cost.

In each area, our goal is to move from existing systems and concepts of operations toward a warfighting capability to counter predicted threats in an increasingly complex and uncertain environment. While the starting point is continued evolution of current systems, we progress toward incremental improvements and spiral development, to new development of known technologies, and finally to new development of undiscovered disruptive technologies. If we are good, and perhaps lucky, this is where today's S&T encounters the unanticipated future. At its best, that is what S&T is all about.

Executing the Strategy

We execute Basic Research (6.1) thru Advanced Technology Development (6.3) funds by dividing S&T into three primary areas – Discovery and Invention (D&I), Innovative Naval Prototypes (INP), and Future Naval Capabilities (FNC). In addition, we maintain Rapid Reaction capability to respond to respond to emerging emergency requirements.

Discovery and Invention

Discovery and Invention (D&I) includes basic research (6.1) and early applied research (6.2) in areas with unique requirements essential to the Naval mission, but also in areas that are undefined but hold promise for future application. This is the nature and the power of Basic Research. D&I develops fundamental knowledge, provides the basis for future Navy/Marine Corps systems, and sustains our Scientist and Engineer workforce. Research areas of emphasis include autonomous sciences, bio-inspired sciences, cognitive/neural training technologies, information technology, advanced quantum computing, materials sciences (metamaterials, integrated computational material sciences, nano-manufacturing), and counter Improvised Explosive Device (IED) sciences.

Approximately 40 percent of S&T investment is in D&I. We assess impact on Navy/Marine Corps missions, as well as potential for innovative performance, in order to invest resources in the best research areas and projects. This develops a broad base of scientific knowledge from which INP, FNC, and quick reaction efforts are generated. Approximately 60 percent of basic research is executed with academic and non-profit performers, with all programs peer reviewed during the second to third year from inception to ensure high quality and integrity.

An important element of D&I is the Defense University Research Instrumentation Program (DURIP), which supports university research essential to Naval research. DURIP complements our D&I programs by supporting purchase of high cost instrumentation necessary to carry out cutting-edge research. ONR awarded 68 DURIP grants in FY 2007, 92 in FY 2008, 82 in FY 2009, 61 in FY 2010, and plans to award approximately 60 grants in FY 2011. Another D&I program, ONR's Basic Research Challenge, stimulates interdisciplinary research in emerging S&T fields by funding promising research in areas not addressed by the current basic program.

D&I investments develop and sustain the S&T workforce and support Science, Technology, Engineering and Mathematics (STEM) outreach. Through Independent Laboratory In-house Research (ILIR) and Independent Applied Research (IAR) programs, ONR sponsors critical research, while furthering education of scientists and engineers at Warfare Centers. Education and research opportunities for undergraduate and graduate students, fellows, and future faculty members and researchers are provided through programs such as the Naval Research Enterprise Internship Program (NREIP), which expose participants to work at Naval laboratories.

Through the University Research Initiative (URI) and Young Investigators Program (YIP), ONR gains access to researchers with a willingness to investigate high priority topics of interest to the Naval services. Through our Multidisciplinary University Research Initiative (MURI), ONR supports multi-disciplinary university teams to speed scientific progress by cross-fertilization of ideas, hasten transition of basic research to practical applications, and train students in cross-disciplinary approaches to science and engineering research of importance to DoD. We actively support Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) with research and education partnerships. We also support the Presidential Early Career Award for Scientists and Engineers (PECASE), honoring achievements of young professionals at the outset of independent research careers in S&T. Through demonstration, apprentice, award, and graduate programs, we encourage young people to explore S&T careers in academia, Naval labs, and industry.

ONR supports research at the Department of the Navy's corporate lab, the Naval Research Laboratory (NRL). This support, known as the NRL base program, develops S&T to meet needs identified in the Naval S&T Strategic Plan, and sustains world class skills and innovation in our in-house laboratory.

Science, Technology, Engineering and Mathematics (STEM)

In late 2009, ONR was tasked with coordinating all Naval STEM educational and outreach activities. Through this STEM education and outreach effort, the Navy is making critical contributions aimed at strengthening America's competitive edge, and ensuring a sufficient talent pool exists to support future Naval technical needs. These professionals are a key to innovation, which is critical to maintaining U.S. economic competitiveness and the Navy's S&T strength.

As you know, the production of STEM graduates in the U.S. is not keeping up with either the U.S. demand or international competition. Yet only fifteen percent of bachelor's degrees earned by U.S. students are in STEM fields. Additionally, if one looks at the breakdown of students receiving STEM degrees, the number of underrepresented minorities and women does not reflect the demographics of our nation. Given that we expect a shortage in STEM fields in the future, these trends need to be attacked now. Additionally, these trends are countered by STEM growth in countries like China and India, with obvious implications for our long term security.

The purpose of the Navy's STEM program is to help reverse these negative trends and ensure a base for a strong, STEM literate Naval workforce in the future. ONR/NRL investments represent nearly 70% of the overall Naval services investments in STEM. The Secretary of the Navy committed to doubling the Navy's investments in STEM over the next five years,

compared with FY 2010. Our investments seek to increase the diversity and numbers of students pursuing STEM degrees and encourage collaboration among the government and best practice organizations, universities and industry. Our areas of emphasis include: 1) freshman and sophomore retention; 2) middle school, hands-on STEM learning programs in urban and rural settings; 3) teacher training; and 4) advanced Ph.D. and post-doctoral support. Perhaps most importantly, our newest programs incorporate both Naval relevant content and metrics for measuring impact and will have to be coordinated, for maximum impact, with other Federal STEM education programs.. Further, these programs were selected based on their potential for rapid growth and geographic expansion.

Innovative Naval Prototypes

Innovative Naval Prototypes (INP) involve 10 percent of the S&T budget and focus on high-risk/high-payoff opportunities emerging from the D&I portfolio that can significantly impact Naval capabilities if we can mature the technology. INPs are discontinuous, disruptive, radical departures from established requirements and operational concepts. Approved and overseen by the Naval S&T Corporate Board (Assistant Secretary of the Navy for Research, Development and Acquisition (RD&A), Assistant Commandant of the Marine Corps and Vice Chief of Naval Operations), the goal is to prove concepts and mature technology within 4-8 years, allowing informed decisions about risk reduction and transition into acquisition programs.

We have seven current INPs:

The Free Electron Laser (FEL) INP will bring laser technology to sea for ship offense and defense against a variety of threats. The FEL will develop a laser that is dynamically tunable to atmosphere-penetrating wavelengths for use in maritime environments. This will allow us to assess the potential of Megawatt class laser-based shipboard defense that includes tracking, discrimination, countermeasures, and scalable direct fire at the speed of light. The FEL is designed to defend against current and future surface and air threats, anti-ship cruise missiles, small boat swarms, and other asymmetric threats.

The Integrated Topside INP will enable Navy to dominate the electromagnetic spectrum through development of multifunction apertures for all ship classes. We are developing: 1) open architecture for Radio Frequency (RF) equipment, plus computer hardware and software that will enable industry to contribute to development of affordable new systems and upgrades, and 2) modular systems that enable the same technology to be scalable across all Naval platforms to significantly reduce logistics, training, and maintenance costs.

The Electromagnetic Rail Gun (EMRG) INP continues to develop and test a scalable, more powerful gun, using non-explosive rounds with no gun propellant. The EMRG has more than doubled current state of the art muzzle energy. The program continues to achieve a limited set of technical objectives while initiating Phase Two of the program. EMRG will provide multi-mission capability for long range, persistent, precision fire without unexploded ordnance issues, while increasing magazine capacity, and decreasing total cost. If current research goes as hoped, Projectiles will eventually fire at a muzzle velocity of Mach 7.5 and reach targets 200+ nautical miles away in less than six minutes, impacting at a velocity exceeding Mach 5. In addition to

Naval surface fire support, Navy is examining lower power, accelerated opportunities for Anti-Surface Warfare and self defense applications with nearer term capability against cruise missiles and other challenging targets. Contractors have built and tested pre-prototype tactical launchers. I invite all of you to schedule a visit to our test bed facility at the Naval Surface Warfare Center at Dahlgren, Virginia and am grateful to your staff members who have already made the visit.

The Large Diameter Unmanned Undersea Vehicle (LDUUV) INP is developing a reliable, long endurance UUV capable of extended operation in cluttered littoral environments. The program will develop the needed energy, autonomy and core UUV systems to operate in a complex ocean environment near harbors, shore, and high surface traffic locations. Key goals include doubling current UUV energy density, and using open architecture to lower costs, while enabling full autonomy in over the horizon operations. Achieving these goals will reduce Naval platform vulnerability, while enhancing warfighter capability and capacity gaps in critical mission areas.

The Autonomous Aerial Cargo/Utility System (AACUS) INP is working to develop intelligent, autonomous capabilities for an aerial cargo/utility system that can provide timely, affordable, reliable shipboard-compatible supply and retrograde. Our challenges include dynamic mission management en-route and using unprepared landing zones under demanding conditions. Potential solutions involve modular capabilities developed on open system architecture, novel human interfaces (to include optional manning), low impact (size, weight, power, and cost) sensors, and multiple flight demonstration and upgrade cycles.

The Persistent Littoral Undersea Surveillance (PLUS) INP is developing an autonomous over-the-horizon Anti-Submarine Warfare (ASW) system that removes humans and manned platforms for detection, location, classification and tracking of submarines. The PLUS INP demonstrates the utility of clandestine unmanned undersea vehicles employing ASW sensors with flexible deployment capabilities. The PLUS INP also provides a number of other technologies that expand our understanding of autonomous operations and help hasten this future capability.

The Sea Base Enablers INP selected three Transformation Craft (T-Craft) concepts for tests to characterize relative motion between vessels, evaluate ramp excursions, and quantify force and structural loads. Results were correlated with computer prediction models, and provided to the design teams for incorporation into technology development. We are completing the program with prototype construction and demonstration of key technology components in FY 2012.

Future Naval Capabilities

Our Future Naval Capability (FNC) program is the most critical component of our transition strategy. FNC investments align the “requirements-driven, transition-oriented” portion of the S&T portfolio to Naval Capability Gaps identified by the Office of the Chief of Naval Operations (OPNAV) and Marine Corps Combat Development Command (MCCDC). FNCs are near-term projects in the 30 percent of our budget focused on Acquisition Enablers. The FNC process delivers mature technologies to acquisition sponsors for incorporation into systems that provide new capabilities to the warfighter.

FNCs are based on earlier D&I investments, where technology has matured to the point that it can achieve a Technology Readiness Level (TRL) of 6 or better within 3-5 years. FNC projects are selected annually to address specific capability gap needs, with final prioritization approved by a 3-Star Technology Oversight Group (TOG) representing OPNAV, United States Marine Corps (USMC), U.S. Fleet Forces Command (USFF), Assistant Secretary of the Navy (ASN-RDA) and ONR.

Approved technology products are required to have Technology Transition Agreements that document the commitment of the resource sponsor, acquisition program, and ONR to develop, deliver and integrate products into new or upgraded systems to be delivered to the Fleet/Force. Every FNC product's progress and status is reviewed annually. Products that no longer have viable transition paths are terminated with residual funding used to solve unexpected problems with existing projects, or start new projects in compliance with Navy priorities.

The measure of FNC success is whether projects meet technology requirements and exit criteria, and whether acquisition sponsors have transition funds in their programs to accept and integrate FNC products. Products with planned transition funds usually transition after risks are mitigated, a definitive plan finalized, and required funding programmed.

Increases and Decreases in FNC Funding

As I stated last year, FNC investments focus on the most pressing capability gaps, generating year-to-year changes in funding for related Program Elements (PEs). As FNC products mature, Technology Readiness Levels (TRL) change, moving products from 6.2 to 6.3 PEs. Year one is predominantly 6.2; the final year predominantly 6.3 – with a mix of 6.2/6.3 in-between. When products transition to Advanced Component Development and Prototypes (6.4) and Engineering and Manufacturing Development (6.5) funding, new FNC products do not always begin in the same PE as those completed. While resulting changes may appear to be program growth, they actually reflect realignment of funds in response to successful transitions – coupled with reprioritization and new starts based on evolving Naval needs and requirements.

S&T Highlights

The Naval S&T portfolio includes a range of projects entering the Fleet/Force or about to enter in a short time. Following are examples of these efforts outlining the impact they will have on Sailors and Marines, today and in the future.

Power and Energy

ONR continues to invest in advanced technologies to boost platform power for improved warfighter capability and to increase energy efficiency to enhance platform endurance and reduce warfighter dependence on fossil fuels. Our S&T focus is on technologies and system architectures that increase both power density and energy efficiency. These efforts directly support the Navy's energy strategy and SECNAV's energy goals of sailing a Green Fleet in 2016 and increasing Department of the Navy (DoN) energy consumption from alternative sources.

Defense Department energy security requirements are driven by a variety of factors: 1) U.S. oil sources may not be stable, 2) price volatility impacts, 3) modern military systems use of energy is increasing, and 4) the logistics of moving fuel can limit combat operations and put warfighter lives at risk. Anyone watching recent news reports has a heightened awareness of each of these factors. In addition, there exist ongoing concerns about international economic manipulation, unexpected energy requirements associated with humanitarian relief, energy requirements associated with future systems, grid vulnerability, and climate instability. These are not new issues and have been studied by the Navy and Defense Department in a systematic fashion throughout the past decade.

ONR's role in energy technologies is to support unique Naval research, leverage government and commercial R&D investments, support workforce development in energy technology areas to meet unique Naval requirements, support test bed evaluations, and be an early adopter of technologies for shore facilities and platforms. These unique Naval areas include fuel, power generation, energy storage, energy distribution and control, and power loads for ships, aircraft, unmanned vehicles and expeditionary systems.

As just one example of practical implementation of our efforts, just over a year ago, Secretary of the Navy Mabus and Secretary of Agriculture Vilsack signed a Memorandum of Understanding between the Department of the Navy and Department of Agriculture with respect to development of advanced bio-fuels and other renewable energy systems. These include wind, solar, hydrokinetic, ocean thermal, and geothermal for electricity generation, and land for energy crops that can be refined into bio-fuels to meet both military and commercial transportation needs. In support of the MoU, ONR established a joint research program with the Agricultural Research Service to look at biomass sustainability with initial work focused in Hawaii.

Our objective is to accelerate the adoption of bio-fuels and blended logistic fuels by supporting Navy certification processes, and understanding and mitigating the impact of emerging fuels on Naval power systems and operations. To achieve these goals, we have invested in research about engine performance, materials compatibility, fuel stability, and bio-fuels and renewable energy.

In partnership with the Defense Advanced Research Projects Agency (DARPA), and the Electric Ship Research and Development Consortium (Florida State University, Massachusetts Institute of Technology, Mississippi State University, Purdue University, University of South Carolina, University of Texas at Austin, U.S. Naval Academy and others), we are moving toward the Navy's All Electric Ship. These programs include development of ONR systems such as EM Railgun and Free Electron Lasers, partnership with DARPA in Silicon Carbide Wide Band-Gap Power Electronics research, and Consortium efforts to develop advanced power concepts and new test and evaluation tools with emphasis on Naval applications.

We are exploring affordable long-endurance fuel cell power, with low noise and heat signature, to meet extended range mission requirements for unmanned air vehicles. We are also exploring advanced platform designs, launch and recovery, and autonomous operation of unmanned sea (surface) vehicles, as well as air independent power systems and lithium-ion battery safety for unmanned undersea vehicles. In addition, ONR is working to develop aviation propulsion and turbine engine technologies to identify and mature critical, relevant variable/adaptive cycle

system technologies for the next generation of carrier-based aircraft, while ensuring affordability and operational readiness.

Operations in Afghanistan forced the Marine Corps to reevaluate energy distribution and use in expeditionary environments. Marines operate over long distances in austere environments, and we are actively pursuing a wide range of ways to address the challenges of providing them with energy when and where they need it. These include lessening energy consumption and dependence on fossil fuels, while achieving resource self-sufficiency. S&T efforts focus on energy requirements of individual Marines, small dispersed units, and the tactical vehicle fleet. Investments in battery technologies, portable power generation, advanced power generation from JP-8 fuel, and renewable energy from solar power, combined with technologies that reduce fuel consumption, allow greater mobility and on-board power for tactical vehicles. These projects significantly reduced energy consumption and usage in expeditionary environments. A notable example is the Ground Renewable Expeditionary Energy System (GREENS) being used in Afghanistan where platoon level bases are powered solely via solar power. Ongoing additional evaluation of non-tactical hydrogen-powered General Motors fuel cell vehicles is occurring at Camp Pendleton and being expanded to Marine Corps Base Hawaii at Kaneohe Bay, in coordination with the other services and the Department of Energy.

Additional research developed the widely used Navy Reverse Osmosis Advanced Research Shipboard Desalination System, as well as the Expeditionary Unit Water Purification (EUWP) system. Developed for USMC expeditionary operations, EUWP was used in the aftermath of Hurricane Katrina at the Biloxi regional hospital and Port of Pascagoula, by the U.S. Coast Guard Station at Port Clarence, Alaska, and on the Macah Indian Reservation at Neah Bay, Washington. ONR also developed a Plasma Arc Waste Destruction System (PAWDS) for the new generation of aircraft carriers that is now being used by cruise lines, and the Micro Auto Gasification System (MAGS) for use in USMC expeditionary operations.

Some of the research in installation energy demand is dedicated to adopting energy efficient structural design practices, and designing energy neutral or low energy structures to simplify incorporation of alternative energy systems – such as at Ilima Middle School on Oahu. Advanced structural concepts provide low cost, energy efficient facilities that are easy to install – and can be *energy positive* by exporting power to a grid. In partnership with the Naval Facilities Command, Hawaii is also the site of ONR research in Ocean Thermal Energy Conversion where a heat exchanger test facility has been recently installed at the Natural Energy Laboratory Hawaii Authority (NELHA) facility at Kona.

Manpower, Personnel, Training and Education

ONR's Capable Manpower FNC is developing innovative products to support Human Capital programs, including manpower, personnel, training, and human systems design products. These will optimize performance, minimize personnel costs, and ensure systems are built to accommodate users that will operate, maintain, and support the systems. Capable Manpower will develop a suite of integrated analytical tools to assist managers to forecast and assess effects of enlisted/officer behavior (recruitment, retention, career decisions, education benefits, etc.) resulting from current and proposed Navy policies. These tools will help meet the CNO/SECNAV goal of creating a

workforce that integrates the total force and adopts personnel policies to make Navy competitive in the marketplace. Another goal is to improve availability and reliability of critical information needed by the command team. To achieve this goal, the program will develop information architecture for combat control rooms blending key elements of information processing, team structure, and display techniques. This program will improve operational decision making by transforming information flow from data-centric architecture requiring significant cognitive effort to integrate and validate the tactical picture – to decision-centered architecture that frees the command team to allocate more cognitive energy to the complexity of the mission. This architecture will guide information system design, manning and training for the submarine Ohio Replacement program control room, as well as surface combatant combat information centers. A unique human systems design approach is developing processes, methods and software specifications to merge the full spectrum of human systems integration into Navy's standards-based, open-architecture, Integrated Product Data Environment for production ship design. The prototype is also focused on the submarine Ohio Replacement program and will demonstrate decreased acquisition and ownership costs while increasing effectiveness of the resulting system.

Infantry Immersion Trainer

The Infantry Immersion Trainer (IIT) is a revolutionary training system that prepares Marines and Sailors for deployment to today's battlefield. The facility uses virtual reality, physical structures, gaming avatars, pyrotechnics, and live role players – simulating a Southwest Asian village in the midst of combat – to give troops necessary skills to win and survive in battle. Equipped with laser-tag-like weaponry, Marines, Navy Corpsmen, and Army soldiers, walk through realistic dwellings and alleys – including sounds and smells – encountering civilians and enemy combatants. The IIT confronts warfighters with a range of scenarios requiring split-second decisions. High-tech simulation provides a safe, realistic, training environment for learning how to prevent fatal errors before exposure to real threats, with the goal of "making the first fight no worse than the last simulation." The IIT incorporates ONR technologies, DARPA RealWorld game-based simulation system, and technologies sponsored by the Army Research Development and Engineering Command's Institute for Creative Technologies at the University of Southern California. ONR continues to support technology upgrades to the IIT at Camp Pendleton and the IIT under construction at Camp Lejeune.

Marines in Operational Environments

Marines must be able to destroy enemy formations in major contingencies, and be equally able to employ superior Irregular Warfare (IW) skills. ONR took the technology lead in balancing traditional and IW capabilities by providing quantifiable technical advantages to warfighters in Afghanistan. While IW favors indirect, asymmetric approaches, it may employ the full range of military and other capabilities, in order to erode an adversary's power, influence, and will. The Marine Air-Ground Task Forces (MAGTF) of the future must be leaner in equipment. ONR initiatives help reduce the load of Marines and Sailors through lighter materials and technologies, while providing enhanced protection in combat. We initiated a focused approach designed to lighten the load of individual Marines, as well as the MAGTF. Depending on the situation, the weight of gear for a Marine in Afghanistan can average 90 pounds. ONR continues to pursue the latest technology to provide Marines with scalable protection based on mission and threat. The

use of unmanned aerial vehicles and robotics for logistics delivery are capabilities equally applicable to IW and traditional warfare. ONR led efforts to improve survivability of USMC tactical vehicles. Efforts to develop optimized fiber composite materials, amenable to advanced high volume fabrication techniques, and active protection systems for vehicles against rocket propelled grenades and missiles make Marine forces more agile, lethal, mobile and survivable.

Improvised Explosive Devices (IEDs)

IEDs represent a persistent and lethal challenge. Continuing work with the Joint IED Defeat Organization (JIEDDO), ONR efforts aim at attacking IED networks and devices across the entire kill chain, and training our forces. Working with other agencies, ONR is investing in prediction efforts involving terrorist activity: bio-forensic profiling to trace origin, factory location, support networks, placement, and dynamic analysis of suicide bombing. Scientists at Columbia, Drexel, University of Miami, and others in ONR's Automated Image Understanding (AIU) program developed computational methods and algorithms for recognizing hundreds of object categories – including tracking and analysis of human behavior. Our intent is to develop automated identification of people and behavior to highlight potentially threatening situations.

Near-term initiatives include the Advanced Technology Development efforts to neutralize IEDs through improved countermeasures as well as locating and directly attacking devices. Long-term S&T includes sensing systems for detection/tracking of explosive components in ports, coastal, and ocean environments. Efforts are underway to develop man/machine interfaces with the goal of developing unmanned, autonomous systems to separate warfighters from hazardous missions, providing increased economy of force. ONR's emphasis on autonomy and development of unmanned systems technologies is embedded throughout the S&T portfolio.

Naval Medical Research

ONR's medical research investments include a large variety of basic through applied efforts addressing pre-deployment care and injury prevention, point-of-injury care, en route and automated care, and post-deployment care, treatment, and restoration. The overarching goals are the prevention and treatment of outcomes that negatively impact warfighter health. Major areas of focus are trauma medicine, casualty prevention, stress physiology, undersea medicine and noise induced hearing loss. Trauma medicine efforts include the development of low-volume resuscitation fluids or medical treatments that are easily stored in ambient temperature, affordable, and administered by the individual. Casualty prevention and stress physiology programs include the characterization of blunt trauma effects, models of the physical and cognitive effects of blast exposure, stress and fatigue management, and the prevention of injury associated with operating in military environments. Undersea medicine, a National Naval Responsibility program, focuses on submarine and diver health and performance with specific emphasis on developing novel strategies that address the health threats associated with decompression illness and oxygen toxicity. ONR is the lead DOD agency for the noise induced hearing loss program with efforts aimed at understanding the physics of noise, reducing noise at the source, monitoring noise exposure and designing new protective equipment, and developing pharmaceuticals for hearing loss prevention and treatment.

Affordable Platforms

Technologies to achieve Total Ownership Cost reduction while maintaining or improving system and platform performance are embedded throughout the S&T portfolio. ONR efforts such as the Navy Manufacturing Technology (ManTech) Program and the Enterprise and Platform Enablers FNC contribute to affordability in acquisition programs and throughout the lifecycle of systems and platforms. ManTech continues to focus on technologies to reduce costs of processing and fabrication for composites, electronics and metals, shipbuilding and repair technology, with technical engineering support with demonstrated savings for DDG 1000, CVN 21, Littoral Combat Ship, and VIRGINIA Class Submarines. The VIRGINIA Class Submarine Affordability Initiative, focused on acquisition cost savings since FY 2006, realized cost savings in Block III totaling over $20 million per hull to date. With projected planned investment of approximately $62 million, savings are estimated to grow to over $32 million per hull.

Modular Open System Architecture

Technology is advancing at an ever-increasing rate. Modular open system architecture enables Navy to procure, modernize and integrate complex systems for all classes of ships, enabling affordable upgrades for new technical advances in response to new threats. One example is the multi-function Electronic Warfare-Electronic Sensing (EW-ES) system ONR delivered to Program Executive Office – Integrated Warfare Systems (PEO-IWS). The system met operational requirements with scalable, open system architecture, allowing S&T results to be used not only for DDG 1000, but for scaled back-fit of all ships requiring EW-ES capability. Similarly, the Affordable Common Radar Architecture program developed architecture for future radars in which the system is divided into frequency independent subsystems which need be developed only once. They can be used for all radars regardless of frequency dependent subsystems, enabling Navy to procure the best components from any company and affordably upgrade only necessary elements. This led ONR to bring together system integrators with acquisition components to develop Naval Radio Frequency (RF) modular open system architecture for the Integrated Topside INP. This will enable Navy to use modular construction to procure RF communications, moderate to low power radar, and electronic warfare capability across ships with common RF hardware. In turn, this will reduce developmental acquisition, training and maintenance costs, while enabling affordable upgrades that can keep agile pace with technology and the threat.

Information Dominance and Autonomy

The Naval services need for information dominance – without growth in manpower – must be achieved through fundamental advances in automated understanding and integration of highly diverse sensor and open source data, as well as the ability to automatically provide assessment and warning. ONR advances in automated image and video understanding in the 1990s became the foundation for many image and video industry standards today, as well as algorithms used by the National Geospatial Intelligence Agency, other intelligence organizations, and industry. We also invested in advancing the science of understanding, manipulating, and integrating so-called "soft" data such as human intelligence and open source data.

Even after the integration of large volumes of data, the task of assessing results across a dynamic battlespace is formidable, and currently requires extensive manpower. To automate this requires major advances in machine reasoning and intelligence. ONR sponsored workshops with the Air Force, Army, DARPA, academia, industry, and other DoD participants to focus on critical issues and identify promising opportunities and high priority S&T investments. This research forms the essential foundation enabling large, diverse, mission-focused autonomous sensor/information networks for supporting rapid, accurate decision-making by commanders in the battlespace.

Understanding Ocean Environments

Understanding the marine environment as a coupled system of atmosphere and ocean is critical for Naval operations including: Anti-Submarine Warfare, Mine Counter-Measures, Surface Warfare, and Naval Special Warfare. Although our capabilities steadily increase, there remains much to learn about ocean processes. One of our challenges is to better understand how tides mix ocean water masses to create currents which affect propagation of sound in the ocean. Our goal is to capture the worldwide effect of tides in our prediction systems. ONR conducts research in partnership with the National Science Foundation and agencies in the University National Oceanographic Laboratory System (UNOLS) to allow joint scheduling and operations for the fleet of research ships used by academic oceanographers. In addition, ONR supports S&T investments dedicated to effective and responsible stewardship of the marine environment, including assessing the impact of national security activities on marine mammals.

Small Business Innovation Research (SBIR)

Unique among S&T tools are the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, which apply a combined 2.8% of externally-executed Navy Research, Development, Test and Engineering (RDT&E) funding to high-priority warfighter needs identified by Fleet/Force acquisition programs. Funded at $343 million in FY10 ($384 million when combined with the complementary STTR program), Naval SBIR focuses on ensuring quick, cost-effective delivery of innovative small business technologies to the Fleet/Force.

Naval SBIR supports delivery of innovative technology, providing incentives to ensure timely engagement by prospective customers and investors. Phase I awards of approximately $150 thousand each (with 545 awards in FY 2010) include a base-plus-option strategy to ensure business continuity as Proof of Principle is established. Phase II awards of approximately $1 million each to mature project work (with 296 awards in FY 2010) include a similar funding strategy with technology decision-gates that ensure continuous engagement with acquisition programs to verify “technology pull” from Naval customers. Naval SBIR customer engagement extends to industry through dialogue about technology innovation, including events such as our annual *Navy Opportunity Forum*, where innovators, industry and government customers learn about small business innovation opportunities.

Naval SBIR used the FY 2006 congressionally-mandated Commercialization Pilot Program to accelerate the transition of technologies, products and services developed under SBIR into Naval acquisition pipelines. This led Navy to develop flexible funding mechanisms and application of

Transition Assistance Program tools for SBIR award-winners, helping make SBIR projects more attractive to DoD and industry investors. Naval SBIR makes a valuable contribution to S&T innovation, Naval RDT&E, acquisition programs, small business development and job creation.

ONR Global

There is a worldwide dimension of S&T reflected in over 100 percent growth in global S&T investment over the last ten years. When Congress established NRL in 1916 and ONR in 1946, the U.S. was arguably the world wide leader in S&T development and innovation. However, the U.S. monopoly no longer exists, making it imperative that we keep our finger on the pulse of S&T in the international environment. Beginning with the establishment of our London office in 1946, ONR established offices in Santiago, Prague, Tokyo and Singapore, closely coordinated with the other services and the Assistant Secretary of Defense (Research and Engineering). These offices provide our window on S&T developments in South America, Europe, and Asia.

The purpose of our effort is to search the globe for emerging scientific research and advanced technologies that enable ONR to address both current Fleet/Force needs, as well as requirements of future Naval missions and capabilities. We do this by working through ONR Global offices to establish new contacts and leverage relationships with international leaders in relevant research fields. This allows us to gain new perspectives and expertise, identify geographically significant trends and advances, and help forecast global trends and threats. It also enables us to recruit the world's best and brightest in research partnerships that benefit U.S. forces and allies.

ONR Global programs include the Science Advisor Program which communicates Fleet/Force capability needs to the Naval Research Enterprise (NRE) (consisting primarily of the Navy labs, warfare centers and affiliated universities) and facilitates the development of solutions that can transition back to the Fleet/Force. Program participants are typically engineers who coordinate and conduct Naval experimentation, develop prototype solutions, define transition options, and collaborate with Fleet/Force to define S&T investment needs to meet future Naval requirements.

To increase Naval awareness of global technology, our International Science Program provides scientists from academia, government and industry opportunities to engage leading international scientists and innovators. Our worldwide technical staff helps establish relationships with international leaders in relevant fields, establish direct collaboration between ONR and NRL scientists and their foreign counterparts, and identify significant trends, accomplishments, and centers of excellence for Naval S&T. This strengthens our ability to forecast both trends and threats in global S&T, and avoid technological surprise.

Conclusion

Thank you for the opportunity to discuss Naval S&T. The FY 2012 President's Budget request will enable us to continue moving toward greater integration of capabilities, more effective partnership between research and acquisition, and a clearer vision of how to achieve shared goals among the Army, Air Force, DARPA and other DoD research organizations. At the same time, we continue to focus most of our investment on external performers – outside the Naval R&D system – in order to tap into the full spectrum of innovative thinking and discovery, and to

accelerate transition of appropriate technologies to civilian use. For example, algorithms developed for sonar signal processing have been adapted and are now used for improved Breast Cancer detection.

For all of these reasons, I believe the state of our S&T investments is sound; represents careful stewardship of taxpayer dollars; and will significantly enhance the safety and performance of our warfighters as they serve in defense of the United States, today and in the future. Thank you for your support.