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HOUSE ARMED SERVICES COMMITTEE
INTELLIGENCE, EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
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BEFORE THE
INTELLIGENCE, EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
HOUSE ARMED SERVICES COMMITTEE
ON
THE FISCAL YEAR 2015 BUDGET REQUEST

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Introduction

It is an honor to report on Department of the Navy (DoN) Science and Technology (S&T) and discuss how the President's FY 2015 Budget supports the Navy and Marine Corps (USMC). The FY 2015 Budget requests approximately $2 billion for Naval S&T. The Navy and Marine Corps use S&T to enable the Fleet/Force to maintain the technological edge necessary to prevail in any environment where we may be called to defend U.S. interests. We work with the Secretary of the Navy (SECNAV), Chief of Naval Operations (CNO) and Commandant of the Marine Corps (CMC) to balance the allocation of resources between near-term technology development and long-term research. We strive to improve affordability, communication with the acquisition community, and engage with stakeholders.

Science and Technology Strategic Plan

The Naval S&T Strategic Plan guides our investments and is regularly updated by Navy and USMC leadership to validate alignment of S&T with current missions, leadership priorities, and future requirements. It ensures S&T has long-term focus, meets near-term objectives, and makes what we do clear to decision makers, partners, customers and performers. The Plan identifies nine areas that help to focus S&T to meet Navy/USMC needs: 1) Assure Access to Maritime Battlespace, 2) Autonomy and Unmanned Systems, 3) Expeditionary and Irregular Warfare, 4) Information Dominance, 5) Platform Design and Survivability, 6) Power and Energy, 7) Power Projection and Integrated Defense, 8) Total Ownership Cost, and 9) Warfighter Performance. 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. Beginning with the evolution of current systems through incremental improvement and spiral development of known technology, we move toward exploiting yet-to-be-discovered, disruptive, game-changing technologies. The S&T Strategic Plan and focus areas are currently under review and will be updated in the near future.

Implementing the Strategy

Based on time-to-delivery and specification of need, Naval S&T can be viewed as fitting into four primary areas – Discovery and Invention (D&I), Leap Ahead Innovations (Innovative Naval Prototypes/INP), Acquisition Enablers (Future Naval Capabilities/FNC), and a Quick Reaction capability to respond to emerging requirements. Our S&T portfolio balances a range of complementary but competing initiatives by supporting advances in established operational areas – while sustaining long-term research that may prove disruptive to traditional operational concepts.

Discovery and Invention

Discovery and Invention (D&I) includes basic research (6.1) and early applied research (6.2) in areas essential to Naval missions, as well as emerging areas with promise for future application. D&I develops fundamental knowledge, provides a basis for future Navy/Marine Corps systems, and sustains our Scientist/Engineer workforce. D&I develops knowledge from which INP, FNC, and Quick Reaction efforts are generated and is the foundation for advanced technology.

Approximately 45 percent of ONR investments are in D&I, with roughly 60 percent of that total executed by academic and non-profit performers. D&I is peer reviewed by outside experts who independently assess scientific merit – and overseen by ONR program officers and senior leadership. Investment decisions are guided by risk, impact, significance, originality, principal investigator, and budget resources.

ONR's University Research Initiative (URI) includes the Multidisciplinary University Research Initiative (MURI), the Defense University Research Implementation Program (DURIP), and the Presidential Early Career Award for Scientist and Engineers (PECASE). MURI supports teams of researchers investigating topics that intersect multiple technical disciplines. DURIP provides grants for the purchase of instrumentation necessary to perform research essential to the Navy. PECASE recognizes achievements of young scientists/engineers and encourages them to explore professions in academia and Naval laboratories. The Basic Research Challenge funds promising research not addressed by ONR's core program. The Young Investigator Program supports scientists and engineers with exceptional promise for Naval research. Research opportunities for undergraduate and grad students, fellows, and future faculty members are provided by the Naval Research Enterprise Internship Program (NREIP), where participants work at Naval laboratories and warfare centers. The In-House Laboratory Independent Research (ILIR) and Independent Applied Research (IAR) programs sponsor critical research, while furthering the education of scientists and engineers at warfare centers. ONR also brings Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) together with Naval laboratories and warfare centers to give students hands-on experience in the Naval research environment.

Supporting warfighters depends on our Science, Technology, Engineering and Mathematics (STEM) workforce – but that workforce is aging. With half of Navy science and engineering professionals retirement eligible by 2020, we face an acute shortfall in our Naval engineering, computer science and ocean engineering workforce. Production of engineers has been flat for two decades, and less in specialty fields. A complicating factor is that DoN must rely on U.S. citizens for classified work; the number of U.S. citizen STEM graduates will not keep up with domestic or international competition for the same talent. ONR evaluates STEM investments with metrics tailored to measure numbers of students and teachers, overall impact, and overall ability to achieve Naval requirements in coordination with other federal STEM programs.

Leap Ahead Innovations (Innovative Naval Prototypes)

Innovative Naval Prototypes (INP) total about 12 percent of the S&T budget. INPs are high-risk/high-payoff opportunities from D&I that are discontinuous, disruptive departures from established requirements and operational concepts that can dramatically change the way Naval forces fight, while reducing acquisition risk. Overseen by the Naval Research, Development, Testing and Evaluation (RTD&E) Corporate Board (Undersecretary of the Navy; Assistant Secretary of the Navy for Research, Development and Acquisition (ASN-RDA); Vice CNO; Assistant CMC; Director of Innovation, Test, and Evaluation and Technology Requirements; Deputy Assistant Secretary of the Navy for RDT&E; and Deputy Under Secretary of the Navy for Plans, Policy, Oversight and Integration), the goal is to prove concepts and mature technology in 4-7 years, allowing informed decisions about risk reduction and transition to acquisition programs. INP Program Managers and Deputies are from ONR and the acquisition community.

INPs include:

Integrated Topside (InTop) will enable the Navy to operate freely in the electromagnetic spectrum while denying adversaries' ability to do the same through development of multi-beam, multi-function ultra-wideband apertures and Radio Frequency (RF) equipment for all ship classes. We are developing Electronic Warfare, Information Operations, Radar, Satellite, and Line of Sight Communications using: 1) open architecture RF hardware/software to enable a broad industrial base to contribute to development of affordable systems, and 2) modular systems to enable technology to be scalable across Navy platforms and reduce logistics, training, and maintenance costs. We continue prototype tests/demonstrations with testing by the Naval Undersea Warfare Center (NUWC) for submarine Satellite Communications (SATCOM) and by the Naval Research Laboratory (NRL) for the Surface Electronic Warfare Improvement Program (SEWIP). Accomplishments include over the air testing of the Submarine Wideband SATCOM Antenna transmitter, integration of all antennas and electronics for the Electronic Warfare/Information Operations/Line of Sight Communications Advanced Development Model, building the Low Level Resource Allocation Manager, and award of the Flexible Distributed Array Radar contract.

The Large Displacement Unmanned Undersea Vehicle (LDUUV) program is developing a reliable, fully autonomous, long endurance UUV capable of extended operation (60+ days) in cluttered littoral environments. The program has already built three vehicles and is developing the energy, autonomy and core systems to operate in a complex ocean environment near harbors, shorelines, and other high traffic locations. Key goals include doubling current air-independent UUV energy density, using open architecture to lower cost, and enabling full pier to pier autonomy in over-the-horizon operations. Achieving these goals will reduce platform vulnerability, enhance warfighter capability and safety, and close gaps in critical and complex mission areas by extending the reach of the Navy into denied areas.

The Autonomous Aerial Cargo/Utility System (AACUS) is developing intelligent, autonomous capabilities for rapid, affordable, reliable rotorcraft supply in permissive, hostile and GPS-denied settings. AACUS-enabled aircraft will be supervised by field personnel from a handheld device. Challenges include dynamic mission management and contingency planning, as well as landing execution and obstacle avoidance. AACUS has already demonstrated numerous successful flights and is designed for open system architecture to promote modularity and affordability. It could be used in logistics missions, Casualty Evacuation (CASEVAC), combat rescue, and humanitarian aid missions. S&T partners include the Air Force, Army, USMC, National Aeronautics and Space Administration (NASA), Naval Air Systems Command (NAVAIR), and other academic, private sector, and government organizations.

The Electromagnetic Railgun (EMRG) has multi-mission potential for long-range land-attack, ballistic and cruise missile defense, and anti-surface warfare against ships and small boats. Fired by electric pulse, Railgun eliminates gun propellant from magazines resulting in greater resistance to battle damage. Since 2005, launch energy has advanced by a factor of 5 (to 32 mega joules) with potential to launch projectiles 110 nautical miles. Projectile design is underway, with early prototype testing, component development, and modeling and simulation.

Barrel life has increased from tens of shots to over 400, with a program path to achieve 1000 shots. Advanced composite launchers have been strength tested to operational levels. Physical size of the pulsed power system was reduced by a factor of 2.5 through increased energy density so the system will fit in current and future surface combatants. Current research is focused on a rep-rate capability of multiple rounds per minute which entails development of a tactical prototype gun barrel and pulsed power systems incorporating advanced cooling techniques. Components are designed to transition directly into prototype systems now being conceptualized. ONR is working with Naval Sea Systems Command (NAVSEA) and the Office of the Secretary of Defense (OSD) Strategic Capabilities Office to ensure commonality and reduce the need for expensive redesign. Developmental tests are ongoing at Naval Surface Warfare Center, Dahlgren and NRL, along with evaluations of integration into new and existing Naval platforms.

Electromagnetic Railgun testing aboard a Joint High Speed Vessel (JHSV) will begin in 2016 and utilize components largely in common with those developed and demonstrated at Dahlgren. At-sea testing is one of the critical events planned in coming years to demonstrate multi-mission capability. At-sea tests capture lessons learned for incorporation into a full future tactical design and allow us to understand any potential modifications before fully integrating the technology on our ships. Further, it will gather data to support design for reliability and sustainability related to Railgun operation in a marine environment.

Finally, although similarly high-risk and disruptive, SwampWorks programs are smaller than INPs and intended to produce quick results in 1-3 years. SwampWorks efforts have substantial flexibility in planning and execution, with a streamlined approval process. Formal transition agreements are not required, but SwampWorks programs have advocates outside ONR, either from the acquisition community or Fleet/Force. SwampWorks products are frequently inserted into Fleet/Force experimentation.

Directed Energy Roadmap

Development and ship integration of energy-intensive systems such as Directed Energy Weapons (DEW) (e.g. high-energy lasers (HEL) and High Powered Radio Frequency (HPRF)) and EMRG requires careful engineering. Shipboard integration considerations include space, weight, power, cooling, stability, impact on combat systems, fire control, and interfaces. Technical maturity and integration will be accomplished through a measured approach to allocation of ship services and interface with ship systems.

Navy's near-term focus is on a Solid State Laser Quick Reaction Capability (SSL-QRC), which will field a prototype system based on the Laser Weapon System (LaWS), and the Solid State Laser Technology Maturation (SSL-TM) program. The Navy plans to deploy SSL-QRC (LaWS) to the Persian Gulf aboard USS PONCE in 2014 to demonstrate the ability to meet gaps in ship self-defense against armed fast boats and unmanned aerial vehicle threats. Navy is also investigating the use of non-lethal HPRF technologies for vessel stopping and counter UAS. Development continues on Free Electron Laser technologies for long-term solutions requiring power levels beyond that which Solid State Lasers can deliver.

SSL-TM will help determine the load capacity and most effective means to integrate a HEL on surface ships such as DDG-51 and the Littoral Combat Ship. The SSL-TM goal is to demonstrate a 100-150 kilowatt Advanced Development Model (ADM) by 2016. The program will address technical challenges in rugged laser subsystems, optics suitable for maritime environments, and capability to propagate lethal power levels in the maritime atmosphere. The SSL-TM prototype will be sufficiently mature to commence an acquisition program of record.

Progress on technologies covered in the Naval DE Roadmap efforts (HEL, HPRF) and EMRG are projected to result in capabilities that meet future requirements. As part of the Navy's Two-Pass Six-Gate review process for major acquisition programs, a Gate 6 Configuration Steering Board (CSB) is conducted annually for each ship class. Once a DEW achieves maturity, the CSB reviews technology, requirements, and cost to determine if transitioning to acquisition program and incorporation in a ship class is warranted. If warranted, the CSB determines on which hull the technology will be incorporated. For technology that provides significant capability but also significant installation impact to a ship, cost/benefit will be weighed against installation during new construction. If the installation impact is less, the technology could be included as part of a back fit or post-delivery installation.

In 2013, NAVSEA developed the Naval Power Systems Technology Development Roadmap (NPS TDR). NPS TDR aligns power system developments with warfighter needs, including DEWs and energy-intensive weapons and sensors for shipboard use, to ensure that future ships are capable of accepting power and cooling loads of such systems as they are developed. The roadmap addresses new construction integration and back fit of technologies for ships in service. NPS TDR is adapted to evolving requirements from weapons and sensor system developments, as well as changes in the Navy's 30-year shipbuilding plan, and will be updated every two years. NPS TDR introduced the concept of an Energy Magazine to provide the required power from the ship's electrical system and interface with high powered weapons and sensors. The Energy Magazine will initially support near-term applications, such as HEL, on a legacy platform. As new systems become available, the Energy Magazine can be expanded to accommodate multiple loads by providing the appropriate power conversion and energy storage.

The Naval Directed Energy Steering Group is currently drafting a Naval DE roadmap based on the Naval DE Vision and Strategy to establish goals, principles, priorities, roles, responsibilities, and objectives regarding acquisition and fielding of DEWs by the Navy and Marine Corps. This roadmap will address the way ahead for platform requirements, as well as power and cooling necessary to support these systems.

Acquisition Enablers (Future Naval Capabilities)

Acquisition Enablers (AE) are the critical component of our transition strategy. AE consists of our Future Naval Capabilities (FNC) program, USMC Advanced Technology Development (6.3) funds, Joint Non-Lethal Weapons Directorate (6.3) funds, the Manufacturing Technology (ManTech) program, and Low Observable, Counter Low Observable funds.

FNCs are near-term (2-4 year), requirements-driven, delivery-oriented S&T projects. FNCs deliver mature technologies to acquisition sponsors for incorporation into systems that provide

new capabilities. FNCs use a collaborative process involving requirements, research, acquisition, and Fleet/Force communities to align this part of the S&T portfolio with Naval Capability Gaps identified by the Office of the Chief of Naval Operations (OPNAV) and the Marine Corps Combat Development Command (MCCDC). A gap is any capability required to achieve Naval objectives that is not achievable with current platforms, weapon systems, doctrine, organizational structure, training, materials, leadership, personnel or facilities and requires S&T investment to solve or overcome. Capability Gaps define the requirement, not how to meet it.

FNCs are aligned to functional areas called "Pillars": Sea Shield, Sea Strike, Sea Basing, FORCEnet, Naval Expeditionary Maneuver Warfare, Capable Manpower, Force Health Protection, Enterprise and Platform Enablers, and Power and Energy. FNC projects address specific gaps in each of those areas, with final prioritization approved by a 3-Star Technology Oversight Group (TOG) representing OPNAV, Marine Corps, U.S. Fleet Forces Command, ASN-RDA, and ONR. FNCs are based on D&I investments where technology can be matured from Technology Readiness Level (TRL) 3 to TRL 6 in 3-5 years. Selection takes account of related work in the Department of Defense (DoD), government agencies, industry and Naval centers of excellence. Our investments focus on the most pressing gaps, with funding changes based on successful transitions, reprioritization, new starts, and evolving Naval needs. As FNC products mature, Technology Readiness Levels (TRL) change, moving products from 6.2 to 6.3 PEs. Year one is mostly 6.2; the final year mostly 6.3 – with a mix of 6.2/6.3 between. As FNC products transition from S&T to Advanced Component Development and Prototypes (6.4) and Engineering and Manufacturing Development (6.5), responsibility for continued development shifts from ONR to acquisition commands.

Approved FNC products have Technology Transition Agreements to document the commitment of the resource sponsor, acquisition program, and ONR to develop, deliver and integrate products into new or upgraded systems. Every product is measured by technical and financial milestones. All products must meet required transition commitment levels for S&T development to continue. Products that no longer have viable transition paths are terminated with residual funding used to solve problems with existing projects, or start new projects in compliance with Navy priorities, charters, business rules and development guidelines. The measure of success is whether projects meet technology requirements and exit criteria, and whether acquisition sponsors have transition funds in programs to accept and integrate FNC products. The transition status of FNC products is actively monitored on an annual basis, with products terminated if the S&T is failing or the transition plan is no longer viable. Through the end of FY 2013, 216 FNC products completed S&T development (a success rate of 84%), with 41 FNC products terminated before completion.

Results are evaluated by a Transition Review Board (TRB) consisting of Naval Reserve Officers representing Requirements, Acquisition and S&T communities. The TRB provides an objective, independent assessment of FNC products after successful transition or termination, analyzing the causes and residual value of unsuccessful transitions and deployments. Even in case of products which do not deploy, there is significant residual value in technology that can be leveraged for follow-on S&T efforts and made available for future transitions. Nothing goes to waste.

Quick Reaction S&T

ONR maintains quick-reaction capability for projects lasting 12-24 months that respond to immediate requirements identified by Fleet/Force or Naval leadership. TechSolutions provides short-term solutions to immediate operational and tactical requirements. Accessible via Internet and SIPRnet, TechSolutions accepts recommendations from Sailors and Marines about ways to improve mission effectiveness through the application of technology. TechSolutions uses rapid prototyping to meet specific requirements, with each project structured around definable metrics, and appropriate acquisition/test systems by integrated product teams. While neither a substitute for the acquisition process, nor a replacement for systems commands, TechSolutions prototypes deliver solutions to address immediate needs that can be easily transitioned to the Fleet/Force.

Technology development often occurs faster than DoD Planning, Programming, Budgeting and Execution (PPBE) can respond. Our Technology Insertion for Program Savings (TIPS) program provides current-year funding (inside the PPBE process), eliminating time lag in the PPBE cycle. TIPS provides up to $2 million for development efforts taking no more than two years, coupled with Fleet/Force support and resource sponsor commitment to fund moving the technology into the acquisition Program of Record (POR) or operating system. TIPS focuses on improvements that substantially reduce operating and support costs for warfighting systems.

In partnership with ONR, Naval Warfare Development Command (NWDC), Naval Postgraduate School, Naval War College and Marine Corps Warfighting Lab (MCWL) assess new warfighting concepts and technologies. Initiatives in support of our maritime strategy are applied, tested, analyzed and refined through war games, exercises, experiments and operational lessons learned.

Government Accountability Office (GAO) Report on Technology Transition

In the March 2013 Government Accountability Office Report, "DEFENSE TECHNOLOGY DEVELOPMENT: Technology Transition Programs Support Military Users, but Opportunities Exist to Improve Measurement of Outcomes (GAO-13-286)," GAO reported:

"…the Office of Naval Research (ONR) has a well-established technology transition focus. ONR's Office of Transition manages the Future Naval Capabilities (FNC) portfolio, which is the Navy's largest transition program—for which nearly $450 million was budgeted in fiscal year 2013. The program, which was initiated in 1999, seeks to provide the best technology solutions to address operational requirements, delivering technology products to acquisition programs that enhance capabilities within a 5-year time frame. ONR's Offices of Transition and Innovation also support rapid technology transition to the fleet, force, and acquisition communities via the Rapid Technology Transition (RTT), Technology Insertion Program for Savings (TIPS), TechSolutions (TS), and SwampWorks and Experimentation (SW/Exp) programs." (p. 9)

GAO said, "The Navy uses a Transition Review Board to monitor completed projects from the Future Naval Capabilities, Rapid Technology Transition, and Technology Insertion Program for Savings programs. The board determines and reports on whether transitioned projects are utilized in systems that support Navy warfighters. The Navy determined, for example, that of the 155 technology products the Future Naval Capabilities program delivered to acquisition

programs between fiscal years 2006-2011, 21 percent were subsequently deployed to fleet forces, 35 percent were still with the acquisition programs, and 44 percent failed to deploy. For projects that do not successfully deploy, the board assesses whether there are other benefits achieved, such as technologies leveraged for follow-on S&T work. The board also identifies obstacles to transition, such as loss of interest by the user or inadequacy of funding. These findings, along with a detailed one-page summary for each project, are then used to inform the Navy's annual review process. We found that by maintaining this level of tracking, the Navy is better aware of the benefits and obstacles associated with a substantial portion of their S&T portfolio, which may better inform decisions made by Navy leadership." (pp. 21-22)

GAO continued, "At the program level, many program officials indicated that senior leadership engagement, particularly in providing oversight for projects through to transition, is essential to having an effective program. We found the Future Naval Capabilities program provides a good example of senior leadership positively affecting project management activities. Specifically, due to funding constraints in its fiscal year 2013 S&T budget, Navy senior leadership supported the termination of ongoing Future Naval Capabilities projects that were determined to be lower priorities so that new, higher priority projects could be pursued. Navy officials stated that this type of awareness and understanding at senior levels enables the Future Naval Capabilities program to make efficient decisions that are less likely to meet resistance and that support the highest priority projects being developed for transition opportunities. (p. 25)

"Several transition programs also emphasized the relationship between "working-level" stakeholders—S&T developers and acquisition programs or warfighters in the field—when discussing the keys to technology transition. These stakeholders manage expectations throughout a project and ensure it will meet user needs. This reduces the risk of completed projects languishing because funding is not available or because user requirements have changed, or both. Some programs that we reviewed use integrated product teams, which may be composed of individuals representing the requirements, acquisition, operational, and S&T communities, among others, to facilitate continuous communication with stakeholders and ensure that transition planning is on track. In the case of the Navy, integrated product teams identify capability gaps, provide input on which S&T projects may address those gaps, assess project progress, make sure transition strategies remain valid, and confirm funding is aligned to support transition. According to Navy officials, the results of integrated product team efforts also support information sharing across senior- and working-level stakeholders to validate development status and transition planning activities." (pp. 25-26)

GAO concluded, "We found the Future Naval Capabilities program uses technology transition agreements as management tools to increase the level of documented commitment as a project progresses over time. To accomplish this, the program has three levels for agreements that reflect the requisite knowledge available at different phases of a project. Key elements of an initial agreement include a basic project description, identification of initial exit criteria, a high-level integration strategy, and a likely transition funding source. As a project progresses, the other two levels of agreement require increasing commitment and specificity of requirements from stakeholders to develop, deliver, and integrate a Future Naval Capabilities project into an acquisition program or other form of deployment. Key elements of the second and third tier agreements involve refining and finalizing project descriptions, detailing exit criteria, providing

greater specificity about the integration strategy, and providing estimates for transition costs and eventually executing transition funding. Stakeholders review the agreements annually to revalidate the commitments laid out within the document. (p.27)

"We also found Transition Commitment Level (TCL) assessment tools… offer another means of validating that transition programs are investing in projects that have a firm transition commitment from prospective users. These tools provide scorecards that chart how well-defined the fundamental characteristics that support a strong commitment to transition projects are at a given point in time. The Future Naval Capabilities program uses a single TCL tool that documents level of transition commitment from project start to completion." (p.27)

S&T Highlights

The Naval S&T portfolio includes a range of projects and programs entering or about to enter the Fleet/Force. Examples follow.

Expeditionary Maneuver Warfare and Combating Terrorism

Marine expeditionary forces are forward-deployed and forward-based, right-sized to respond to missions across the range of military operations from combat to Humanitarian Assistance and Disaster Relief (HADR). This is best achieved by a Middleweight Force which can launch from the sea and project power in sophisticated anti-access, area-denial (A2/AD) environments. The imperative to lighten the load for every Marine and the Marine Air-Ground Task Force (MAGTAF) is critical, requiring research in technologies that increase speed, agility and range, develop advanced materials for lighter body armor, helmets and eye protection, while reducing fuel consumption and vulnerability to Improvised Explosive Devices (IEDs) and mines. We develop over-horizon, beyond line-of-sight, restricted environment communications, and adaptable sensor systems to detect, classify, identify, locate and track low level entities in urban clutter, improve situational awareness, and enhance real time tactical decision making.

Improving resilience of Marines enables them to more effectively, efficiently observe, orient, decide and act (OODA) in complex, stressful conditions. We explore technologies to provide autonomous logistics, and enhance fuel, water and maintenance self-sufficiency. On-demand, reduced logistics enable a high operational tempo, and allow the Corps to out-maneuver and dominate any enemy. Marines out-perform and out-think enemies by understanding battlespace in greater detail, making decisions with greater understanding of enemy intent, and getting inside the enemy decision cycle. To achieve this, ONR created a small unit leader training framework based on codified learning models and theories to deliver technology and knowledge products for the USMC Training and Education Command (TECOM) that maximizes learning and skill acquisition at minimal cost. We invest in S&T to improve training efficiency based on cutting-edge, neuro-cognitive, psychologically-driven instructional strategies that enable Sailors and Marines to survive the brutal environment of combat, as well as retain emotional and mental health after they leave the traumatic environment.

Current S&T investments include projects to improve On-Board Vehicle Power, Advanced Remanufacturing and Sustainment Technologies, and Internally Transportable Vehicle

Autonomy Conversion. Force Protection projects include development of Personal Protection Technologies, On-The-Move Detection-of-Threat Optics, the Modular Explosive Hazard Defeat System (MEHDS), and Ground Based Air Defense (On-the-Move). Fires projects (Advanced Ammunition and Energetics) include an Integrated Day-Night Sight, the High Reliability DPICM (Dual Purpose Improved Conventional Munition) Replacement Program, and High Performance Alloys for Weapons. Logistics applications will improve Pallet Handling and Packaging, a JP-8 Solid Oxide Fuel Cell, and Autonomous Resupply technology. Human Performance, Training and Education investments will provide an Advanced Training System for Small Unit Decision-Making, and Training to Optimize Use of Resilience Skills (TOURS). Finally, Intelligence, Surveillance and Reconnaissance projects include Night Wide Area Augmentation System (WAAS), Entity Disambiguation, and Semantic Web enablement to enhance mission-centric knowledge generation and delivery. Our S&T efforts are undertaken hand-in-glove with the Marine Corps Warfighting Laboratory at Quantico, Virginia, whose mission is to rigorously explore and assess Marine Corps concepts using an integral combination of war-gaming, concept-based experimentation, technology assessments, and analysis to validate, modify or reject the concept's viability, and identify opportunities for future force development.

Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

The proliferation of anti-access, area-denial (A2/AD) capabilities among potential adversaries drives the need for technologies that assure access for Naval forces. Our challenges include the requirement to project power despite A2/AD challenges and to provide information dominance to the warfighter.

Improved decision making is central to the Navy's S&T plan to provide information dominance to the warfighter. One goal is to develop a highly flexible, open architecture, information and decision making capability with applications enabling operational and tactical forces to function with the same distributed information base across all warfare and mission areas. Information gathering and analysis will be largely automated and autonomously controlled so warfighters can have more time to make decisions and execute plans. A key aspect of this is our use of the electromagnetic spectrum for dominance, while denying the same to our adversaries. To this end ONR, Navy, and the other services are working to deliver hardware and software to support electromagnetic spectrum dominance in the near and far term. Capabilities are in various stages of maturity and deployment.

ONR developed software to evaluate effectiveness of new Electronic Warfare countermeasures. When the Fleet identified a requirement to improve threat awareness and assess vulnerability to anti-ship cruise missiles using organic Electronics Support Measures (ESM) sensors and radar, ONR used the same software to address the new requirement by developing a Human-Machine Interface (HMI), installing it on ships, and deploying scientists to make the new HMI sailor friendly. This gave the Task Force a clearer picture of ESM effectiveness and vulnerabilities relative to current sensors, weather, and threats – allowing them to reassign sensor coverage and move platforms to reduce vulnerabilities.

The Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) effort is developing flexible, dynamic system architecture to detect IED signals across the entire spectrum and provide automated responses. Unlike current technology, JCREW is designed to allow detection and communication systems to operate simultaneously.

Ocean Battlespace Sensing

To continue to dominate in the maritime environment Naval forces must be able to accurately predict and adapt to ocean, air, littoral and riverine environments on both tactical and strategic levels. Recent changes in climate conditions and extremes have created an emerging need for more accurate and longer range forecasts for DoD and Naval operations. In support of the Navy's Task Force Climate Change, the National Oceanographic Partnership Program, and in partnership with the Air Force, Department of Energy, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and National Science Foundation (NSF), we invest in S&T to provide mobile autonomous environment sensing, match predictive capability to tactical requirements, develop systems that adapt to environmental variability, and integrate atmospheric and ocean models to enable better forecasting. Additional investments will provide a better understanding of surface wind impact on upper ocean dynamics and energy fluxes across ocean boundary layers, increase knowledge of high latitude Arctic environments, and enhance our ability to forecast operational conditions with longer lead times. The payoff is safer, more efficient Naval operations in maritime environments through improved immediate, seasonal and longer range forecasts.

ONR's environmental research is heavily field-oriented, employing oceanographic ships, aircraft, and autonomous air and undersea vehicles. For example, the Navy owns six University-National Oceanographic Laboratory System (UNOLS) Ocean Class Research Vessels that ONR schedules and supports in partnership with NSF. Construction of two replacement vessels is underway, with Auxiliary General Oceanographic Research Ship (AGOR) 27 – Research Vessel (R/V) *Neil Armstrong* assigned to Woods Hole Oceanographic Institution, and AGOR 28 – R/V *Sally Ride* assigned to Scripps Institution of Oceanography. Both are expected to begin research operations in FY 2015.

In addition, we are developing rapid, standoff mine countermeasures to support unencumbered maneuver of combatants, assure access, ensure strategic mobility and sustainment, decrease mine countermeasure (MCM) hazards, and increase the standoff range of combatants from minefields. ONR experiments with sensing and autonomy technologies help small vessels to operate at night, in all weather, at higher speeds, and with less risk over large, poorly mapped riverine systems. Our Advanced Undersea Weapon System (AUWS) will deliver targeting sensors and remotely controllable or autonomous weapons into chokepoints or channels to neutralize maritime threats. ONR's Advanced Sonar Technology for High Clearance Rate MCM in the surf and autonomous minehunting payloads for Unmanned Surface Vehicles (USV), reduce timelines for detecting, identifying and clearing floating, drifting, moored and bottom mines in shallow water.

ONR supports research in acoustic propagation and scattering to improve anti-submarine wide area surveillance, detection, localization, tracking, and attack capabilities against adversary submarines in noisy, cluttered shallow water environments. We provide S&T to mitigate effects

of acoustic systems on marine mammals, to improve probability of kill for undersea weapons, and to enable new undersea weapon concepts of operation. Projects include the Remote Aerial Sonar and Communications Laser (RASCL), Affordable Compact Bow Sonar for large deck surface ships, holding threat submarines at risk in forward areas, screening transiting battle groups, and providing torpedo defense for ships.

Sea Warfare and Weapons

ONR's major focus in this area is to improve surface, submarine, ground, and air platforms, as well as undersea weapon performance. S&T investments provide options for advanced electrical systems and components, and for survivable, agile, mobile, sustainable, manned and unmanned, surface and sub-surface sea platforms, and undersea weapons. Significant investments provide S&T to improve performance and affordability of the nation's strategic submarine assets under the Ohio Replacement Program (ORP), as well as Virginia-class submarines. Our Electric Ship Research and Development Consortium enlists academic institutions to develop electric power architectures and technologies to enable use of next generation high power sensors and weapons, including directed energy weapons (DEW) systems described earlier. Investments encompass projects to transition S&T necessary to improve performance and capabilities of our current fleet of torpedoes, undersea weapons and vehicles, as well as effective countermeasures and defensive weapons to protect against undersea weapon threats. Undersea vehicle S&T includes research, development and deployment of long-endurance, air-independent power systems for unmanned undersea vehicles (UUVs). Additionally, we utilize extensive experience in surface craft design and autonomy to provide the Fleet with unmanned surface vessels (USVs) capable of operating effectively in a range of marine environments.

A key enabler of these Sea Warfare and other capabilities is S&T investment in naval materials. These investments focus on performance and affordability of advanced materials for applications such as lightweight structures, corrosion and biofouling mitigation, maintenance cost-reduction, undersea acoustics, and energy- and power-dense electrical energy conversion and storage. These efforts explore and apply fundamental materials physics to discover and engineer future materials meeting warfighting platform demands now and in the future. Consistent with this approach, our investment in Integrated Computational Materials Engineering is a key contributor to the recently established Lightweight and Modern Metals Manufacturing Initiative (LM3I).

Warfighter Performance

Warfighter Performance S&T addresses the full range of research issues involving human system interactions, medical and biological systems, and supports the SECNAV mission of protecting the safety and privacy rights of human research subjects.

Human system research helps the DoN recruit the right people, assign them to the right jobs, while ensuring they have the right skills in safe systems that are designed to support effective decision making and collaboration. Our S&T investments in this area helps improve small team, platform, task force, and battle group operations by developing training technology and decision support systems that accommodate human capabilities and limits. ONR initiatives include simulation-based approaches to fleet integrated, multi-platform, multi-mission training and

experimentation that enable near-real time collaboration, decision-making and planning across platforms and organizations.

Warfighter performance goals are to enhance performance, improve the timeliness and quality of decision making, develop strategies to mitigate workload, resolve ambiguity, and reduce workload and manning, while improving situational awareness and speed of command. Training technology S&T designs virtual networked learning environments that exploit live assets, virtual simulators and artificially intelligent constructive (Live, Virtual, Constructive/LVC) entities in distributed training environments to increase individual and team skill, knowledge, expertise and experience in warfighting tasks. S&T enables the Navy and Marine Corps to effectively and affordably train in classrooms, simulated environments, and on deployment.

Medical S&T improves the health, well-being, protection and survival of personnel in undersea, shipboard and expeditionary settings. ONR develops medical equipment, diagnostic capabilities, and treatments to improve warfighter performance and resilience. ONR develops solutions for point of injury care and casualty evacuation, new approaches to mitigate risks associated with operations in extreme environments such as dive medicine, and continues to address noise induced hearing loss by reducing noise at the source, limiting exposure, and developing protective technologies.

ONR's biological research program exploits principles from nature to design, control and power autonomous systems; improve processes, materials and sensors; and develop synthetic biology tools to support the Fleet/Force. Biocentric technologies offer a variety of enabling capabilities, including bio-inspired autonomous vehicles, acoustic/seismic discrimination systems, microbial fuel cells for sustainable power, engineered plants that produce energetic material precursors, and diagnostic tools to assess the health of marine mammals.

Human subject research is critical to support the Navy and Marine Corps warfighter, training and operational capability, and Navy Medicine. Many RDT&E activities designed to respond to Fleet/Force requirements necessitate human subject participation. As part of the DoN Human Research Protection Program, ONR is responsible for implementation of human subject protections in the Navy's systems commands, operational forces, training units, and at Navy-sponsored extramural institutions. ONR reconciles the competing priorities of conducting potentially risky research involving human subjects and compliance with federal, DoD, and DoN human protection policies.

Naval Air Warfare and Weapons

ONR's Naval Air Warfare goal is to develop, demonstrate and transition technologies to expand Naval weapon system stand-off ranges and reduce engagement timelines to enable rapid, precise, assured defeat of moving land, sea and air targets. We invest in S&T to develop propulsion for high speed weapons requiring technologies associated with high acceleration, high temperature, and high strength materials. We develop advanced structural materials and corrosion protection for aircraft, improvements that enhance operational characteristics such as improved lift, and to address other requirements driven by operations in the unique maritime environment. These include kinematic and lethality enhancements to increase range and effectiveness of tactical

weapons, and aided target recognition to provide the F/A-18 with advanced target identification capabilities.

Naval Research Laboratory (NRL)

ONR supports the DoN corporate lab, the Naval Research Laboratory (NRL). 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. Research at NRL is the foundation that can focus on any area to develop technology from concept to operation when high-priority, short-term needs arise. NRL is the lead Navy lab for space systems, firefighting, tactical electronic warfare, advanced electronics and artificial intelligence. Among our greatest challenges is to recapitalize NRL infrastructure. I invite you to visit this facility and learn more about research undertaken there by our world-class scientists and engineers.

ONR Global

ONR has offices in London, Prague, Singapore, Tokyo and Santiago – and closely coordinates activities with the other services and Assistant Secretary of Defense (Research and Engineering). We search for emerging research and technologies to help address current Naval needs, as well as requirements for future capabilities. ONR Global establishes contacts with international S&T leaders, giving us new perspectives and helping identify trends and forecast threats. It enables us to recruit the world's scientists and engineers in partnerships to benefit the U.S. and our allies. Global includes Science Advisors who communicate Fleet/Force needs to the Naval Research Enterprise (primarily Navy labs, warfare centers, affiliated universities) to facilitate development of solutions to transition to the Fleet/Force. Participants include Naval engineers who coordinate experimentation, develop prototypes, define transition options, and collaborate with Fleet/Force to define S&T investments. Our International Science Program gives scientists from academia, government and industry opportunities to engage leading international scientists and innovators. Our technical staff helps establish collaboration between Naval scientists and their foreign counterparts, and identifies centers of excellence for Naval S&T.

Conclusion

The FY 2015 President's Budget request will enable us to continue moving toward enhanced capabilities, more effective partnership between research and acquisition, and strengthened partnerships with the Army, Air Force, DARPA and other DoD research organizations – as well as performers outside the Naval R&D system. We strive to tap into the full spectrum of discovery and accelerate the transition of appropriate technologies to civilian use. Our S&T investments represent careful stewardship of taxpayer dollars that will achieve these goals and significantly enhance the safety and performance of warfighters as they serve in defense of the United States. Thank you for your support.