

NOT FOR PUBLICATION UNTIL RELEASED BY THE
SENATE ARMED SERVICES COMMITTEE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
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BEFORE THE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
SENATE ARMED SERVICES COMMITTEE
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Introduction

Thank you for the opportunity to discuss the investments the Department of the Navy (DoN) is making in Science and Technology (S&T). Today, more than any other time in our Nation's recent history, these efforts are critical to building the future Fleet and Force in support of our National Defense Strategy. I am honored to be the Chief of Naval Research and guide the Naval Research Enterprise.

Founding of ONR

Seventy five years ago, on 1 August 1946, the Congress founded the Office of Naval Research (ONR) to *plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security*. In those early decades, ONR established a partnership model with industry and academia to seed new scientific research, harvest new concepts, build new technology and deliver it to the fleet and force. At that time, U.S. government investment was the biggest force in the market and drove the research and development enterprise. Those days are in the past. Today, commercial research and development investment outpaces government R&D in the United States and across the globe and we find ourselves in a highly competitive environment with near peer adversaries.

Naval Research Enterprise (NRE)

As the Chief of Naval Research I lead the community called the Naval Research Enterprise (NRE). The NRE consists of the Office of Naval Research (ONR), the Naval Research Laboratory (NRL), ONR Global and PMR 51 and is part of the larger Naval Research and Development Establishment (NR&DE) which includes the Naval Warfare Centers (Air Warfare, Information Warfare, Surface Warfare and Undersea Warfare), the Marine Corps Warfighting Laboratory, the Naval Post Graduate School, the Engineering and Expeditionary Warfare Center, University Affiliated Research Centers (UARCs) at University of Hawaii, University of Washington, University of Texas, Penn State University and Johns Hopkins University and Federally Funded Research and Development Centers doing naval work.

Naval forces fight from the ocean floor, into space and everywhere in between. As we pursue distributed maritime operations, we have to network Sailors and Marines to autonomous and manned platforms on the surface, under sea, on land, in the air, and in space. As the Chief of Naval Research, I am responsible for reimagining naval power for the future in all of these domains.

People

At its core, our business is a people business. Over 4000 scientists and engineers are in the NRE, representing the talent that brings new technology and capabilities to the warfighter. They are, in turn, supported by the technicians, contracting officers, lawyers, comptrollers who execute the logistics of S&T. While we can't match the sheer numbers of scientists and engineers with our near peer competitors in China, we can leverage the research, the diversity, the protection of intellectual property and the open innovation environment that thrives here in the US.

To remain ahead, we must modernize the NRE talent management framework through diversity, employee satisfaction, retention, and succession planning. Thanks to the valuable legal authorities in hiring, pay, scholarships, contracting, cash prize awards, and other areas the Congress provided to the science and technology reinvention laboratories, the Naval Research Enterprise continues to attract and retain key talent.

Given the disruptions and opportunities exposed by the COVID-19 pandemic with telework, remote work and other flexibilities, we are exploring more innovations to the future of work. One key area we are reimagining at this very moment is the Naval Science, Technology, Engineering & Math (STEM) program, for which I am the Naval STEM Executive. The naval research enterprise workforce must reflect the diversity of American society. Through STEM opportunities and research networks to Historically Black Colleges and Universities /Minority Institutions (HBC/MI) the naval research enterprise is working to attract talent previously underrepresented in S&T.

Opportunities begin with naval-relevant outreach programs at the pre-kindergarten through high school grade levels. They continue through internships and other programs at undergraduate and graduate schools, and support student advancement into post-doctoral work, continuing through all stages of professional development. We aim to inspire, engage and educate the next generation of scientists and engineers, and to attract, employ, develop and retain our diverse technical workforce through collaboration across the Navy, the federal government and the broad STEM community.

The shortage of homegrown S&T talent is a national security problem and our STEM efforts will be an enduring, long term, solution.

Products

Flowing from the National Defense Strategy, to the Office of Secretary of Defense's Research and Engineering Modernization Priorities, the Chief of Naval Operations' Navigation Plan, and the Navy, Marine Corps, Coast Guard Tri-Service Maritime Strategy, our approach is to address technical risk in the S&T portion of the Navy's future portfolio by conducting more warfighter informed prototyping, experimentation, and demonstrations. Many of the technologies that are available in the near term are enabled by five to fifteen years of basic and applied research. In the near term we are enjoying success in Directed Energy, Unmanned Systems, Artificial Intelligence and Machine learning (AI/ML), and Autonomy. In the October 2019, Navy completed installation of the world's most powerful laser shipboard laser prototype on USS PORTLAND. The Solid State Laser – Technology Maturation (SSL-TM) Program is an ONR initiative. Lasers are a reality and in the fleet as a direct result of years of S&T development efforts. Building on ONR development of event-driven autonomy, multi-USV autonomy and advanced perception, success continues in unmanned surface vessels with the delivery of Sea Hawk, a follow-on to the DARPA & ONR developed Sea Hunter. Sea Hunter is currently part of Surface Development Squadron One and taking part in experimentation and concept development.

Autonomy

As a necessary evolutionary response to the new warfighting paradigm, ONR is working to re-envision unmanned systems as Intelligent Autonomous Systems (IAS). IAS is comprised of autonomy and its intersections with both unmanned systems (UxS) and artificial intelligence (AI). It is a system of humans, machines, and algorithms, performing cooperative roles as individual agents, supervisors, subordinates, and peers. IAS represents the formidable fusion of technologies which is already changing the nature of our personal and professional lives and will have a profound impact on warfare. Autonomous systems provide additional warfighting capability and capacity to augment our traditional combatant force, allowing the option to take on greater operational risk while maintaining a tactical and strategic advantage

By exploiting the technical revolution in autonomy, advanced manufacturing, and artificial intelligence, the naval forces can create many new unmanned, optionally-manned, and minimally-manned platforms that can be employed in a distributed, networked manner.

The IAS approach is particularly relevant in the maritime domain, where the battlespace spans from the seabed to space, and engagements occur across hundreds, even thousands of miles. The development and adoption of IAS is paramount to the Navy and Marine Corp's ability to collect and sift the staggering amount of data required for modern warfare, in order to maintain deterrence and, when required, win decisively in the 21st Century.

Future Products

As the sole investor in dedicated basic research for the entire Department of the Navy, ONR also has its eyes set on providing game-changing technology to the Fleet after next. Specifically, it is looking to Quantum Computing, Biotechnology, Advanced Manufacturing, Full Spectrum Undersea Warfare, and Digital Engineering as areas in need of critical S&T investment today to ensure naval superiority tomorrow.

Quantum

The arrival of quantum technologies in the near future brings great promise for DoD applications, from improved timekeeping and navigation technology for GPS-denied platforms to potential increases in computational speed in solving complex logistics problems. The application space for quantum sensing and quantum information science and technology is broad.

Quantum computing is an emerging technology that derives its power from the properties of large-scale entangled quantum systems. In the future this technology could provide unique advantages over its classical counterparts in certain applications of importance to the DoD, including the discovery of new materials and chemical compounds with unique properties and finding solutions of complex optimization problems such as algorithm development from large data lakes.

Historically, ONR has invested in quantum science, partnering with the academic community, since the organization's inception. One can point to no less than seven Nobel prizes awarded to quantum researchers supported by ONR basic science funding for work ranging from the invention of the laser, to atomic spectroscopy to laser cooling and trapping.

ONR is at the forefront of moving quantum technologies to higher technology readiness for fleet deployment. Future quantum sensors and clocks, for instance, have the potential to completely revolutionize the way Positioning, Navigation and Timing (PNT) is performed on DOD platforms. Today we largely rely on signals from GPS satellites for position and time. A future vision for quantum enabled PNT includes advanced clocks, gyros and accelerometers, together providing a set-and-forget capability where we can initialize the system with accurate time and position and maintain quality PNT throughout the mission. Our researchers are taking early prototype quantum-enabled systems into relevant environments today to push the envelope and expose the hurdles that still remain.

Extending entanglement between systems distributed over a large geographical area (such as in a quantum network coupling many processors or sensors) could yield new communications and sensing modalities. The exploration of these capabilities and the development of components (such as memories and small quantum information processing modules) are some of the identified challenges in this area that ONR-funded researchers are addressing.

Biotechnology

ONR's Biotechnology efforts focus on identifying and exploiting key principles from biology to the design and development of novel materials, sensors and devices, as well as provide environmentally friendly energy strategies to support future operations. Primary areas of research include (i.) Bio-inspired processes, materials, and sensors to provide secure and agile options to enhance performance and reduce cost; (ii.) Synthetic biology to improve stealth and mission capability of maritime platforms and autonomous systems; and (iii.) Novel bio-energy and power solutions to safely extend operational duration.

Advanced manufacturing

In the area of advanced manufacturing, modeling and simulation is used to support discovery of new materials and help reinvigorate US manufacturing capacity and capability. The Navy, working across industry and academia, is the executive agent for the Lightweight Innovations for Tomorrow (LIFT) metals manufacturing institute. LIFT's long-term vision is to: (1) accelerate the development and application of innovative lightweight metal production and component manufacturing technologies to benefit the US transportation, aerospace and defense market sectors; (2) ensure that the U.S. is the world leader in the application of innovative lightweight metal production and component/subsystem manufacturing technologies; and (3) ensure a robust talent pipeline for metals manufacturing.

Full Spectrum Undersea Warfare

Full Spectrum Undersea Warfare (FSUSW) research will help change battlespace capability in this decade. This Innovative Naval Prototype (INP) focuses on expanding and enabling undersea force capability as well as freeing up submarines for other critical tasking. It will adapt existing

human in the loop capability into intelligent autonomous capability and will develop and integrate with other efforts that have been or are being developed by the Navy and DoD Research Enterprise into novel systems to expand the range of lethal and non-lethal effects. Early technical activities in this multi-year effort started this fiscal year and focus on effects related to the emerging Subsea and Seabed Warfare (SSW) warfare area, delivering effects through advanced undersea payloads and payload delivery systems and countering adversary targeting against undersea forces

S&T for Digital Engineering

ONR is pushing into S&T efforts to advance Digital Engineering with full participation from across the Naval Research and Development Establishment (NR&DE). The sheer complexity of the trade space in creating radically new military forces will require significant departures from today's acquisition paradigm, and will be dominated by innovative processes extending today's digital twin efforts into the realm of Digital Engineering and S&T. We will explore trade spaces of existing technologies in the innovation of new capabilities, then use many of the same principles to help in the discovery and invention of new science and technologies. Essential to this effort is a strongly diversified Future Workforce developed through a coordinated Government wide/Navy STEM effort that trains to operate seamlessly in this combined domain.

Process

One of ONR's missions, as a hub for experimentation, is to provide decision-quality data to support future S&T investment and technology readiness decisions. ONR can ensure it is addressing the needs of the fleet and force and also accelerate its learning and development timeline.

Through operational experimentation, the naval research enterprise is able to gain valuable insight into how S&T investments can address existing and emerging capability challenges in the Navy and Marine Corps. Experimentation is mutually beneficial for the warfighter because it provides them with the opportunity to employ new technologies in order to both give feedback to

the developers and understand the realm of the possible and begin to develop the appropriate concepts, doctrine, and training techniques and procedures (TTPs). For example, this month, we started Integrated Battle Problem (IBP 21) in collaboration with Pacific Fleet. Some 30 technologies at varying Technology Readiness Levels are part of a naval exercise in the southern California operations area. This ‘Above the Sea, On the Sea and Below the Sea’ exercise demonstrates how we can align to the Indo-Pacific Command directives and use experimentation to operationalize capability.

Understanding the Warfighting Needs

To develop our portfolio of projects likely to deliver Future Naval Power in both the near and the long term, we have to understand the needs of our warfighters. To help understand these needs, we leverage the expertise of the embedded science advisors in the Fleet and Force, the resource sponsors, technical experts in the programs of record, and the intelligence community. To understand the technical challenges and opportunities, we work with our partners in DoD, small businesses and industry primes and academia; we also monitor research and technology trends from ONR Global, and our subject matter experts at the Naval Research Lab, the Marine Corps Warfighting Lab, the Navy and other service warfare centers, the University Affiliated Research Centers and Federally Funded Research and Development Centers (FFRDCs).

With the support of Congress, we invest the resources across a balanced portfolio and execute our plans and projects as rapidly as possible. The results of the investments are technology, knowledge and the pipeline of people to discover, develop and deliver technological advantage in the near term and the far term. The subject matter expertise that we develop across the technology disciplines are our strategic advantage for the future of Naval Warfare.

Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR)

The SBIR/STTR program is a key enabler of the S&T portfolio. We continue to improve the process with DON SBIR/STTR stakeholders and senior naval leadership in order to ensure better and faster use of SBIR/STTR as a tool to rapidly discover, develop, and deliver technology to the Fleet and Force.

The Navy Technology Acceleration pilot is leveraging small businesses to enable technology adoption at the pace of innovation. To make it easier for small innovative businesses to participate, the DoD SBIR Broad Agency Announcement in 2019 included three broad topics for the Navy. The proposal requirement was simplified from 20 pages to ten pages. The result was the Navy received nearly ten times as many proposals for each of those topics, demonstrating much wider participation from more innovators. The evaluation and selection processes were streamlined to be faster and resulted in 79 Phase I awards in 28 calendar days, 66% faster than our traditional process. The Navy used a flexible contract vehicle to allow multiple Phase I, II, and III awards under a single agreement again showing in innovative approach to making it easier for small businesses to work with the Navy.

The SBIR/STTR Program Office is embracing virtual Forums for SBIR/STTR Transition (FST). Thus far in 2021, the SBIR/STTR Transition Program (STP) has held 2 virtual conferences. The first aligned 34 technologies with Naval Sea Systems Command and the second aligned 44 technologies with Naval Air Systems Command. Each two day event incorporated on demand discussions for each technology, as well as a virtual booth allowing for real-time video conferencing “ask the expert” with SMEs from each company. The two events hosted over 800 attendees ranging from Programs of Record, subject matter experts, to major prime contractors supporting systems integration. The pivot to virtual conferencing has opened the doors for SBIR/STTR participating firms to network with decision makers that may not normally travel to an in person event. The third event of the year, on April 28th, will be aligned with the Naval Information Warfare Systems Command.

Manufacturing Technology

The Navy Manufacturing Technology (ManTech) Program responds to the needs of the Department of the Navy for the production and repair / sustainment of platforms, systems, and equipment. Navy ManTech’s investment strategy has two focus areas: Platform Affordability and Capability Acceleration. For Platform Affordability, ManTech transitions manufacturing technologies which, when implemented, results in a cost reduction or cost avoidance. Platforms

for investment are determined by total acquisition funding; stage in acquisition life-cycle; platform cost-reduction goals; cost-reduction potential for manufacturing; and other factors primarily associated with the ability of ManTech to deliver the technology when needed. Key Navy platforms on the ship side currently supported include: VIRGINIA Class Submarine (VCS); COLUMBIA Class Submarine (CLB); DDG 51 Class destroyer; CVN 78 Class aircraft carrier; and FFG-62 Freedom Class frigate. On the air side, ManTech supports the F-35 Lightning II aircraft and is winding down the portfolio for the CH-53K heavy lift helicopter.

ManTech's VIRGINIA Class Affordability Initiative continues to successfully transition manufacturing technology resulting in affordability improvements. To date, fifty-nine of the ManTech affordability projects have completed and have either been implemented or are in the process of implementation. Recognized cost savings of approximately \$41.7 million per hull have been recognized by General Dynamics Electric Boat (Fall 2020) and PMS 450. As a result, with a two per year build rate, the annual Navy ManTech budget has saved over \$26 million alone. (Annual ManTech budget is \$57 million)

The second investment strategy area supported by Navy ManTech is Capability Acceleration which funds manufacturing technology projects that accelerate the delivery of capabilities to the Navy. Key Capability Acceleration thrust areas include: Swarm / Unmanned Vehicle Production; Advanced Radar and Electronic Warfare for Ships; High Energy Laser (HEL) Weapon Systems; Advanced Submarine Fabrication Technology; Fleet Repair and Sustainment Technology; F-35 Canopy Production Acceleration; and Energetics Production Improvement.

ONR Global

ONR Global is the NRE's hub for Global Technology Awareness, international science and technology partnerships and collaboration, experimentation, and Fleet connection and response via science advisors and TechSolutions. ONR Global's connection to and alignment with the NRE's many stakeholders, collaborators, and partners is what has enabled the local production of fifty ventilators per week in Brazil, the production and testing of additive manufactured N-95 mask designs that are now available to the public, and numerous technology based capabilities

delivered to fleet users for demonstration and experimentation. Additionally, in an era where according to the Congressional Research Service, more than two thirds of the Global R&D Expenditures are outside of the United States and where near peer adversary R&D expenditures exceed our own, it is critical that we maintain awareness of the state of research amongst our allies, our partners, and even our potential adversaries. ONR Global's small team of deployed scientists working with the Departments of State, Defense and Energy, maintain technical awareness, establish collaborations and partnerships between international researchers and U.S. institutions, and invest in unique and promising research with Naval relevance to ensure the NRE and the United States is connected to disruptive discoveries when they are made.

There is certainly more that we as a nation can do to better connect with the vast majority of the scientists and engineers that are outside our borders to help us capture the talent and potential Intellectual Property (IP) they have. By extending IP protection and value capture for the researcher to international researchers, ensuring agile and flexible funding for promising research, and reducing the time to establish relevant partnerships and collaborations, we will counter the massive investments being made by our adversaries in the competition for international talent. We need to ensure our policies, processes, and tools are easy to navigate (even if English is not your first language), promote transparency, and build trust. Finally, we need to make it easier to work with partner nation governments to fund and collaborate on international research. Balancing U.S. research protection and minimizing any policy driven delays will keep the US the S&T partner of choice for our international talent, global allies and partner nations. In the agile and high velocity world of innovation, discovery, and technology based capability, it is paramount that ONR Global remain the partner of choice for global S&T leaders.

NavalX and Technology Bridges

NavalX is the Department of the Navy's agile cell and super-connector to elevate, and scale tools, practices, and training. NavalX facilitates processes and information sharing and empowers our naval network. By guiding, empowering, and connecting our workforce and

growing connections and partnerships with the private sector, we will enable the naval team to accelerate emerging technology discovery, development, and delivery.

A subsidiary of NavalX, Tech Bridges bring together innovation organizations, local industry, academia, small business, and other government entities to accelerate results and solutions to the Department of the Navy by connecting DON initiatives using the innovation pipeline, increasing local access to innovation ecosystems, and reducing the barrier between Navy and non-traditional partners. The Tech Bridge network today is comprised of 15 locations globally. Over the past year, this network generated more than 20,000 connections, \$50 million in projects such as prizes challenges and SBIR projects, and enabled more than 126 different projects in subjects like artificial intelligence and machine learning; 5G-enabled technologies; advanced materials and manufacturing; maintenance and sustainment; autonomy; and data management.

Conclusion

In conclusion, I believe we are at a critical juncture in this nation's history. There is a technology race ongoing, the winner of which will rule this century. Business as usual will not prevail. Our existing processes and organizational structures are under pressure and being challenged like never before. This is the moment to reimagine the future and to take bold and decisive action to ensure the United States and our allies prevail in this technology race.

At the Office of Naval Research, our investment in people, products and process will enable the Navy and Marine Corps to ensure the preservation of national security and the maintenance of future naval power. I invite you to visit us and our Warfare Centers around the country and the Naval Research Laboratory, right here in our Nation's Capital, to see firsthand the advances under development. I am honored to have the opportunity to testify before you today and I look forward to your questions.