UNDERSEA WARFARE

SCIENCE & TECHNOLOGY OBJECTIVES

2016

UNDERSEA WARFARE
CHIEF TECHNOLOGY OFFICE

Enabling Strategic Innovation for the Undersea Force

FOREWARD

RDML Moises DelToro, III
Undersea Warfare Chief Technology Officer

To deliver the best future warfighting capabilities to meet current and emerging needs, the undersea force conducts research across a broad spectrum. Our science and technology (S&T) portfolio attempts to balance near-term needs without sacrificing basic research or the pursuit of long-term revolutionary technologies tied to future capabilities. The distribution and balance among these efforts is critical to ensure that Undersea Warfare (USW) S&T investments are healthy, relevant and address documented needs and requirements.

In this document, the undersea force identifies Science and Technology Objectives (STO) that align to Fleet needs and warfighter requirements. These objectives represent the goals of the USW S&T program and are used as the baseline for identifying, aligning, and synchronizing S&T efforts. They serve as a crucial communication tool and represent a broad strategy for the future, while retaining sufficient flexibility to allow the S&T community to address near term challenges. USW S&T stakeholders, in collaboration with the Office of Naval Research (ONR), the Defense Advanced Research Projects Agency (DARPA), fellow military services, other federal government organizations, academia and industry, will continue to evolve detailed technology development strategies and conduct the necessary research to address these objectives.

Since publishing the first USW S&T Strategic Plan in 2010, the Department of Defense (DOD) and the Navy has faced a period of significantly reduced resources. Undersea Forces will continue to face additional pressures to balance operations and maintenance of existing platforms and systems with the pursuit of evolutionary and in some cases revolutionary new capabilities…always mindful of the entire cost of the capability development from concept design through procurement, operation, sustainment and disposal. Through the efforts of my office, we have strategically positioned the Undersea Enterprise to take advantage of the myriad S&T programs throughout DOD and Navy to address these issues and have a significant track record of success in securing funding to support the needs and requirements for our Undersea Force.

This document is the biennial update and replaces the September 2013 USW S&T Objectives. This is the third edition of the USW STOs, and the changes contained within this document incorporate lessons learned and insights gained through STO workshops and feedback from USW S&T stakeholders.

The USW Chief Technology Officer (CTO) and the entire USW S&T team continue to support the warfighter and to ensure that the S&T investments made on behalf of Undersea Forces and provide the best technology options to meet their operational needs.

EXECUTIVE SUMMARY

The Commander Submarine Forces (COMSUBFOR) established the Undersea Warfare Chief Technology Officer (USW CTO) to understand, influence, and align Undersea Warfare (USW) Science and Technology (S&T) efforts to ensure S&T investments are properly balanced to meet near, mid and far-term capability needs. The USW CTO is charged with developing and publishing the Undersea Warfare Science and Technology Objectives (USW STO).

This document describes the process by which the USW STOs are developed as well as the strategic guidance to support this need, thereby serving as justification for future investment in technology investment to support warfighting in the Undersea Domain.

This document is structured based on focus areas as outlined in the 2015 Naval S&T Strategy. In addition, USW leadership believes that Undersea Maneuver Warfare (UMW) and Undersea Precision Navigation and Timing (UPNT) are critical areas that must be addressed to support future undersea operations.

- Undersea Maneuver Warfare (UMW) - The UMW Focus Area directly addresses the need the need to develop capabilities that not only allow Undersea Forces to operate in their traditional roles and missions, but to expand their capabilities to counter emerging enemy undersea warfare capabilities related to sea-bed operations, sensor deployment, unmanned systems and undersea infrastructure in conjunction with Joint Forces.
- Undersea Precision Navigation and Timing (UPNT) - The UPNT Focus Area directly addresses the increasing concern regarding the threat that anti-access and area denial (A2AD) poses and how Undersea Forces will need to maintain precision navigation accuracy in order to perform current and emerging missions.

The USW S&T Focus Areas are:

1. Assure Access to Maritime Battlespace (AA)
2. Autonomy and Unmanned Systems (AUS)
3. Undersea Maneuver Warfare (UMW)
4. Expeditionary & Irregular Warfare (EIW)
5. Information Dominance & Cyber (IDC)
6. Platform Design & Survivability (PDS)
7. Power and Energy (PE)
8. Strike & Integrated Defense (SID)
9. Warfighter Performance (WP)
10. Undersea Precision Navigation and Timing (UPNT)

The intended audience for this document is current and potential USW stakeholders such as the Naval Research and Development Enterprise (NR&DE) as well as sister services, other government agencies, academia and international partners.

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INTRODUCTION

The Commander Submarine Forces (COMSUBFOR) established the Undersea Warfare Chief Technology Officer (CTO) to understand, influence, and align Undersea Warfare (USW) Science and Technology (S&T) efforts to ensure S&T investments are properly balanced to meet near, mid and far-term capability needs. Figure 1 describes the USW CTO Vision, Goals and Principles and shows how USW CTO describes his team's role in driving innovation for the undersea force.

As assigned by COMSUBFOR, the USW CTO is charged with developing and publishing the USW STOs. The USW STOs describe how Undersea Warfare S&T priorities are established, and guides strategic S&T investments. The USW STOs provide guidance to facilitate the alignment of available S&T investments with capability requirements. The guidance in this document provides S&T investment priorities to Naval Research & Development Establishment (NR&DE) organizations as well as sister services, other government agencies, academia and international partners.

This document replaces the Undersea Warfare Science & Technology Objectives dated September 30, 2013.

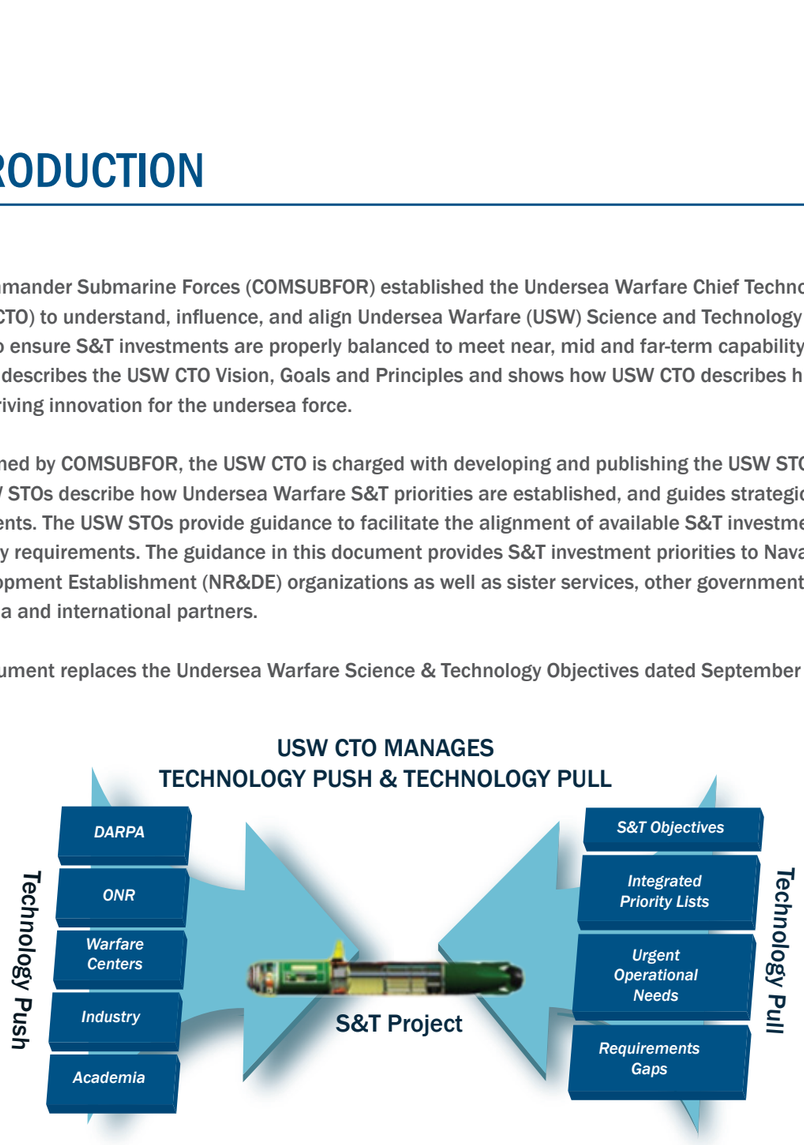

Figure 1: USW CTO Mission Diagram

"Above all, we must remember that innovation is a means, or a process, not an end in itself. Just as we cannot dictate the direction or intensity of the wind at sea, neither can we simply demand innovation to occur in the Navy and Marine Corps. Innovation must be viewed as a continuous cycle"

Ray Mabus
Secretary of the Navy

STRATEGIC FOCUS

Vision — Enable Strategic Innovation for the Undersea Force

Missions — Align Science & Technology providers, industry, academia, resource sponsors, and acquisition offices to meet the future capability needs of the Undersea Force

Principles — Collaboration | Communication | Creativity | Innovation | Resourcefulness

The USW STOs support the Naval and Undersea Forces strategic focus and align with Department of Defense S&T Priorities, Naval S&T Strategy, Commander, Submarine Forces (COMSUBFOR) Commander's Intent for the U.S Submarine Force and Supporting Organizations, OPNAV N97's Integrated Undersea Future Investment Strategy (IUFIS), OPNAV N84 (Director, Innovation, Test & Evaluation, and Technology Requirements) Technology Gaps and the USW S&T Strategic Plan as well as other Navy and USW strategic visions.

As shown in Figure 2, the USW S&T selection and development process attempts to cast the widest net in the beginning to allow for the identification of science, technology and concepts that may have application to the U.S. Navy and the undersea warfighting domain. In order to ensure that the most promising technologies are being funded and developed, proposed projects go through numerous vetting processes based on the sponsor, type and scope of the specific DoD/Navy S&T Program.

The mechanism used to align USW technology development is the Undersea Domain Transition Advisory Board (TAB). The Undersea Domain TAB provides oversight on technologies and investments to sustain America's undersea superiority and enhance our contribution to joint warfare effectiveness for future capabilities initiatives. The TAB evaluates and prioritizes S&T initiatives; advances Research and Development efforts into prototype Fleet experiments. The TAB also fosters future undersea capability ideas and gathers promising technologies across government, industrial, and academic boundaries to quickly demonstrate these mission enablers; and exercises initiatives to deliver robust and operationally relevant Fleet capabilities with sustainable and economical total ownership costs. The TAB is the Navy advocate for all undersea dominance capabilities, whether they are hosted on submarines, aircraft, or surface ships, or in information dominance or unmanned systems.

The TAB considers Chief of Naval Operations (CNO) and Fleet priorities, future concepts, capability and mission requirements, technology gaps, and current S&T/R&D investments to prioritize transitions, experimentation, and future S&T investments. The TAB communicates these priorities to the Fleet, the appropriate OPNAV resource sponsor, the Office of Naval Research (ONR), the Naval Research & Development Enterprise (NR&DE), the Defense Advanced Research Projects Agency (DARPA), the Defense Intelligence Agency (DIA), and industry to align investment strategies, eliminate duplication of effort, and facilitate successful transition of technology into the acquisition processes.

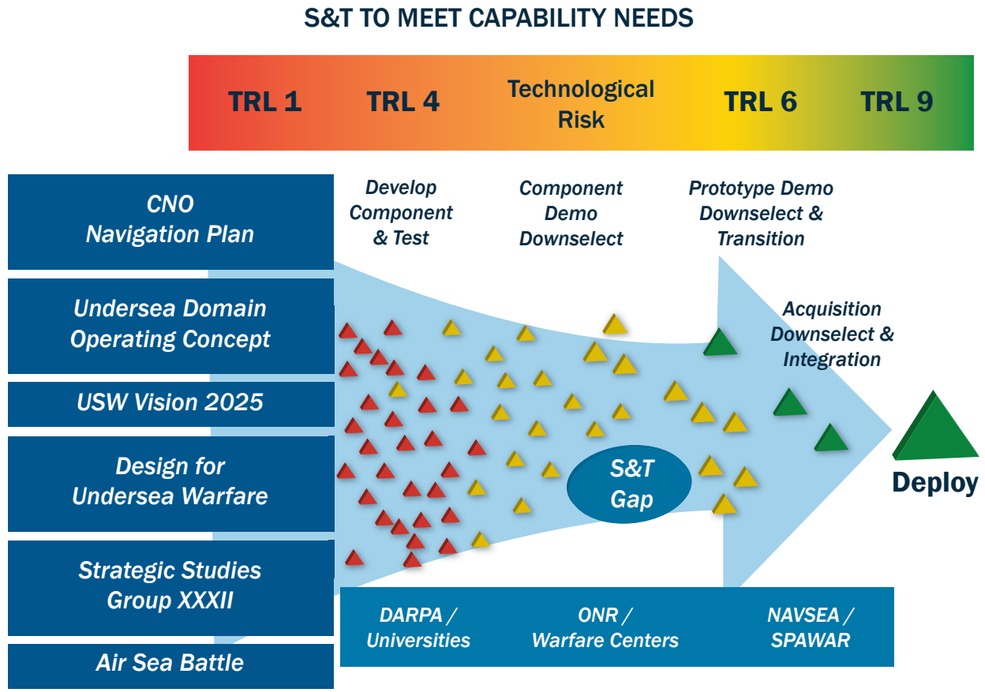

Figure 2: USW S&T Flow Diagram

"Encouraging a broad spectrum of contributors fosters more diverse insights, which can lead to new ideas, new services, and new products. Once we've gathered and identified great ideas, our next challenge is bringing them to fruition and transitioning them to the fleet quickly and cost-effectively. These challenges may appear daunting, but if we draw on our collective traditions of excellence, collaboration, and innovation, we're confident the USW community can successfully meet the challenges."

RDML Moises DelToro III
Undersea Warfare Chief Technology Officer

SCIENCE AND TECHNOLOGY OBJECTIVE DEVELOPMENT PROCESS

To develop the 2016 USW STOs, input was collected from USW stakeholders including Naval Sea Systems Command (NAVSEA) and Space and Naval Warfare Systems Command (SPA WAR, Acquisition Program Management Offices, Resource Sponsors, the Strategic Systems Programs (SSP) Office, Defense Advanced Research Projects Agency (DARPA), NR&DE, and the Fleet. The input was articulated from varying viewpoints, timeframes, and risk tolerance levels and encompassed elements of technology surprise and S&T opportunities. The input was assessed and assimilated to produce the following ten USW S&T focus areas.

1. Assure Access to Maritime Battlespace (AA)
2. Autonomy and Unmanned Systems (AUS)
3. Undersea Maneuver Warfare (UMW)
4. Expeditionary & Irregular Warfare (EIW)
5. Information Dominance & Cyber (IDC)
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USW S&T Stakeholders have varied missions and are responsible for specific areas of development for technology related to undersea warfare. From platforms to sensors and training to tools, there are a wide range of subject matter experts who are called upon to conceptualize, design, build, deploy, operate, maintain and evaluate USW systems. To help the reader determine who has expertise in and is responsible for specific technology development, we have included a list of primary organizations and acquisition program offices and their mission or specific technical areas they support.

Naval Sea Systems Command (NAVSEA) – Design, build, deliver and maintain ships and systems on time and on cost for the U.S. Navy.

- **Naval Undersea Warfare Center (NUWC)** – The United States Navy's full-spectrum research, development, test and evaluation, engineering and fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapons systems associated with undersea warfare.
- **Naval Surface Warfare Center (NSWC)** – Navy's principal Research, Development, Test and Evaluation (RDT&E) assessment activity for surface ship and submarine systems and subsystems.
- **Industrial Operations (SEA 04X)** -Provides management direction to the Naval Shipyards and serves as the NAVSEA Headquarters focal point for Depot Level Maintenance.
- **Submarine Training Systems (SEA 07TR)** – Systems and programs associated with training submariners.
- **Advance Submarine Systems Development (SEA073)** – Bridge S&T and R&D through demonstration and validation of innovative and promising technologies to provide undersea capabilities that are safer, stealthier, or lower cost.
- **Submarine Escape & Rescue (PMS-391)** – Development, procurement, and platform integration of submarine escape, rescue, and survivability.
- **Strategic/Attack Submarines (PMS-392)** – life cycle support of in-service submarines that safely maximizes operational time and capability.
- **Submarine HM&E Engineering (PMS-392T)** – Conducts the research needed to replace legacy hull, mechanical, and electrical equipment with state of the practice, COTS-based machinery to reduce total ownership costs and improve submariners' quality of life through the elimination or reduction of maintenance.
- **Advanced Undersea Systems (PMS-394)** - Acquisition and life cycle support for advanced undersea systems, SEAWOLF Class submarines including USS JIMMY CARTER (SSN 23), Deep Submergence Vehicle (DSV) ALVIN, Universal Launch and Recovery Module (ULRM), related Research and Development (R&D) systems, and Large Ocean Interface development and integration efforts for unmanned systems.
- **Submarine Special Operations Forces (PMS-399)** - Coordinates research and development, acquisition, test and evaluation, and in-service support of Dry Deck Shelters (DDS), SOF Host Submarine (HOSUB) Systems, and future SOF undersea mobility systems. PMS 399 is also responsible for the lifecycle support of the Mobile Anti-Submarine Training Target (MASTT) Program.

Program Executive Office, Submarines (PEO SUB)

- **SSBN Ohio Replacement (PMS-397)** - Conducts the early research and design for the next-generation Sea-Based Strategic Deterrence submarine (SSBN).
- **Submarine Acoustic Systems (PMS-401)** - Responsible for the development, acquisition, delivery and life cycle support of submarine towed and hull-mounted acoustic sensors as well as associated processing and support systems.
- **Undersea Weapons (PMS-404)** - Oversees the research, development, construction, and modernization of all undersea weapons, including those employed aboard surface ships and aircraft.
- **Undersea Defensive Warfare Systems (PMS-415)** - Conducts research, development, and construction of submarine defensive systems including noise makers and anti-torpedo torpedoes.
- **Submarine Combat and Weapons Control (PMS-425)** - Develops and acquires the combat and weapons control systems for both in-service and new construction ships.
- **Submarine Sensor Systems (PMS-435)** - Designs, develops, and oversees the construction of Electronic Warfare Systems, radar, periscopes, and the Photonics Mast.
- **Virginia Class Submarines (PMS-450)** - Oversees the design, construction and delivery of the United States' newest attack submarine.

- **Maritime Surveillance Systems (PMS-485)** - Provides long-life fixed, and on demand, mobile maritime surveillance capability in littoral regions and open ocean areas of national interest in support of Joint and naval Task Force Commanders. Specific mission areas supported by MSS include area sanitization, expeditionary force support, barrier operations, and ocean area surveillance.

Office of Naval Research (ONR) – Coordinates, executes, and promotes the science and technology programs of the United States Navy and Marine Corps.

Defense Advanced Research Projects Agency (DARPA) – Make pivotal investments in breakthrough technologies for national security.

The USW STOs represent the specific S&T needs of Undersea Warfare and will be used as the baseline for identifying, prioritizing, aligning and synchronizing future investment in USW-related S&T. They represent a broad strategy that provides focused direction for the future while retaining sufficient flexibility to allow the S&T community to meet emerging challenges.

Enduring Focus on Affordability

Keeping in line with the Naval S&T Strategy, the USW force agrees that total ownership cost is critical to maintaining existing undersea capabilities and in developing future systems, but will become even more important in the decades to come. Expanding unrest in the world coupled with anticipated reduction in the Defense budget will necessitate that each and every individual in the technology development process always keep the underlying theme of affordability in mind. The reader will see that affordability is pervasive across all of the USW S&T focus areas. Affordability concerns should always influence the way government and industry designs, develops, manufactures, maintains and disposes of our myriad undersea systems.

USW S&T Portfolio Assessment

The effectiveness of USW STOs are evaluated and documented annually through an assessment of the portfolio health. The USW S&T Portfolio Health Assessment (PHA) identifies the current status of alignment between the current S&T efforts, the STOs and the USW S&T Strategic Plan. It also identifies S&T areas that are weak and need to be addressed, S&T areas of opportunity that should be exploited, and S&T areas with emerging capability requirements. The assessment is meant to influence decisions related to initiation, continuation or termination of areas of investment to include rebalancing of the USW S&T portfolio.

Revision and Maintenance

This document has been approved for public release and distribution is unlimited. The USW STOs will be reviewed biennially for update. Any suggestions for addition or modification of this document shall be submitted to the USW CTO for socialization and consideration throughout the USW enterprise. For a digital copy of the USW STOs, please download at http://www.defenseinnovationmarketplace.mil/navy.html.

SCIENCE AND TECHNOLOGY OBJECTIVES

Document Structure and Reader Instructions

The USW STOs are anchored in the challenges of fighting in the Undersea Domain and, based on earlier warfighter analysis, have determined that the identified needs are best addressed by technology acquisition and/or development.

This document is structured principally along ten technology focus areas. As shown in Figure 3., each focus area is a description of the focus area related to USW, the technology development goals in that focus area, the STO identifier and finally, the objectives.

USW TECHNOLOGY FOCUS AREA (FA)
Explanation of Science & Technology Focus Area

GOALS:
- Goal 1
- Goal 2
- Goal n

Objectives:
USW-[FA]-01
USW-[FA]-02
USW-[FA]-n

Figure 3: Undersea Warfare Science and Technology Objective Structure

USW TECHNOLOGY FOCUS AREA LEGEND

- Assured Access to Maritime Battlespace (AA)
- Autonomy & Unmanned Systems (AUS)
- Undersea Maneuver Warfare (UMW)
- Expeditionary and Irregular Warfare (EIW)
- Information Dominance & Cyber (IDC)
- Platform Design & Survivability (PDS)
- Power & Energy (PE)
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ASSURE ACCESS TO MARITIME BATTLESPACE (AA)

Undersea Forces are a key facilitator to allied forces to provide assured access with influence (A2I) to deter the adversary and then gain the initiative should hostilities commence. Undersea warfighting in anti-access/area denial (A2/AD) environments allows countering or circumventing adversary perimeters, critical infrastructure operations, and deterrence through undersea exploitation while maintaining the ability to deny the adversary access to the same battlespace.

GOALS:

- Assured access to the global ocean and littoral reaches and hold strategic and tactical targets at risk
- Sense and predict environmental properties in the global ocean and littorals to support tactical and strategic planning and operations
- Improved operational performance by adapting systems to the current and evolving environment

ATLANTIC OCEAN (May 21, 2015) A dolphin jumps in front of the Virginia-class attack submarine Pre-Commissioning Unit (PCU) John Warner (SSN 785) as the boat conducts sea trials in the Atlantic Ocean. (U.S. Navy photo courtesy of Huntington Ingalls Industries by Chris Oxley/Released)

Objectives

USW-AA-01:

Reduce both acoustic and non-acoustic signatures of undersea assets both above and below the water surface to avoid detection and counter-detection and quickly regain stealth.

USW-AA-02:

Improve detection, classification and contact management capabilities against undersea warfare targets across all projected operational environments

USW-AA-03:

Improve above water sensing capability and ability to covertly determine contact parameters across all operational environmental conditions

USW-AA-04:

Develop environmentally adaptable sensor suites, based on inputs from organic measurements and METOC information, to optimize detection, classification, and localization performance above and below the water surface. The environmental information will also be used to improve platform stealth and control its signatures

USW-AA-05:

Improve capability to exploit and defeat adversary undersea assets

USW-AA-06:

Develop Theater ASW Commander battle management decision support system tools

"The person, the team of technology and people that taps into the best process is going to win… and again, designed in with minimal cost of ownership. All of this is going to have to fall in on an operational concept that employs all of this, that's going to be much different than we have right now. And then that is going to elevate to a strategic employment around the world that will allow us to control the seas and project power anywhere in the world."

Admiral John Richardson
Chief of Naval Operations

AUTONOMY & UNMANNED SYSTEMS (AUS)

Autonomy and unmanned systems are key force multipliers that facilitate operations across multiple warfighting domains and will be used extensively in the undersea operating domain. Future forces will continue to rely upon stealth, large area presence, and the ability to disrupt the enemy's command and control (C2). In order to fight efficiently, effectively and stealthily, a wide array of unmanned/autonomous systems will be utilized to perform multiple missions in order to maintain undersea dominance.

GOALS:

- **Seamless integration of manned and unmanned/autonomous undersea systems into the undersea warfighting domain**
- **Common control architecture and interfaces that support unmanned/autonomous systems operation**

Objectives

USW-AUS-01:

Develop the capability to utilize unmanned systems as forward undersea controllers/threat designators

USW-AUS-02:

Improve the endurance, persistence, reliability and safety of unmanned systems and sensors through launch, mission execution, recovery and turn-around

USW-AUS-03:

Develop capability to enable rapid and reliable targeting of multiple contacts via improved unmanned systems sensor exploitation

USW-AUS-04:

Enable seamless integration of unmanned systems into the undersea force and cross-domain mission planning, information management and energy management environment

USW-AUS-05:

Develop remote support capabilities for UUS including power and energy and delivery methods to position and pre-position a large number of unmanned undersea assets

USW-AUS-06:

Optimize operator integration with unmanned underwater systems to achieve greater mission effectiveness

USW-AUS-07:

Develop capabilities to counter adversary unmanned systems

USW-AUS-08:

Develop a multiple modality undersea communication network to improve reliability, reduce latency, and provide sufficient data rate to enbale coordination of large number of unmanned undersea assets

NUWC Division Newport worked closely with the Naval Research Laboratory and Oceaneering International Inc. to develop the eXperimental Fuel Cell (XFC) unmanned aerial system (UAS). In August 2013 the XFC UAS was deployed from the submerged submarine USS Providence (SSN 719) and vertically launched from a Sea Robin launch. (NUWC photo)

"The next generation of fast attack submarine has to have UUV's as a key part of expanding its reach so the affected domain of that submarine grows from just the immediate area that its sensors interact with to something larger"

RADM Michael Jabaley
Program Executive Officer, Submarines

UNDERSEA MANEUVER WARFARE (UMW)

Maneuver warfare is based on rapid, flexible, and opportunistic maneuver that seeks to shatter the enemy's cohesion through actions which create a turbulent and rapidly deteriorating situation with which the enemy cannot cope. Undersea Forces inherently support major tenets of maneuver warfare in the areas of surprise and deception. Future Undersea Forces will become increasingly critical to the Joint force as the enabler for conventional, above-water forces to be employed to defeat the threat posed by A2/AD tactics.

GOALS:

- Manipulate the adversary's maritime situational awareness
- Deny the adversary freedom of maneuver in the maritime domain
- Enhance freedom of maneuver for U.S./Allied forces in the maritime domain
- Deliver kinetic and non-kinetic effects from the undersea that impact an adversary's ability or will to fight
- Enable means of swift aggregation and disaggregation of Undersea Forces

Objectives

USW-UMW-01:

Improve ways to control undersea force signatures and manage force exposure to better drive adversary perception and response to undersea maneuver

USW-UMW-02:

Provide methods of active and passive signature control to support undersea maneuver

USW-UMW-03:

Widen the spectrum of effects which Undersea Forces are able to create against adversaries using innovative payloads

USW-UMW-04:

Develop ways for Undersea Forces to better communicate via non-traditional spectra in order to widen the array of deterrent, response, and maneuver options available to the undersea force

USW-UMW-05:

Develop methods of swift undersea lifting and handling capability to support the maneuver of low-mobility undersea forces

USW-UMW-06:

Develop technologies which allow Undersea Forces to dynamically respond within the vicinity of one another to adversary actions and emerging situations

USW-UMW-07:

Improve methods of command and control of Undersea Forces to better coordinate undersea maneuver within the Undersea Domain and across domains

USW-UMW-08:

Enable the execution of multiple concurrent missions by Undersea Forces to maximize the effects which Undersea Forces are able to create

USW-UMW-09:

Develop low cost, unmanned auxiliary Undersea Forces which are able to extend the ability for Undersea Forces to spread effects and enable better disaggregation of Undersea Forces

[Lockheed Martin's] "Area 51" is a small mock control room near Washington D.C. that provides a test bay to allow developers and fleet customers to try out a variety of commercial software and hardware technologies in the physical constraints of a Los Angeles-class and Virginia-class submarine control room and wardroom. The facility couples the latest Advanced Processor Build (APB) software with multi-touch tables, tablets, Xbox controllers, Kinect, Google Earth, and a variety of other technologies. Photo Courtesy: Lockheed Martin

"To win the fight, you must get to the fight, and once there you must be able to maneuver freely to maximize your effectiveness and minimize friendly casualties.

Not since the Cold War have I seen the USW mission more relevant or technology's role more important."

RADM William R. Merz
Commander, Submarine Group 7

EXPEDITIONARY & IRREGULAR WARFARE (EIW)

Undersea assets are key enablers for Expeditionary and Irregular Warfare (EIW). They provide the ability for small, clandestine units to exploit the undersea environment. They also enable littoral access and crisis response for conventional forces across the range of military operations. These capabilities become increasingly important in A2/AD operations of the future.

GOALS:

- Safe, reliable and less complex interfaces that enable future EIW operations
- Reduced time and complexity of deployment and recovery of expeditionary forces and associated systems

PACIFIC OCEAN (Feb. 20, 2012) SEALs and divers from SEAL Delivery Vehicle Team (SDVT) 1 swim back to the guided-missile submarine USS Michigan (SSGN 727) during an exercise for certification on SEAL delivery vehicle operations in the southern Pacific Ocean. The exercises educate operators and divers on the techniques and procedures related to the delivery vehicle and its operations. (U.S. Navy photo by Mass Communication Specialist 3rd Class Kristopher Kirsop/Released)

Objectives

USW-EIW-01:

Improve the tagging, tracking and locating (TTL) capability of Special Operations Forces (SOF) against quiet or stationary targets and threats

USW-EIW-02:

Improve submarine platform interfaces to increase efficiency and safety of deployment and recovery operations for SOF

USW-EIW-03:

Develop reliable, secure and clandestine high data rate underwater communications capability to support SOF

USW-EIW-04:

Develop capability to use submarine launched UAS for intelligence, surveillance and reconnaissance (ISR) support to EIW forces

"[We will] develop concepts and capabilities to provide more options to national leaders, from non-conflict competition to high-end combat at sea. Operations short of conflict should be designed to contain and control escalation on terms favorable to the U.S. Combat at sea must address "blue-water" scenarios far from land and power projection ashore in a highly "informationalized" and contested environment."

Admiral John Richardson
Chief of Naval Operations

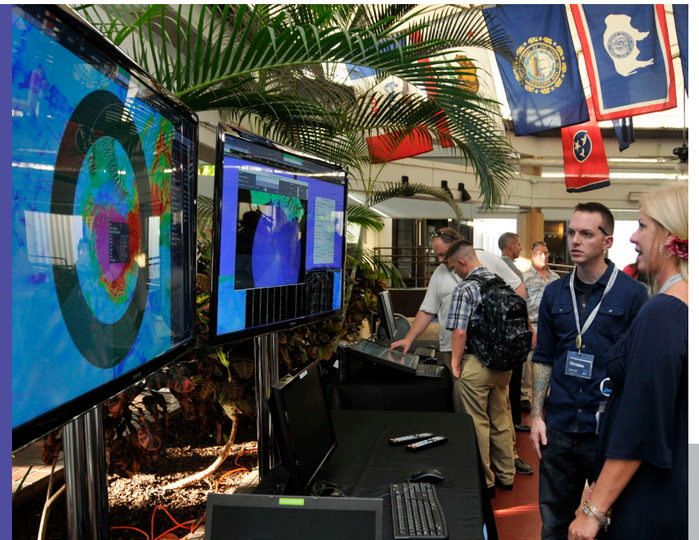
INFORMATION DOMINANCE & CYBER (IDC)

Undersea assets are key enablers to achieving and sustaining information dominance. They provide undersea C2 and undersea enablement of battlespace awareness (environment and adversary disposition). These challenges must be met with the dynamic and complex environmental context of the Undersea Domain as well as any and all operational conditions – spanning the permissive, contested and denied.

GOALS:

- Assured undersea command, control & high data-rate communications and significantly improved battlespace awareness capability for Undersea Forces
- Ensure Undersea Forces have the capability to defend against cyber-attack and have the ability to counter and/or deliver cyber effects

PEARL HARBOR (Oct. 27, 2014)
Kim Smith,principal software engineer for In Depth Engineering, shows a new type of sonar equipment called a multi-layer geo to attendees at the Tactical Advancements for the Next Generation (TANG) Expo, during a weeklong workshop at Joint Base Pearl Harbor-Hickam. The workshop is intended to improve watch team efficiency, build smoother communication, create a stronger Integrated Undersea Surveillance System community and boost skills in order to improve the capabilities of submarines and their crews in the fleet. (U.S. Navy photo by Mass Communication Specialist 1st Class Steven Khor/ Released)



Objectives

USW-IDC-01:

Improve capability and capacity to safely, reliably and securely transmit tactically relevant information/data at depth across a constellation of manned, unmanned and unattended systems

USW-IDC-02:

Enhance robust, tactically-responsive, cross-domain C2 for undersea assets with minimal risk of counter-detection

USW-IDC-03:

Develop cyber vulnerability assessment tools that inform undersea warfighters of adversary intrusion of undersea systems

USW-IDC-04:

Develop cybersecurity vulnerability assessment tools that inform the operator of the transition from the current state to the desired state

USW-IDC-05:

Develop Electronic Attack and Electronic Protection capabilities that reduce an adversary's ability to challenge friendly information warfare objectives, while simultaneously challenging the adversary's ability to conduct their own information operation

"The electromagnetic spectrum looks potentially very attractive in your ability to put an effect on a target to perhaps neuter its capabilities, to otherwise make it ineffective for what it's doing there. With a reversible effect on it without going all the way to a level of violence that may not be appropriate."

RADM Charles Richard
Director, Undersea Warfare Division

PLATFORM DESIGN & SURVIVABILITY (PDS)

Addressing all phases of design, development, construction and deployment is critical in order to develop agile, energy-efficient, and flexible platforms. Undersea platforms must be capable of operating in the harsh undersea environment and enable operations in hostile areas while avoiding, defeating and surviving attacks.

GOALS:

- Design and engineering tools to support future development, deployment, maintenance and support of undersea systems
- Advanced manufacturing tools and technologies that support rapid, low-cost and/or remote design and manufacture
- Ability for undersea platforms to remain undetected and operate unencumbered in the future operational environment

Objectives

USW-PDS-01:
Develop the capability for undersea assets to measure in-situ vulnerability, control their distinguishing signatures and mitigate emissions, allowing undersea platforms to blend into/mimic the surrounding environment

USW-PDS-02:
Develop platform and component design tools that provide for optimum mission flexibility without compromising mission accomplishment

USW-PDS-03:
Improve and validate models and tools designed to reduce the susceptibility of undersea platforms to detection

USW-PDS-04:
Improve capabilities to predict, monitor, prevent and control corrosion/marine growth fouling on undersea platforms without degrading performance

USW-PDS-05:
Improve ability to assess and/or repair damage while forward deployed or underway

USW-PDS-06:
Develop/improve non-invasive capability to monitor, diagnose, and prognosticate hull conditions, predict failures and alert operators while underway and during scheduled/unscheduled maintenance

USW-PDS-07:
Develop/certify advanced platform, component and/or part design and manufacturing capabilities that allow for qualification and production of processes and materials to support rapid, low-cost manufacture for in-service and acquisition programs

BETHESDA, Md. (March 5, 2013) Dr. Jennifer Wolk, a materials engineer at Naval Surface Warfare Center Carderock Division (NSWCCD), is researching nonferrous naval materials such as aluminum and titanium, in particular in the area of microstructural evolution of these materials due to joining. She also works in advanced manufacturing processes, such as friction stir welding, cold spray and additive manufacturing. (U.S. Navy photo/Released)

“Although we’ve been generally successful at developing technology for the Navy after next it’s no longer enough in today’s environment. We know we must continue to foster rapid innovation to help solve technological capability gaps in the short term.”

RADM Michael Jabaley
Program Executive Officer, Submarines

POWER & ENERGY (PE)

Safe and reliable power and energy sources are key enablers that ensure undersea dominance is maintained. Long endurance systems will support the disruption of enemy activities and provide maximum mission flexibility. High power and energy dense systems must support the operations of multiple undersea assets and missions without sacrificing payload volume.

GOALS:

- **Improved energy density, safety and reliability of power and energy sources that support undersea platforms and operations**
- **Ability for Undersea Forces to take advantage of the abundant energy sources that reside in their operational environment**

Objectives

USW-PE-01:

Develop safe, reliable, affordable and high efficiency energy management, generation, transfer, shipment, deployment and storage for undersea platforms

USW-PE-02:

Develop safe, reliable, affordable and efficient high pulse power management, generation, transfer and employment.

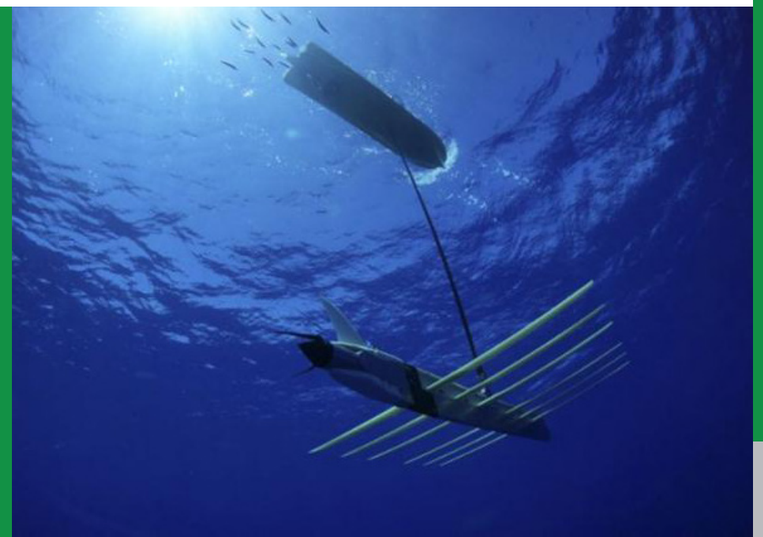
USW-PE-03:

Develop the capability to reliably and safely harvest, obtain, store and transfer energy to undersea assets

USW-PE-04:

Develop capability to reliably characterize the failure effects and modes of power and energy sources

An underwater view of Liquid Robotics' SHARC, a wave-powered, autonomous ocean vehicle for persistent surveillance and communications. (Reuters/Liquid Robotics)



"Undersea dominance – that is an inherently Department of Navy domain. And we are just scratching the surface in some of the capabilities to be able to give…forward fleet commanders the emerging capabilities and technologies to build the Eisenhower highway network undersea across the entire sea. Thousands of miles of logistical networks to allow large scale deployment of UUVs, allowing them to communicate, engage, resupply…those technologies are focused around the same technologies that support our directed energy, our unmanned systems and our electric weapons."

RADM Mathias Winter
Chief of Naval Research

STRIKE & INTEGRATED DEFENSE (SID)

Undersea assets are key to projection of military power and defense of United States interests at home and around the globe. Undersea warfighters will utilize on demand weapons, undersea platforms and systems that enable Undersea Forces to complete missions in hostile environments by avoiding, defeating and surviving attacks.

GOALS:

- Increased capability, capacity, endurance, affordability and range of undersea weapons systems to include the development and integration of directed energy weapons
- Ability for undersea systems to avoid, detect and/or counter enemy attack

Objectives

USW-SID-01:

Improve offensive undersea weapon lethality performance to deny adversary safe havens and support mission and platform kill

USW-SID-02:

Increase submarine payload capacity

USW-SID-03:

Develop the capability to target and prosecute adversary mobile and fixed distributed netted systems (DNS)

USW-SID-04:

Improve strike weapon system performance and affordability

USW-SID-05:

Develop the next generation of weapons, countermeasures and payloads

USW-SID-06:

Improve the ability to counter adversary Undersea Warfare (USW) capabilities, including unmanned systems that threaten undersea systems

USW-SID-07:

Improve modularity in weapon system design to permit mission reconfiguration, repair and reduce support requirements

USW-SID-08:

Improve weapons systems design to permit over-the-horizon targeting from multiple sources to extend the range beyond organic sensors, decoupling the shooter from the sensor

ATLANTIC OCEAN (June 2, 2014)
A trident II D-5 ballistic missile is launched from the Ohio-class ballistic missile submarine USS West Virginia (SSBN 736) during a missile test at the Atlantic Missile Range. The test flights were part of a demonstration and shakedown operation, which the Navy uses to certify a submarine for deployment after a major overhaul. The missiles were converted into test configurations with kits containing range safety devices and flight telemetry instrumentation. The U.S. Navy supports U.S. Strategic Command's strategic deterrence missions by operating and maintaining Ohio-class ballistic missile submarines to deter regional and strategic threats. The triad, the U.S. strategic nuclear forces of ICBMs, bombers, and ballistic missile submarines, remains the primary deterrent of nuclear attacks against the U.S., our allies, and partners. (U.S. Navy photo/Released)

"We need to be thinking about cross-domain capabilities like nextgeneration sub-launched anti-surface weapons, land-attack weapons, and more. Like I said, there are a lot of different things that could fit in those nice big tubes that will be on the Virginias, and we need to be thinking about how we can exploit that flexibility to achieve the greatest tactical, operational, and strategic effects."

CONGRESSMAN J. RANDY FORBES (R-VA)
Chairman, House Armed Services Committee

WARFIGHTER PERFORMANCE (WP)

In order to optimize warfighter performance and effectiveness in the undersea environment, future forces will leverage new techniques in processing, displays, training, health surveillance and delivery, behavioral solutions, personnel processes and man-machine teaming. These enhancements will correlate to return on investment measures as expressed as total ownership cost decision trade space for USW technology insertion.
The outcome measures should improve major program managers' design and procurement decisions resulting in reduced total ownership costs and increased readiness.

GOALS:

- User-centered design methodologies to solve submarine "Plan-Brief-Execute-Assess" support needs
- Improved availability, reliability, quality, time-latency of receipt and usefulness of critical data and information needed by the tactical team to make better-informed decisions in the time available
- Human machine interface designs based on results of task analyses, applying cognitive science, human factors expertise and best-practices
- Training tailored to the individual and team anywhere, anytime through simulation-based technologies for multi-mission, multi-platform training
- Enhanced submariner readiness and retention by monitoring and improving the health, wellness, and resilience of the submariner
- Systems that support and exploit individual differences of undersea operators

Virginia-class layout in Combat Systems Collaboration And Fleet Experimentation (CAFÉ) laboratory. NUWC Newport.

Objectives

USW-WP-01:

Develop unmanned systems battlespace management capability that collects relevant sensor data, in real time, network platform sensors, detect threats, control, coordinate and de-conflict operations

USW-WP-02:

Develop human-centered analytic techniques that allow submarine commanders to rapidly and confidently move from data-to-options-to-informed decisions both tactically and in terms of personnel and administrative data

USW-WP-03:

Develop on-board adaptive training tools to support both individual operator instruction and integrated team training that both increases operator retention and improves individual and team proficiency

USW-WP-04:

Develop distributed schoolhouse capabilities that operates within a common virtual environment to allow access and manipulation by geographically distributed students (individually or collaboratively in teams) and instructors

USW-WP-05:

Enhance the resilience of individual submariners to reduce unplanned losses through selection, self-assessment, training and informed submarine force integration processes

USW-WP-06:

Improve submariner medical health and psychological wellness through comprehensive monitoring to identify and reduce the medical and psychological risk factors

USW-WP-07:

Improve the effectiveness of shallow water submarine escape, rescue and survivability

"Virtual and simulated environments offer an unprecedented opportunity for the Department of the Navy to transform how it connects people, ideas, and information"

Ray Mabus
Secretary of the Navy

UNDERSEA PRECISION NAVIGATION & TIMING (UPNT)

The ability for undersea assets to operate with precise understanding and awareness of positional location is paramount toward conducting undersea missions. Future undersea assets will require new innovative methods for determining position and timing with minimal error in an increasingly adverse operational environment.

GOALS:

- Identify, pursue, and mature enabling technologies that allow undersea assets the continued ability to reliably determine position and timing with high accuracy confidence and minimized uncertainty in an evolving far-forward environment.

- Identify, pursue, and mature new positioning, navigation, and timing technologies which enable reduced dependence on overhead sensors.

Objectives

USW-UPNT-01:

Improve precision navigation capabilities for undersea assets that reduce position errors in GPS-denied and/or detached, degraded, intermittent, and low-bandwidth (DDIL) environments

USW-UPNT-02:

Develop methods to gather and utilize bathymetric data to be used for alternative navigation sources

USW-UPNT-03:

Develop next generation capabilities to support strategic deterrence mission without use of above water sensors

USW-UPNT-04:

Develop next generation capabilities to collect geo-acoustic and oceanographic data using organic and non-organic sensors

USW-UPNT-05:

Develop data fusion technologies to integrate navigation data from multiple sources to enable navigation planning, waterspace management, and improved situational awareness via a holistic navigation operational picture

USW-UPNT-06:

Develop submarine navigator tools that support planning activities, and the means to determine the limitations of knowledge surrounding such planning tools, as expressed by a suitably quantified uncertainty

ARCTIC CIRCLE (March 15, 2016)
Los Angeles-class submarine USS Hartford (SSN-768), surfaces near Ice Camp Sargo during Ice Exercise (ICEX) 2016. ICEX 2016 is a five-week exercise designed to research, test, and evaluate operational capabilities in the region. ICEX 2016 allows the U.S. Navy to assess operational readiness in the Arctic, increase experience in the region, advance understanding of the Arctic Environment, and develop partnerships and collaborative efforts. (U.S.Navy photo by Mass Communication Specialist 2nd Class Tyler Thompson/Released)

“Undersea forces operate far forward, are persistent and covert. Our non-provocative influence can deter and de-escalate potential conflicts by providing cross-domain intelligence, real-time warning to U.S. leadership, and rapid transition from peacetime if required. We are the anti-A2AD force, operating inside adversary defenses, using our access to set the table for the joint force, capitalizing on our stealth, and exercising surprise at the time and place of our choosing.”

VADM Joseph Tofalo
Commander, Submarine Forces

USW STO TO COMSUBFOR COMMANDER'S INTENT LINES OF EFFORT MAPPING

USW STOs	LOE 1	LOE 2	LOE 3	LOE 4
	Provide Ready Forces	Maximize Employment Effectiveness	Develop Future Force Capabilities	Empower our People, the Foundation of our Strength
Assure Access to Maritime Battlespace				
USW-AA-01		●	●	
USW-AA-02		●	●	
USW-AA-03		●	●	
USW-AA-04		●	●	
USW-AA-05		●	●	
USW-AA-06		●	●	
Autonomy and Unmanned Systems				
USW-AUS-01		●	●	
USW-AUS-02		●	●	
USW-AUS-03		●	●	
USW-AUS-04		●	●	
USW-AUS-05		●	●	
USW-AUS-06		●	●	
USW-AUS-07		●	●	
USW-AUS-08		●	●	
Undersea Maneuver Warfare				
USW-UMW-01			●	
USW-UMW-02			●	
USW-UMW-03			●	
USW-UMW-04		●	●	
USW-UMW-05			●	
USW-UMW-06			●	
USW-UMW-07			●	
USW-UMW-08			●	
USW-UMW-09	●		●	
Expeditionary & Irregular Warfare				
USW-EIW-01		●	●	
USW-EIW-02		●	●	
USW-EIW-03		●	●	
USW-EIW-04		●	●	
Information Dominance & Cyber				
USW-IDC-01		●	●	
USW-IDC-02		●	●	
USW-IDC-03	●	●	●	
USW-IDC-04	●	●	●	

USW STOs	LOE 1	LOE 2	LOE 3	LOE 4
	Provide Ready Forces	Maximize Employment Effectiveness	Develop Future Force Capabilities	Empower our People, the Foundation of our Strength
Platform Design & Survivability				
USW-PDS-01		●	●	
USW-PDS-02	●	●	●	
USW-PDS-03	●	●	●	
USW-PDS-04	●		●	
USW-PDS-05	●		●	
USW-PDS-06	●		●	
USW-PDS-07	●	●	●	
Power and Energy				
USW-PE-01	●		●	
USW-PE-02	●		●	
USW-PE-03	●		●	
USW-PE-04	●		●	
Strike & Integrated Defense				
USW-SID-01		●	●	
USW-SID-02		●	●	
USW-SID-03		●	●	
USW-SID-04		●	●	
USW-SID-05		●	●	
USW-SID-06		●	●	
USW-SID-07		●	●	
USW-SID-08		●	●	
Warfighter Performance				
USW-WP-01	●		●	●
USW-WP-02	●		●	●
USW-WP-03	●		●	●
USW-WP-04	●		●	●
USW-WP-05	●		●	●
USW-WP-06	●		●	●
USW-WP-07	●		●	●
Undersea Precision Navigation and Timing				
USW-UPNT-01			●	
USW-UPNT-02			●	
USW-UPNT-03			●	
USW-UPNT-04			●	
USW-UPNT-05			●	
USW-UPNT-06	●		●	●

Table 1: USW STO to Commander's Intent Mapping

USW STOs vs. LOEs

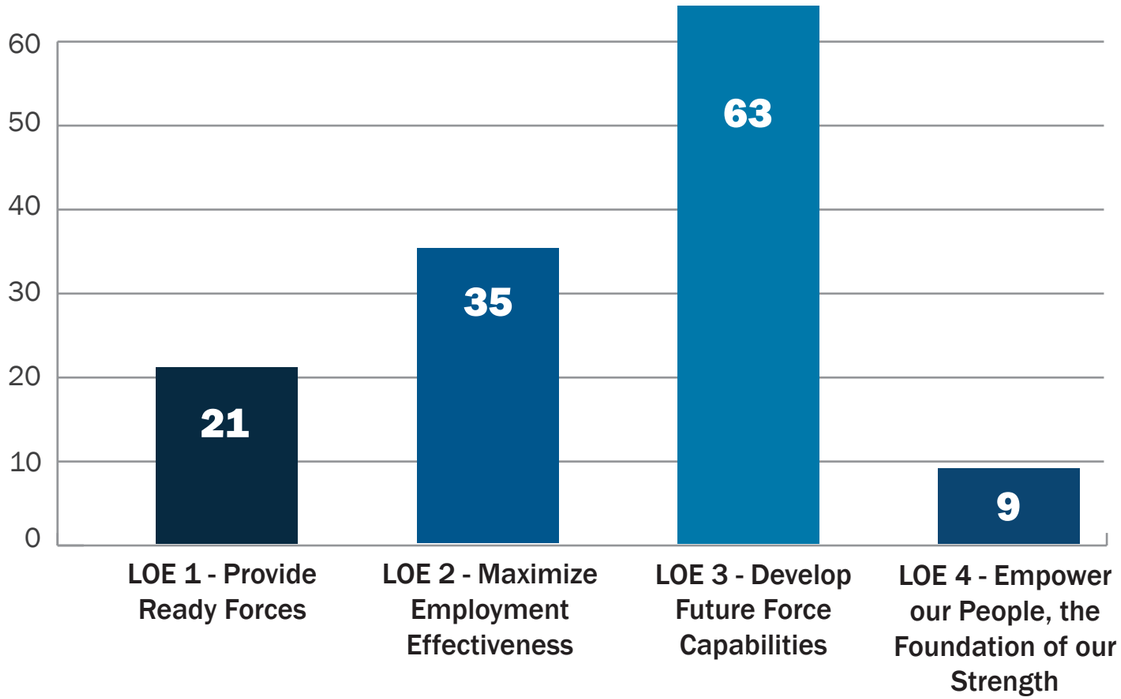


Figure 4: USW STO to Commander's Intent Distribution

USW STO TO COMSUBFOR UNDERSEA DOMINANCE GOALS MAPPING

USW STOs	COMSUBFOR Undersea Dominance Goals				
	Grow Longer Arms	Beat the Adversary's System	Get on the Same Page	Protect Our Strategic Assets... and Threaten Theirs	Own The Best Platforms
Assure Access to Maritime Battlespace					
USW-AA-01		●		●	●
USW-AA-02		●			
USW-AA-03		●			
USW-AA-04				●	●
USW-AA-05		●			
USW-AA-06			●		
Autonomy and Unmanned Systems					
USW-AUS-01	●	●			
USW-AUS-02	●				
USW-AUS-03		●		●	
USW-AUS-04			●		
USW-AUS-05			●		
USW-AUS-06			●	●	
USW-AUS-07		●			
USW-AUS-08			●		
Undersea Maneuver Warfare					
USW-UMW-01		●			
USW-UMW-02		●		●	●
USW-UMW-03	●	●	●		
USW-UMW-04	●	●			●
USW-UMW-05	●				
USW-UMW-06	●	●			
USW-UMW-07			●		
USW-UMW-08	●	●			●
USW-UMW-09	●	●			
Expeditionary & Irregular Warfare					
USW-EIW-01		●			
USW-EIW-02			●		
USW-EIW-03			●		
USW-EIW-04	●		●		
Information Dominance & Cyber					
USW-IDC-01	●		●		
USW-IDC-02			●		
USW-IDC-03				●	●
USW-IDC-04				●	●

USW STOs	COMSUBFOR Undersea Dominance Goals				
	Grow Longer Arms	Beat the Adversary's System	Get on the Same Page	Protect Our Strategic Assets... and Threaten Theirs	Own The Best Platforms
Platform Design & Survivability					
USW-PDS-01				●	
USW-PDS-02		●			●
USW-PDS-03		●			●
USW-PDS-04					●
USW-PDS-05					●
USW-PDS-06					●
USW-PDS-07					
Power and Energy					
USW-PE-01	●				●
USW-PE-02	●				●
USW-PE-03	●				
USW-PE-04					●
Strike & Integrated Defense					
USW-SID-01		●			
USW-SID-02	●	●		●	
USW-SID-03		●			
USW-SID-04		●			●
USW-SID-05	●	●		●	
USW-SID-06		●		●	
USW-SID-07					●
USW-SID-08	●		●		
Warfighter Performance					
USW-WP-01			●		●
USW-WP-02			●		
USW-WP-03			●		●
USW-WP-04			●		
USW-WP-05			●		●
USW-WP-06	●	●			●
USW-WP-07					●
Undersea Precision Navigation and Timing					
USW-UPNT-01	●	●	●		●
USW-UPNT-02		●		●	●
USW-UPNT-03				●	
USW-UPNT-04				●	●
USW-UPNT-05			●	●	
USW-UPNT-06			●		

Table 2: USW STO to COMSUBFOR Undersea Dominance Goals Mapping

USW STOs vs. USD Goals

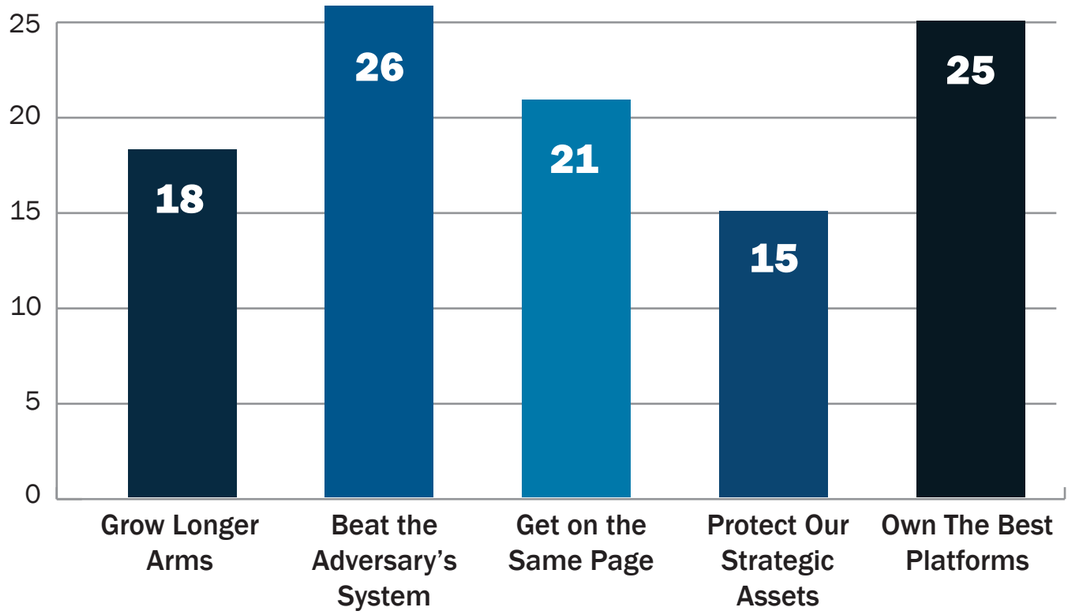


Figure 5: USW STO to COMSUBFOR Undersea Dominance Goals Distribution

APPENDIX A - REFERENCES

National Strategic Documents

- National Security Strategy
- The National Military Strategy of the United States of America
- Quadrennial Defense Review
- The National Strategy for Maritime Security

Joint and Naval Strategic Documents

- Air Sea Battle: A Point of Departure Operational Concept
- Joint Operating Environment
- Joint Operational Access Concept
- Department of the Navy Objectives for FY 2012 and Beyond
- CNO Navigation Plan
- A Design for Maintaining Maritime Superiority
- CNO SSG XXXII Way Ahead Plan: Sustaining the Navy's Undersea superiority
- A Cooperative Strategy for 21st Century Seapower
- Naval Operations Concept
- Naval S&T Strategy
- Undersea Warfare Vision 2025
- Undersea Dominance Campaign Plan
- Commander's Intent for the U.S. Submarine Force and Supporting Organizations
- Integrated Undersea Future Investment Strategy (IUFIS)
- Naval Special Warfare S&T Strategic Plan
- Operation of the Defense Acquisition System, DoD Instruction 5000.2
- International Hydrographic Organization Geospatial Standard for Hydrographic Data

Naval S&T Documents

- Naval Technology Gaps
- Surface Enterprise Science & Technology Objectives
- Naval Aviation Enterprise Science & Technology Objectives
- Information Warfare Science & Technology Objectives
- Integrated Undersea Surveillance System S&T Objectives (ISTOs)

APPENDIX B – ABBREVIATIONS & ACRONYMS

A2AD	Anti-Access/Area Denial
A2I	assured access with influence
AA	Assure Access to Maritime Battlespace
ASN (RDA)	Assistant Secretary of the Navy for Research, Development and Acquisition
ASuW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
AUS	Autonomy and Unmanned Systems
BOD	Board of Directors
C2	Command and Control
CS-21R	Cooperative Strategy for 21st Century
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
COMSUBFOR	Commander, Submarine Force
CTO	Chief Technology Officer
D&I	Discovery and Invention
DARPA	Defense Advance Research Project Agency
DDIL	Detached, degraded, intermittent, and low-bandwidth
DEA	Data Exchange Annex
DIA	Defense Intelligence Agency
DNS	Distributed Netted Systems
DOD	Department of Defense
EIW	Expeditionary & Irregular Warfare
FCG	Future Capability Group
FA	Focus Area
GTA	Global Technology Awareness
IDC	Information Dominance & Cyber
IEA	Information Exchange Annex
IUFIS	Integrated Undersea Future Investment Strategy
LOE	Line of Effort
NAVSEA	Naval Sea Systems Command
NIPO	Navy International Programs Office
NR&DE	Naval Research and Development Enterprise
NUWC	Naval Undersea Warfare Center
NWDC	Naval Warfare Development Command
ONI	Office of Naval Intelligence
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
OSD	Office of the Secretary of Defense
PDS	Platform Design & Survivability
PE	Power and Energy
PEO SUB	Program Executive Office, Submarines
PHA	Portfolio Health Assessment

POC	Point of Contact
POR	Program of Record
RF	Radio Frequency
S&T	Science and Technology
SDMG	Ship Alt Development Modernization Group
SID	Strike & Integrated Defense
SITG	Submarine Information Technology Governance Group
SOF	Special Operations Forces
SPAWAR	Space & Naval Warfare Systems Command
SSG	Strategic Studies Group
STEED	Science and Technology Executive Engagement Day
STO	Science and Technology Objective
STRG	Submarine Tactical Requirements Group
TAB	Transition Advisory Board
TOG	Technical Oversight Group
TPO	Technical Projects Officer
TTL	Tagging, tracking and locating
UMW	Undersea Maneuver Warfare
USD	Undersea Domain
USE	Undersea Enterprise
USW	Undersea Warfare
UPNT	Undersea Precision Navigation and Timing
UUS	Unmanned Undersea System
UWDC	Undersea Warfare Development Command
WP	Warfighter Performance

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UNDERSEA WARFARE
CHIEF TECHNOLOGY OFFICE

Enabling Strategic Innovation for the Undersea Force