

Leveraging the USW Force for Undersea Superiority; Sea Floor to Space, Deep Water to the Littorals, and Across the Electromagnetic Spectrum

UNDERSEA WARFARE DIVISION



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NAVSEA WARFARE CENTERS: “BE THE DISRUPTED, OR BE THE DISRUPTORS”

A MESSAGE FROM THE NAVAL UNDERSEA WARFARE CENTER

Last fall, I shared my views about collaborating to leverage emerging technologies in undersea warfare. Continuing that dialog is critical to ensuring we “expand the undersea advantage.” In particular, I look forward to hearing your insights and ideas about new capabilities, services, and products that you see on the horizon. Now more

than ever, NDIA is needed to help lead the way by bringing government, industry, and academic visionaries together at conferences and roundtables to champion innovation, embrace a measure of risk, and share lessons learned.

As the NAVSEA Warfare Centers commemorate our 25th anniversary this year, we recognize that our mission hasn’t changed dramatically since 1992, but our operating environment certainly has. We are living in an era of extremely rapid social and technological change, marked by both dramatic breakthroughs in fundamental areas of science and technology and accelerated dispersal of new capabilities. Many of the advances in biology, chemistry, physics, natural science, data analytics, quantum computing, robotics, and artificial intelligence have the potential to drastically alter the landscape of future warfare, and specifically undersea warfare (USW). Will we be ready for it? The answer boils down to a single choice: we can either be disrupted or be the disruptors. We, in partnership with government, industry, and academia,

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must innovatively apply the right technologies to address the most critical challenges for USW component areas, including observation and sensing, command and control, engagement, and platform design.

These technological breakthroughs are driven by significant and rapid advancements in hardware

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capability, such as transistor density and ubiquitous sensors, statistical and computational methods (big data analytics, deep learning, etc.), computer science, as evidenced by Artificial Intelligence (AI), and biological and natural sciences, such as a brain-machine interface. The proliferation of the transistor onboard Navy platforms is a good example of rapid technological adoption. When the USS Nautilus was launched in 1954, it marked the advent of the modern submarine era, yet it had zero transistors. Today's submarines are equipped with chip-laden servers in which a single commercially available chip has more than 7 billion transistors. Couple the advancement in computational power with the exponential growth of smaller, autonomous, networked sensors (by 2020, the number of sensors around the globe is expected to rise to 20-30 billion), and our ability to leverage the internet of things (IoT) and run our decision cycle faster becomes central to maintaining maritime superiority.

We have an imperative to exploit the untapped potential from the plethora of IoT devices and their attendant networked sensors, which combined with quantum-level processing utilizing new deep learning and AI algorithms, will enable a game-changing awareness of our surroundings. We will need to quickly perfect and synthesize big data analytics and deep learning algorithms to transform the data generated by IoT devices (public domain sources could include satellite photos, environmental sensors, social media, financial and logistic activity) into information that ultimately can be acted upon. But none of this can be done without significant computational power required to generate and access vast databases of historical ground truth to perform real-time anomaly detection. We believe data analytics and computational power will be up to the challenge, but will our command and control capabilities keep pace as we add payloads such as unmanned autonomous systems? What will command and control look like as we adapt AI and brain-machine interface technologies that have the potential to create serious disruption for how we control large sensor fields, unmanned vehicles, and design platforms? We must pursue these technologies and develop strategies in which we are the first and best adopters for both offensive and defensive applications.

All of these technological changes, fed by advances in learning, will put "human-led" decision capabilities in forward-deployed systems. We've seen examples

of both synchronized robots and a collaboration of robots performing self-organizing tasks or learned behavior. How do we, as technologists and warfighters, incorporate these innovations into our systems, our doctrine, and our training? The picture of the future is one where cueing will evolve to a scale not previously imagined. Researchers at Harvard University built a bio-hybrid stingray of plastic and powered by light-sensitive rat heart muscles that can live almost a week in a sugar water and salt solution. Bio-hybrids, or robots that mimic biologics, introduce a whole new range of possibilities.

Think of the potential for USW with the future synergistic intersection of basic science and the eventual technical application of advanced computing, AI, and robotics. How do we make sure we design for this potential capacity and flexibility in the future? We are moving into an era in which we can design material properties to meet our requirements, and field new capabilities, platforms, and payloads.

To prepare to meet such a dynamic and challenging future head on, we must look to higher-level guidance, such as the Office of Naval Research's Science and Technology Strategy and the Department of the Navy Research, Development, Test and Evaluation 30 Year Strategic Plan. The latter outlines several strategic focus areas designed to foster innovation, increase collaboration, and enable robust competition to create a culture for delivering and fielding advanced warfighting capabilities. These focus areas include providing industry and small business with continuing access to Department of the Navy needs and plans, discoveries, findings, and in-house capabilities to inform independent research and development investments; accelerating the development of promising engineering, scientific, and technology



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innovations, including those developed by other services, commercial industry, allies, and partners; and utilizing national and foreign critical technologies through other services, government, commercial and academic partnerships and collaboration.

In alignment with this higher-level guidance, the NAVSEA Warfare Centers are developing Long Range Research and Development Plans (LRRDPs) for surface, undersea, mine and expeditionary warfare mission areas, as well as for platforms and lifecycle support technologies – across our 10 divisions – as the framework to identify the future technologies the Navy will draw upon for today, tomorrow, and the Navy after next. We envision playing a leading role in defining the future force in collaboration with the fleet, the Warfare Centers' fleet engagement teams and chief technology officers, academic and industry partners, University Affiliated Research Centers, and Federally Funded Research and Development Centers.

Another step is to more closely align our investments, such as Naval Innovative Science and Engineering (219), Capital Improvement Program, Internal Research and Development, workforce, and Naval Engineering Education Consortium, with mission areas and the higher-level guidance. For example, NUWC scientists are researching bio-inspired technologies such as hydrodynamic detection abilities found in seals as a method to perform non-acoustic sensing; echolocation found in bats to develop bio-inspired broadband sonar; and mimicking neurological computer architectures as a way to perform reconfigurable computing, which may someday allow computers to process information the same way a brain does.

The Warfare Centers are leveraging high velocity learning methods – reinvigorating a culture of assessment and increasing the speed at which we learn and share that learning – to better implement our LRRDPs. For example, our divisions are using the iNFUSION social intranet platform as a way for our workforce to connect, learn and share information quickly within the naval enterprise. Other examples include crowdsourcing ideation platforms that encourage the innovative thinking of our employees. Our divisions are conducting hackathon and slack hack (more focused / intense shorter duration) events as ways to enable employees to develop new concepts and ideas to solve technical challenges. Results from these events include "Berries for Boomers," which has been studied by the Navy and aims to improve

morale and job performance on submarines by providing fresh food via hydroponic gardening, and "Brilliant Bubbles," which proposes a low-cost, wide-area undersea search and surveillance capability. The Warfare Centers are actively supporting the rapid prototyping, experimentation and demonstration program, which has resulted in a number of fielded urgent rapid capability initiatives. We're also encouraging our workforce to become "fast followers and adopters" when industry or academia has the technological lead. Regular exchanges with our partners will increase our chances for success, so NDIA conferences will continue to play critical roles in connecting the threads of innovation across the undersea warfare community.

Above all, we must continue to ask ourselves, "what's next?" We want industry to share ideas about where the next wave of technological innovation will come from. Global threats will continue to diversify as the pace of technology rapidly advances and its availability is more ubiquitous. The commercial sector is becoming the locus of cutting edge technology, so we must find ways to adapt the technology, and develop the doctrine and training required to incorporate it into warfighting concept of operations to outpace our adversaries. Just as the technologies the fleet is using now were developed many years ago, it's imperative that we start thinking of the future – the next 50 years and beyond – today to make sure we get there first. Our nation and Navy are counting on us.

DIVISION CHAIR'S MESSAGE



PAUL E. NORMAND, CHAIRMAN
UNDERSEA WARFARE DIVISION

Thank you for your continued support of National Defense Industrial Association's Undersea Warfare Division. Our goals are to provide you the best classified forums to understand the Navy's objectives to achieve and maintain superiority in the most demanding environment.

I would like to congratulate Wayne Jakubowski and Gregory Vaughan for their outstanding leadership in the execution of our spring conferences in San Diego each year. They will be relieved by Greg Bauer and RADM(ret) Joe Horn who after a great turnover will lead next year's spring conference. Thank you Wayne and Greg and welcome to Greg and Joe.

The challenges that our country faces are enormous and we must work together for the greater good of the country. I encourage you to engage your members of Congress and ask them to reach across the aisle and achieve consensus with their colleagues taking into consideration the greater good of our great country over partisan objectives. Just like undersea warfare is a team and coalition fight, Members of Congress achieving consensus on the budget is equally important. Furthermore, make sure that your members understand the **negative impact** that continuing resolutions have on your company and encourage them to pass the authorization and appropriations bills before the start of the fiscal year.

The challenges that our country faces are enormous and we must work together for the greater good of the country.

The Executive Board held elections just before this conference and I am being relieved as the Chairman of the Undersea Warfare Division at the conclusion of this plenary session. I am pleased to introduce Michael Tucker as the Chairman of the Undersea Warfare Division. Michael served as the Deputy Chairman for the last two years and is a gifted leader who I am confident will lead the division to new levels of achievement. I wish Michael and his leadership team all the best and stand by to provide assistance when asked.

More importantly, I ask that each one of you as individuals and as members of your respective companies continue your quest for excellence in the execution of your lives. America needs you; and as a team we can achieve more and continue to sustain our dominance of the undersea domain.



ADMIRAL KIDD CONFERENCE CENTER
NAVAL BASE PT. LOMA

FALL 2016 NDIA UNDERSEA WARFARE AWARDS



DAVID MEDEIROS, CHAIRMAN
AWARDS COMMITTEE

The NDIA Undersea Warfare Division (UWD) Bronze Award is issued to recognize outstanding individual achievements in either Science or Engineering in the field of Undersea Warfare and is awarded to key individuals in the principal Navy and University Laboratories engaged in Undersea Warfare related activities. By recognizing these individual achievements, the UWD seeks to:

- Reward achievement in the field of Undersea Warfare;
- Inspire accomplishment by other workers in the field;
- Increase public awareness of the field and its importance to Defense preparedness.

The NDIA UWD was pleased to present Bronze Medal Awards to the following individuals during the Plenary Session of the fall 2016 USW Conference in Groton, CT. Unfortunately, Mr. Griffin was not able to attend the fall conference to receive his award in person.



MR. RICK FILLHART
NAVAL AIR WARFARE CENTER (NAWC),
AIRCRAFT DIVISION

Mr. Fillhart's contributions to developments for Undersea Warfare are directly reflected in the design and integration of new multi-static systems that employ coherent acoustic source technology and improved signal processing and displays into Maritime Patrol and Reconnaissance Aircraft. In particular, Mr. Fillhart's technical expertise in leading the Multi-static Active Coherent (MAC) system developments has enhanced the ability of the U.S. Navy to conduct the airborne Anti-Submarine Warfare (ASW) mission to maintain this country's air and sea maritime superiority.



MR. DAVID EVERHART
NAVAL SURFACE WARFARE CENTER,
PANAMA CITY DIVISION

Mr. Everhart's influence within the USW community has been recognized and respected for the technological advancements and innovative practices he has introduced and underscore his exceptional achievements spanning a distinguished 35-year career. He has distinguished himself as the Navy's Research and Development Subject Matter Expert while leading the transformation from traditional mining capabilities to the development of new minefield concepts to support precision mining and smart networked mining capabilities.

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MR. KENNETH ANDRONOWITZ
NAVAL UNDERSEA WARFARE CENTER,
DIVISION NEWPORT

Every day in his role as manager of the Anti-Submarine Warfare Advanced Development Laboratory, Mr. Andronowicz makes significant contributions to securing the Navy's undersea posture through thoughtful analysis and evaluation of at-sea data. He provides technical leadership and direction in the research, development, and deployment of advanced automated concepts to improve torpedo defense and anti-submarine warfare capabilities for the Navy and has recommended and transitioned numerous automated torpedo defense solutions that improve the warfighters' self-defense capabilities.



MR. KEVIN CRONIN
NAVAL UNDERSEA WARFARE CENTER,
DIVISION NEWPORT

A recognized subject matter expert in Sonar and Combat Control Display technologies and Test and Evaluation for undersea warfare (USW), Mr. Cronin has provided sustained exceptional service. As Division Newport's Customer Advocate, he provided technical expertise and leadership to the NAVSEA Warfare Centers, sponsors, and stakeholders with seamless coordination to gain and secure support for sonar and combat control technologies for the U.S. Navy. Through exceptional customer advocacy efforts with key stakeholders, he has helped enhance Division Newport's reputation as a leader in systems engineering through several programs of record.



MR. THOMAS GRIFFIN
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY DIVISION

Across his thirty-year career, Mr. Thomas Griffin has distinguished himself as a recognized leader in the management, development, design and testing of undersea weapon technology. Mr. Griffin's career has focused on leading the development of Underwater Warhead technology for the Office of Naval Research. During this time, he served as the Principal Investigator for numerous research programs that have developed technology for Light Weight Torpedo and both offensive and defensive 6.75 inch Underwater Weapons. Mr. Griffin has been a major contributor to the ONR 6.3 investment that has realized the directed energy warhead technology currently resident in the CRAW warhead and capable of providing the fleet with significant ASW lethal effects.

FALL 2016 NDIA UNDERSEA WARFARE AWARDS

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The NDIA UWD is honored to recognize these significant contributions to the Undersea Warfare community through our awards program.

Congratulations to the Awardees!



NDIA UWD 2016 ACADEMIC SPEAKER AWARD



MARK ROTHGEB, CHAIRMAN
ACADEMIC FELLOWSHIP COMMITTEE

The NDIA Undersea Warfare Division (UWD) established the Academic Fellowship Program in 1990 to provide financial aid to Ph.D. candidates at universities closely associated with the Navy's undersea warfare community. The objective is to encourage outstanding science and engineering students specializing in fields pertinent to undersea warfare to present their research at our conferences. The student candidate pool is primarily derived from the Navy's University Affiliated Research Centers (UARCs) and the Naval Postgraduate School (NPS). This spring we are pleased to host six academic research contributors from a variety of organizations covering a broad spectrum of topics.



Ensign Mitchell Heaton has a B.S. in Aeronautical Science and is currently enrolled in the Undersea Warfare curriculum at NPS and is pursuing a master's degree in Applied Mathematics. He will be discussing techniques for optimizing recovery of UAVs launched from a submarine to enable re-use, minimize real-time data transfer, and mitigate adversarial exploitation. His presentation is titled

"Randomized Path Optimization for the Mitigated Counter Detection of UAVs".



Chris Monaco received his B.S. and M.S. in Mechanical Engineering at The Pennsylvania State University and is currently pursuing his Ph.D. Chris will be discussing an approach to using vehicle sensors to perform odometry using trackable features in both the underwater and ground environments to estimate vehicle velocities with six degrees of freedom. His presentation is titled "Feature-Based Estimation of

Vehicle Ego-motion and Motion of External Agents".



Paul Stankiewicz is an engineer at the Johns Hopkins Applied Physics and is currently pursuing a Ph.D. at Johns Hopkins University focusing on applying optimal adaptive sampling techniques to autonomous underwater vehicles (AUVs) for environmental monitoring. His Test and Evaluation (T&E) focused topic addresses the challenge of complex, non-deterministic, polynomial-time hard

interactions between the autonomy and the environment and how to intelligently generate test scenarios. His briefing is titled "Adaptive Sampling Methods Applied to Test and Evaluation of Autonomous Systems".



Ryan Somero is a Ph.D. student in the Kevin T. Crofton Department of Aerospace and Ocean Engineering at Virginia Tech. His research is focused on persistent ocean features generated by the interaction of a ship with the ocean environment. His research focuses on ship wake features that are not predictable by current models that neglect complex environmental conditions. He will be presenting his

research titled "Impact of Langmuir Type Circulations on the Structure, Dynamics, and Persistence of Ship Wakes".



Thomas Powers is a Ph.D. Candidate at the University of Washington Department of Electrical Engineering. His current research focuses are developing algorithms for discrete optimization and machine learning. In particular, he will be discussing algorithms to optimize ping sequencing in deep water active sonar arrays to reduce the exponential time processing of brute force algorithms.

His presentations is titled "Constrained Robust Submodular Sensor Selection with Application to Multistatic Sonar Arrays".



Benjamin Goldsberry attended Florida State University and received his bachelor's degree in Applied and Computational Mathematics. He completed his Masters degree in Mechanical Engineering at the University of Texas at Austin, where he studied underwater acoustic propagation and has continued working toward his Ph.D. program researching computational methods

and inverse design of acoustic metamaterials. His research focuses on methods for effectively addressing the large number of design variables required for composite material design for vibro-acoustic sound absorption. His briefing is titled "Inverse Design of Sound-absorbing Materials Using Bayesian Inversion".

UNDERSEA COMMAND, CONTROL, COMMUNICATIONS AND COMBAT SYSTEMS COMMITTEE



PAUL ROSBOLT, CHAIRMAN
DR. BOB ZARNICH, DEPUTY CHAIRMAN
JOHN LINDERMAN, WARFIGHTER PERFORMANCE SESSION CHAIR
CAPT DOUG ADAMS, USN (PEO IWS 5), NAVY LIAISON

Greetings, All! I'm looking forward to a great conference in San Diego! Any excuse to get out of Washington is a good one. We have some terrific speakers lined up for the technical sessions, including CAPT Cory Jackson, Program Manager for Submarine Combat Systems, CAPT Ron Toland, CO of the Fleet ASW Training Center, and CAPT Doug Adams, Program Manager for USW Systems. There are many exciting things going on in USW, particularly in Theater ASW. The whole concept of NIF-CU (Naval Integrated Framework-Counter Undersea) is being fleshed out, and made reality. One of our presenters, Mr. Mike O'Hare, will give us an update on where we are headed in NIF-CU. And now, a word from our sponsor, CAPT Doug Adams.

IWS 5 strives to provide game-changing Anti-Submarine Warfare (ASW) capability to the Fleet across a large spectrum of systems and platforms including: submarine combat systems, surface ASW combat systems, surveillance sonar systems, CVN Tactical Operations Center, and ASW Command and Control. Consistent with messages from leadership, our cornerstones are rapid delivery, innovation, and bringing the warfighters into the development process to give them what they really need. In the next few paragraphs I will discuss two separate but complimentary efforts; Theater ASW (TASW) and Undersea Warfare Decision Support System (USW-DSS).

TASW

The Navy is leveraging existing studies and campaign analyses to collectively determine how to best field an improved TASW capability. Collectively, the Navy is determining what existing Program of Record changes are needed to deliver a more interoperable family of systems. Key enabling requirements include fully-realized USW data fusion technologies, collaborative mission planning, networked communications systems, centralized data management, and flexibility/robustness.

A key to this strategy is to upgrade the existing TASW

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command and control nodes, and then apply the same disciplined approach to these nodes that is used to continuously improve our submarine and surface ASW combat systems. This approach includes an effective research and development process that fosters innovation, incorporates science and technology development from DoD and Industry, includes planned hardware updates, as well as an integrated training continuum; all driven toward delivering the latest ASW capability to the warfighter.

USW-DSS

USW-DSS enables the ASW Commander (ASWC) to plan, coordinate, establish, and maintain an undersea common tactical picture and execute tactical control. Employing net-centric decision-making tools in an open-architecture framework, it enables near-real-time sharing of key ASW tactical data and shortens the ASW kill chain. USW-DSS complements and interfaces with common operational picture (COP) systems such as Global Command and Control System-Maritime and Link-11/16. The SQQ-89 surface ship ASW combat system on cruisers and destroyers provides ship, sensor and track data to USW-DSS. These data sources enable USW-DSS to generate a shared composite track picture for situational awareness. Integrated decision support tools provide the sea combat commander, theater ASW commander, and ASWC the ability to plan, conduct, and coordinate USW operations across all ASW platforms.

USW-DSS Build 2 Release 3 (B2R3) completed initial operational test and evaluation (IOT&E) in FY 2013. By the end of FY17, USW-DSS will be delivered to a total of 61 surface combatants, aircraft carriers, and shore commands. B2R3 fully leverages the Consolidated Afloat Networks and Enterprise Services hardware and software computing environment by installing as software-only on ships. A B2R3 software update (Build 3 Fleet Capability Release (FCR) 1) will commence in FY 2017. B2R3 fielding is planned to continue through FY 2020 until Build 3 matures. The focus of USW-DSS Build 3 FCR 1 is on improvements for TASW Commanders.

UNDERSEA MINE WARFARE COMMITTEE



JON TOBIAS, CHAIRMAN
ERIC HOLMES, DEPUTY CHAIRMAN

First, I'd like to thank Eric Holmes for his dedication to the Mine Warfare (MIW) community the last several years as Chairman of the MIW Committee. Eric has been a

driving force to ensure relevant and impactful issues were brought forward throughout the Undersea Warfare community and in this forum. His networking and insights have been invaluable in fostering a truly collaborative relationship between the Navy MIW organizations and industry. Eric will remain a valuable member of the team and I look forward to his continued support and engagement.

This year's conference theme, "Leveraging the USW Force for undersea superiority: sea floor to space, deep water to the littorals, and across the electromagnetic spectrum," provides a lot of room to address the ever-complex Mine Warfare (MIW) environment. Similar to the challenges identified in the last two conferences, a common theme continues to emerge...synergy, or lack thereof, for the integration of capabilities in legacy Mine Countermeasures (MCM) systems (the dedicated MCM force), MCM Mission Package (MP) systems (to include those intended for Littoral Combat Ship (LCS) and systems that can be deployed or integrated into other platforms to include Unmanned Underwater Vehicles [UUVs]), and emerging Expeditionary MCM systems. Maximizing the integration of these systems will be the key to ensuring that the Navy maintains undersea superiority in the near future.

With the planned retirement of the Avenger MCM vessels and MH-53 Sea Dragon helicopters, much of the Navy's MCM capability and capacity still lies in these aging systems. A mix of unmanned and manned systems that are LCS-based is intended to fulfill the Navy's future MIW requirements, even before the MH-53E Sea Dragon helicopters and Avenger class MCM ships are retired.

The MCM MP will include a mix of underwater, surface and airborne capabilities very dissimilar to the former MCM 'Triad.' Airborne Laser Mine Detection System (ALMDS) and Airborne Mine Neutralization System (AMNS) continue integration in the MH-60S Seahawk

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helicopter. The Mine Hunting Unmanned Surface Vehicle (USV) (MHU) program is providing an interim USV based mine hunting capability using the AN/AQS-24 towed sonar, with MHUs currently deployed in the U.S. Central Command Area of Responsibility (CENTCOM AOR). The Common Unmanned Surface Vessel (CUSV) will serve as a host platform and key enabler for a variety of MCM detect/classify, identify, and neutralize capabilities. Initially, it will serve as the employment platform for Unmanned Influence Sweep System (UISS) to provide sustained influence sweep capability, and future integration of a towed mine hunting sonar like the AN/AQS-20 Advanced Mine Hunting system is a possibility. The Knifefish Unmanned Underwater Vehicle (UUV) will provide capability to detect/classify and identify buried and bottom mines in a single pass utilizing a low frequency broad band sonar. Knifefish recently completed a comprehensive evaluation off the coast of Boston using submerged Navy mine test targets. The evaluation represents a significant milestone in the Knifefish program and demonstrates the UUV's capability to detect and classify potential mines, at a variety of depths, each posing a unique threat to naval vessels operating in a mission area. PMS 406 continues to work with its industry partner, General Dynamics Mission Systems, to develop, test, and deliver the needed Knifefish capability to the fleet. The system performed well against a variety of surrogate targets and they are confident performance will remain on schedule.

A more recent emerging future capability is the Barracuda system for near surface mine detection. PMS 420 has provided a recent overview on the acquisition developments. Notice that the MIW community is no longer making a distinction between deep, shallow, and very shallow waters within the water space.

In addition to PMS 420's work to develop and integrate the MCM MPs, PMS 406 will continue to determine how to satisfy the requirements left unmet by the RMS program cancellation. And though the MIW program office (PMS 495) primarily manages most

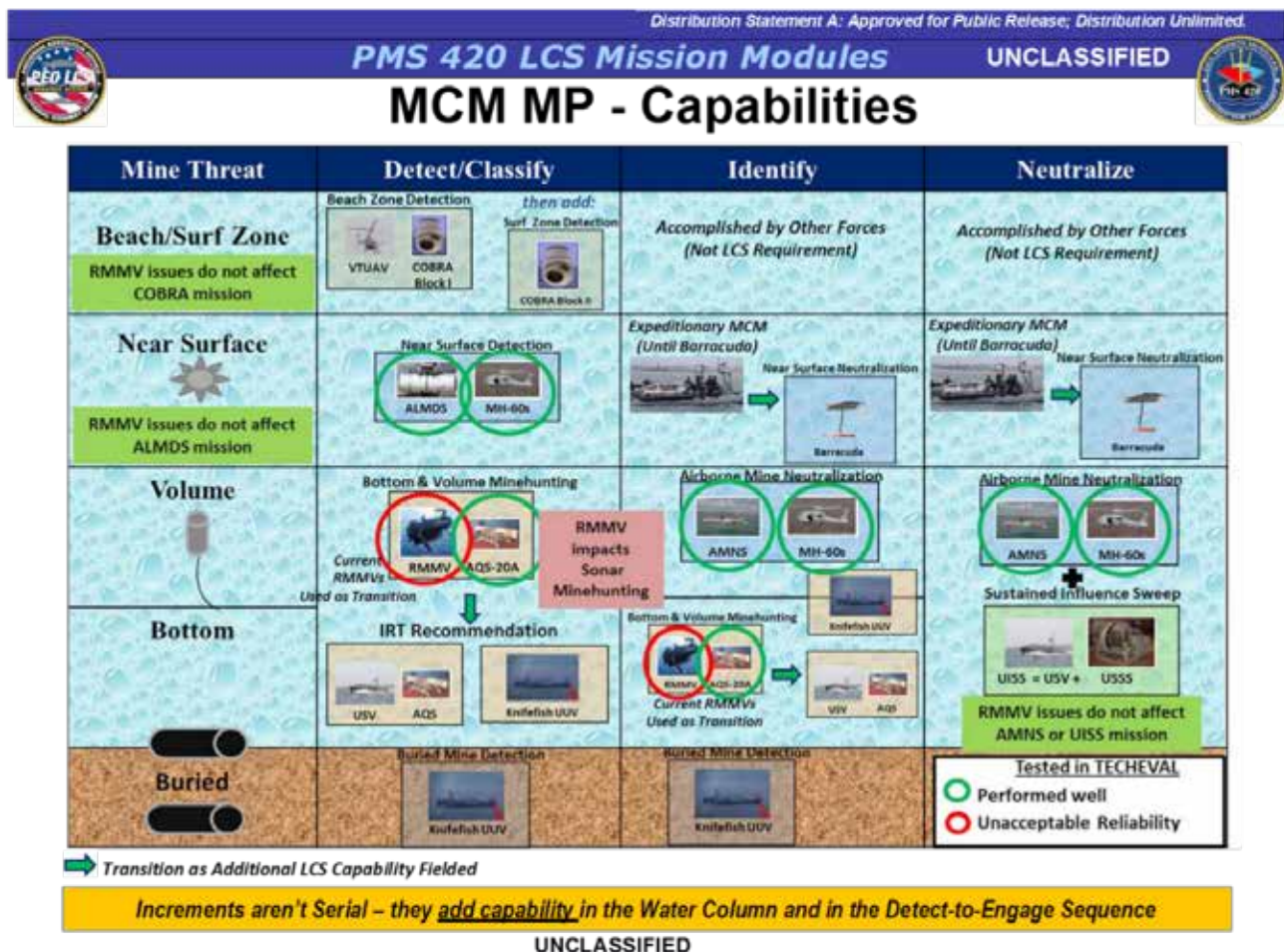
existing legacy MIW systems, they are also looking at enhanced capabilities, particularly in improved mine neutralization, leveraging the ONR Single Sortie Detect to Engage (SS-DTE) Future Naval Capability (FNC).

It is doubtful that these systems will be sufficient in numbers and capabilities to meet the needs in all maritime theatres. Different unmanned systems, other than those that we are currently developing for MIW, will likely be needed. Larger vehicles than those that are LCS-based will be required with extended range and endurance, improved autonomy, integrated command, control and communication systems. Urgent Operational Needs (UONS) and leveraging commercial off-the-shelf (COTS) technologies have led to rapid prototyping and the associated demonstration and test which have contributed to re-thinking MCM concepts of operations (CONOPS) and unmanned vehicle requirements and designs.

One of those capabilities, the Large Displacement Unmanned Underwater Vehicle (LDUUV) will directly

support future MIW requirements from survey to MIW payload delivery. Naval Undersea Warfare Center (NUWC) Newport is looking for a variety of contract mechanisms to get industry involved in the prototyping, which will include a variety of payloads to include mines. The two prototypes will be used to assess key system performance and technology attributes and support concept of operations development. The second phase includes delivering two additional prototype vehicles in FY22. These prototypes will support advanced performance and technology assessments and will be used for host platform integration on a ship or submarine.

In response to a Joint Emergent Operational Need (JEON), the Extra Large Unmanned Undersea Vehicle (XLUUV) requests for proposals are forthcoming. The competition will include both vehicle design and construction. The Navy envisions the XLUUV as a modular, open architecture system that can be reconfigured with different payloads, per a September request for information. The vehicle will be able to



Source: CAPT Casey J. Moton. "LCS Mission Modules Program Update." Navy League 2016 Sea-Air-Space Exposition, 17 May 2016

UNDERSEA MINE WARFARE COMMITTEE

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be launched pier-side without needing to be carried aboard a host ship. Both LDUUV and XLUUV provide greater endurance and payload capacity than current systems, and could perform mine hunting, Intelligence Preparation of the Operational Environment (IPOE), mine delivery, or small UUV (e.g. mini- and micro-UUVs) deployment and recovery.

There will still likely be gaps in capability and capacity once the current developing MCM systems are fielded. Expeditionary MCM (ExMCM) is an emerging concept and capability that is focused on the littorals. The ExMCM Mk 18 Family of Systems, along with developing remotely operated vehicles, new neutralization systems, and the ExMCM 'Company' concept, can provide partial gap filler capability. A Mk 18 Mod 2 system was recently launched from an MH-60S. However, ExMCM proposed integration in LCS and a component of the Mission Package may not meet expectations. As capable as these systems are to support expeditionary operations and have been very successfully tried and tested in the CENTCOM AOR, these systems and forces employing them may not provide the endurance and persistence required for extended or expansive MCM operations required in other AORs where the lines of communication are very long, less forward basing is available, and there are much more austere and extreme operating environments.

There are many challenges that should not be surprising after decades of trying to transition from employing 'dedicated' MCM systems to 'organic' ones. Many of the 'dedicated' systems are still out there providing the capabilities required to achieve MCM objectives. MCM is a very complex problem with many organizational, technical, environmental, and resourcing variables. Mr. David Broyles published a very thought provoking paper for the Center for Naval Analysis titled, "A Prognosis for Mine Countermeasures: Getting the Mine out of the Minefield" in February 2017. Clearly the title is a play on the mantra of the 1990's to, "...get the man out of the minefield." The paper provides insight and background on the symptoms and root causes of the challenges to MCM, as well as some proposed solutions.

Last fall, the Chief of Naval Operations (CNO) reorganized the OPNAV staff and dissolved the recently established Unmanned Warfare Systems Directorate (OPNAV N99) shifting the resourcing and requirements of unmanned systems into technology

development or domain-based warfare directorates. The move is aimed at more efficiently integrating manned and unmanned systems. The Director of Warfare Integration (OPNAV N9I) now oversees unmanned integration, accelerated acquisition and oversight, and will work with acquisition program executive officers, resources sponsors and the fleet for its new oversight responsibilities, and will work with the research community and with Deputy Assistant Secretary of the Navy for Unmanned Systems (DASN UxS) to accelerate prototype acquisition. One body which may be able to provide the synergy, focus, and leadership for addressing the future of MCM is the CNO Mine Warfare Governance Council lead by OPNAV N9. The council was created to oversee mine warfare capability development, acquisition, production, testing, sustainment and maintenance which, according to the charter "pose unique integration and fielding challenges as new technologies are introduced to the fleet. The council will resolve impediments to MIW technology development and testing, pursue cost efficiencies and inform senior Navy leadership of key issues requiring decisions."

In closing, I was hoping to provide industry a summary of the, as I see it, three major movements in the MCM arena. For the future, there will be more pressure than ever to get the developing capabilities across the respective program milestone finish lines. Programs at ONR (Future Naval Capabilities (FNC) Program), DARPA, and NSWC Panama City and technology developments in Industry and academia, will all support the future systems. I intentionally left out any significant mention or discussion regarding mining. I hope to address the mining picture in future articles. I look forward to engaging you and discussing these issues as I assume the committee chairmanship.

UNDERSEA WARFARE VEHICLES COMMITTEE



TOM RUZIC, CHAIRMAN
CHUCK FRALICK, DEPUTY CHAIRMAN
MIKE GRANT, NUWC DIVISION
NEWPORT, NAVY LIASON

UNMANNED UNDERWATER SYSTEMS UPDATE:

This issue I have a message from Mr. Howard Berkof, Deputy Program Manager for the Unmanned Maritime Systems Program Office (PMS 406) within the Program Executive Office for Littoral Combat Ship (LCS). Howard is responsible for the development, procurement, test, fielding, and sustainment for numerous ACAT and non-ACAT unmanned platform and payload programs.

The design, development, and testing of the Navy's next-generation of unmanned underwater vehicles (UUVs) continues to accelerate in Program Executive Office (PEO) Littoral Combat Ships (LCS). The last year has witnessed significant program milestones achieved, key acquisition decisions enacted, and critical technology advancements attained. Unmanned systems are a key enabler for both LCS and the Undersea Enterprise and an important component of the Chief of Naval Operations' (CNO's) Design for Maintaining Maritime Superiority.

The increasing interest in UUVs is a reflection of both the increased technical maturation of systems long in the developmental pipeline and a growing understanding across the Navy that unmanned systems of all types—air, ground, surface, and undersea—are a critical enabler to combat success in the future.

The Navy's Family of UUVs approach will deliver enhanced, efficient capabilities to the Fleet. Within PEO LCS, three essential UUV efforts are managed and coordinated by the Program Officer for Unmanned Maritime Systems (PMS 406), and include the Knifefish minehunting system; the Snakehead Large Diameter UUV (LDUUV); and the Extra Large UUV (XLUUV). PMS 406's efforts are not limited to these three programs. The program office's expansive portfolio also extends to managing the Navy's Mine Countermeasures Unmanned Surface Vehicle (MCM USV); delivering and testing the AN/AQS-20 Mine Hunting sonar; evolution of the Rigid Hull Inflatable Boat (RHIB)-based Mine Hunting Units (MHUs) supporting urgent 5th

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Fleet operational requirements; evolving discussions with DARPA on the future transition of their large Sea Hunter USV; and growing collaboration with the Pentagon's Strategic Capabilities Office's Ghost Fleet initiative.

Below is a program update on the current status and significant events expected to take place on Knifefish, Snakehead LDUUV, and XLUUV over the next year.

Knifefish:

Knifefish is a self-propelled UUV that operates untethered from the ship or platform from which it deploys. Operating independently in relatively shallow ocean waters, the UUV uses a Low Frequency Broadband (LFBB) sonar to search for volume, proud (secured to the ocean floor), and buried mines. Knifefish is an important element in the Navy's evolving mine warfare vision for removing ships and sailors from the dangers of operating within a minefield. The 22-foot long UUV can be launched from an LCS or other surface platforms. The system is being built by General Dynamics Mission Systems.

Currently in contractor development testing, the Knifefish successfully conducted a robust series of ocean tests in late 2016 in Narragansett Bay. As part of the test, eight mine representative targets were scattered across an underwater range. Knifefish successfully found all eight mines and categorized six of the eight "mines" in a key test of the vehicle's performance. Developmental testing will continue through the remainder of this year, with the system expected to transition to Navy operational testing in 2018.

While Knifefish is well on its way down the development path, opportunities still exist for additional industry involvement in the program.

UNDERSEA WARFARE VEHICLES COMMITTEE

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A Pre-Planned Product Improvement (P3I) effort for Knifefish is envisioned for new concepts and technologies that can improve the vehicle in the areas of launch and recovery; power and endurance; sensors and reliability; navigation precision; communications and data exchange; and mission data download and transmission.

Snakehead LDUUV:

The Snakehead LDUUV program has swiftly pivoted to a new acquisition strategy over the last year that seeks to initially deliver this innovative capability to the fleet by 2021 with incremental improvements thereafter. In January, Snakehead LDUUV was approved for an Accelerated Acquisition Approach as part of the Navy's Maritime Accelerated Capabilities Office (MACO). This approach grants Snakehead LDUUV certain waivers and exemptions from the normal acquisition process in order to reduce design and development time. This will speed the initial fielding of this capability to the fleet for experimentation and assessment, allowing the incremental capability cycle to begin earlier and providing benefit to fleet missions sooner.

Under this new, streamlined acquisition approach, initial prototypes of the Snakehead LDUUV could be ready for in-water testing and experimentation as early as 2019. While this approach will carry some operational, programmatic, and technical risks, these are far outweighed by benefits of getting advanced technology sooner for user assessment. Limited procurement of prototypes also affords the Navy the opportunity to quickly switch to new payloads as fleet demand or experimentation results warrant. As acting Assistant Secretary of the Navy (Research, Development and Acquisition) Allison Stiller told a Navy League meeting in February, "we will have to take calculated risks. Some things may work; some may not. We will move ahead with the speed and innovation that the warfighter demands."

PMS 406 is also leveraging the standard Request for Information (RFI) process to assess the technical and manufacturing base, gauge its experience level and capabilities, and gain insights from UUV designs that industry has already developed. The program office received 52 responses from 49 different firms as a result of a May 2016 RFI solicitation. A follow-on Industry Day meeting in September 2016 witnessed 138 companies in attendance to provide feedback on the acquisition approach for LDUUV.

The current operational focus for Phase I will be on Intelligence Preparation of the Operational Environment. Extensive use of the Set-Based Design approach proved valuable in determining the relevance of this early mission set for Snakehead LDUUV. It will also be used to help determine mission priorities for follow-on phases of the program.

Funding remains a consistent challenge, as with all programs. Discussions are ongoing as part of the budget process to ensure the program execution and schedule are well managed.

XLUUV:

The initial Request for Proposal (RFP) for the Extra Large UUV (XLUUV) was released on February 17 and the final RFP was released on March 3 with proposals from industry due by mid-May. This is another significant milestone achievement for the program and provides another example of the fast-track acquisition strategy being employed by PMS 406 to accelerate this capability to the fleet. The RFP release builds off of a well-attended Industry Day the Navy conducted in January with more than 50 potential industry partners in attendance.

This vehicle will extend the range of current platforms to undertake specific maritime missions and can be launched from a pier or platforms at sea. XLUUV's modular design will enable the UUV to deploy multiple types of payloads. Key performance attributes include: extended vehicle range and persistence; a reconfigurable, modular payload bay; modular construction; autonomy; and pier launch capability.

PMS 406 is aiming to award design contracts before the end of fiscal year 2017. Up to two contractors will be asked to conduct tradeoffs as part of a 15-month design phase. Once the phase is completed a single contractor's design will be selected to build up to five vehicles, with the first XLUUV targeted for delivery in late 2020, followed by two additional vehicles in 2021 and the remaining two in 2022.

UNDERSEA WARFARE AVIATION COMMITTEE



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NAVAIR and industry partners are committed to provide the most capable aviation platforms, sensors, weapons, avionics systems and training ever seen

on budget and on schedule. The Aviation Committee is honored to help facilitate the needed information exchange and be a part of such extraordinary developments. These platforms will continue to evolve and integrate with unmanned systems and sensors as needed to keep pace with the tremendous advancements these emerging technologies are making every day. Below are some announcements and achievements released in the public domain that the Aviation UWD and supporting communities can be proud of:



Navy partnership hits milestone, 50th P-8A delivered

NAVAL AIR SYSTEMS COMMAND, PATUXENT RIVER, Md.
— The U.S. Navy accepted its 50th P-8A Poseidon (P-8A) aircraft at the Naval Air Station (NAS) Jacksonville, Florida today. The Navy's Poseidon is replacing the legacy P-3 Orion and will improve an operator's ability to efficiently conduct anti-submarine warfare; anti-surface warfare; and intelligence, surveillance, and reconnaissance missions. The P-8A program of record calls for a total requirement for 117 of the 737-based

anti-submarine warfare jets.

"I'd like to formally thank the team, including PMA-290, Boeing and our entire P-8A industry team, as we deliver the 50th P-8A Poseidon early and under budget," said [Capt. Tony Rossi](#), the Navy's program manager for Maritime Patrol and Reconnaissance Aircraft. "This milestone demonstrates outstanding work ethic, professionalism and dedication to the fleet."

"The P-8A is special," added Rossi. "This is the first time a Navy combat aircraft was built from the ground up on a commercial production line. We've leveraged commercial expertise and experience, and a highly reliable airframe, the 737, which has reduced production time and overall production costs."

Since the initial contract award, the program has reduced P-8 costs by more than 30 percent and has saved the U.S. Navy more than \$2.1 Billion.

"Together, we and our industry partners are transforming today's maritime patrol and reconnaissance force for the evolving threats and diverse mission requirements," he said. "This replacement for the P-3C builds on lessons-learned, while enhancing those capabilities with unique features, such as an electro-optical/infrared (EO/IR) sensor turret and increased acoustic processing capability with 64 passive sonobuoys, 32 multistatic sonobuoys and concurrent passive and active processing."

The fleet's transformation from the legacy P-3C to the P-8A is expected to be completed by Fiscal Year 2019.

As of April 2016, all six active and one fleet replacement squadron at NAS Jacksonville have completed their fleet transition training from the P-3C to the P-8A and the first west coast P-8A squadron, VP-4, has relocated its home port from Kaneohe Bay, Hawaii to NAS Whidbey Island, Washington. All squadrons will complete transition training by Fiscal Year 2019.

UNDERSEA WARFARE AVIATION COMMITTEE

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MH-60R/S life-extension, upgrades await funding

The US Navy (USN) is working through a variety of upgrades for its workhorse Sikorsky MH-60R/S helicopters, and is awaiting studies for an upcoming life-extension programme.

Officials hope to begin an MH-60R/S Service Life Assessment/Extension Program (SLAP/SLEP) to keep the aircraft flying beyond 10,000 hours and potentially through the 2040s, said Captain Craig Grubb, program manager for USN H-60 helicopters.

An MH-60S SLAP was scheduled to begin in 2017, but may not start until 2018 because there is no appropriated budget for this year and the Congress is eyeing the programme for cuts anyway. An R-modal SLAP is slated to start in 2020. Those SLAPs are likely four-year efforts to determine what upgrade work needs to be done.

"We can start pretty much right away" once a budget is passed, Capt Grubb said during a 3 April briefing at Navy League's annual Sea-Air-Space exposition.

The SLAP will make clearer what needs to be done for the SLEPs, and Capt Grubb added that this could include adding titanium braces, new wiring, generators, hydraulics, and so on.

"We have seen issues with the MH-60S" as the aircraft's structure is manufactured differently from other H-60s, he said, adding that the navy is less concerned with the R-model because of its different construction.

Meanwhile, the navy is working to add a 'mixed loads enhanced targeting capability' to improve the

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MH-60R/S helicopters weapons deployment, such as with its 20 mm gun, Hellfire missiles, or Advanced Precision Kill Weapon Systems (APKWS).

A 'phase 0/1' of that effort includes an enhanced day or night colour head-up display (HUD), and a constantly computed impact point (CCIP).

The navy is also planning a 'phase 2/3' - although this is not yet funded - to add Multispectral Targeting (MTS) slewing based on where heads are pointed, a CCIP reticle for APKWS and Hellfire missiles, and degraded visual environment (DVE) capability.



US Navy's MH-60R submarine periscope detection kits

The U.S. Navy has awarded a contract to deliver automatic radar periscope detection and discrimination (ARPDD) standard retrofit p-kits deployed on the navy's MH-60R helicopters.

Under the contract, Lockheed is to deliver 29 systems that will allow the helicopters to discriminate between a periscope and other small surface objects, thereby

UNDERSEA WARFARE AVIATION COMMITTEE

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improving the probability of finding a submarine.

Lockheed Martin will undertake most of the work at its New York facilities and is expected to complete work on the program by September 2020.

The first MH-60R maritime helicopter entered the U.S. Navy fleet in 2005 while the Telephonics radar-based ARPDD system achieved Initial Operational Capability in 2013.

Navy improves P-8A surveillance plane, drone integration



The Navy is modernizing software for its Boeing P-8A multi-mission maritime surveillance aircraft to improve Anti-Submarine Warfare, Anti-Surface Warfare and operational integration with unmanned systems service officials said.

The P-8A multi-mission maritime aircraft was first engineered for the Navy's Maritime Patrol and Reconnaissance Force (MPRF) to replace the P-3 Orion aircraft after it had been in use for 50 years.

The P-8A carries out intelligence, reconnaissance, and surveillance (IRS) using the AN/APY-10 Raytheon radar system, which provides detailed imaging of land, marine, and littoral zones, and has the unique ability to detect briefly surfaced submarine periscopes.

According to Naval Air Systems Command (NAVAIR), the aircraft also carries torpedoes and cruise missiles, as well as sonobuoys, which are deposited into the water and use sonar technology to locate submarines.

"The P-8A Poseidon system sustains and improves the

armed maritime and littoral intelligence, surveillance and reconnaissance capabilities for United States naval forces in traditional, joint and combined roles to counter changing and emerging threats," said Lt. j.g. Seth Clarke, a spokesman for the Navy.

Maritime surveillance has been transitioning toward unmanned systems, yet the P-8A operates with a nine-person crew. Navy and industry developers say the P-8A remains in operation because it provides concentrated intelligence that is essential to complete surveillance.

"It is equipped to complement (and may be integrated with) unmanned assets while also providing fleet operators with the added benefit of interfacing with unmanned aircraft systems when performing certain operations and missions," Lt. Clarke explained.

The P-8A works with the Broad Area Maritime Surveillance—Demonstrator (BAMS-D), NAVAIR's unmanned aircraft program, which is capable of large-scale surveillance and feeds data to the P-8A systems. The P-8A aircraft can then be used more effectively by being deployed to areas identified as requiring more sophisticated reconnaissance.

Boeing, aircraft's manufacturer since the original contract was awarded in 2004, expects the work to be completed by December 2019.

UNDERSEA SENSOR SYSTEMS COMMITTEE



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LIAISON

The Sensors Committee spring session addresses sensor needs for submarines and surface ships as well as sensors on fixed

surveillance systems, distributed netted sensors and unmanned vehicles. This year's theme "Leveraging the USW Force for Undersea Superiority; Sea Floor to Space, Deep Water to the Littorals, and Across the Electromagnetic Spectrum" emphasizes the need for full spectrum sensors and signal processing that provide improved performance to the warfighter in all environments. These sensors and signal processing will be necessary to maintain tactical and strategic awareness in the evolving maritime undersea battle space. During this session we will receive a brief from our Navy liaison Mr. Pete Scala, Director of IWS5A Advanced Development. Mr. Scala will discuss the AxB process, APB sensor algorithms and new conformal submarine arrays. Mr. John Curtis of PMS485 Maritime Surveillance Systems, will discuss the roadmap for Deployable Systems Technology and their approach to leveraging

the USW Force for Undersea Superiority from Deep Water to the Littorals. In addition, Mr. Shelby Sullivan from DARPA/STO will discuss the Transformational Reliable Acoustic Path System (TRAPS), an exciting new development in deep-ocean surveillance systems.

These presentations are just a sample of the stimulating session we have planned. NDIA is a team effort. Forums such as the USW Division of NDIA bring together intellectual resources, i.e. the Uniformed Services, Navy Labs, Academia, and Industry. We all work together to share information, collaborate, and coordinate our investment resources so that we can provide the best systems to the warfighter. The presenters are key to the information transfer and I want to thank them for their effort. I want to thank Joe Cuschieri, the Deputy Chairman, for helping organize the agenda. Finally, I'd like to express our sincere appreciation to Pete Scala from the IWS 5 PEO who is the Navy Liaison for our USW Sensors committee. Pete has a wealth of pertinent experience and is a strong asset to the team.



SPRING 2016 UNDERSEA WARFARE DIVISION CONFERENCE



**WAYNE JAKUBOWSKI, CHAIRMAN
 SPRING CONFERENCE**
**GREG VAUGHN, CO-CHAIRMAN
 SPRING CONFERENCE**

This year's Undersea Warfare Spring Conference Theme, "Leveraging the USW Force for undersea superiority: sea

floor to space, deep water to the littorals, and across the electromagnetic spectrum" has never been more relevant to the success of our nation and the mission of our Navy. Not only is this reflective of the mandate from our Chief of Naval Operations, Admiral John Richardson, but it is also essential to the fundamentals of free trade and keeping the sea lanes of commerce and communications open to all. The undersea domain has established itself as pivotal when considering surveillance, threat assessment, pre-positioning, engagement, access, denial, and strategic deterrence. So in addition to the coverage definitions contained within our theme, the engagement phase coverages, listed above, also cover the full spectrum of requirements for our undersea forces. This year we also focus on Theater ASW and the requirement to effectively act as a collective team. Our adversaries watch closely how and why we operate as a force and look for ways to counter our effectiveness. Their investments in submarine platforms clearly indicate their assessment of this domain and the need for platforms to counter our capability in this area.

Our Plenary session speakers will provide a current update to attendees covering operations,

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investments, relevant programs, areas of continued focus, gaps, and current intelligence. Our speakers cover all domains including, surface, air, submarine, special operations, warfighter development, foreign technology, and both manned and unmanned platform initiatives. Our six technical tracks will provide further details on specific programs, test results, and future thinking.

New this year is an O-6 panel that will close out the first day with a discussion of operator USW experience and perspectives on Theater USW. Representing aviation, surface, and submarine perspectives, the panel will be moderated by Mr. Jerry Ferguson, and should provide even more insight into how our USW team performs and how it can perform better. Also new this year is a networking reception that immediately follows the plenary session. This reception is in lieu of the normal networking dinner and has been formatted to provide an enhanced opportunity for attendees and speakers to interact and discuss ideas.

Thanks for your investment in time to participate with us in this conference and we look forward to the opportunity to exchange information in a classified and not-for-attribution environment.



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