RDML Eric H. Ver Hage
Commander, NAVSEA Warfare Centers

Donald F. McCormack
Executive Director, NAVSEA Warfare Centers

150 YEARS OF REVOLUTIONARY EVOLUTION

QUICK – Name a technology that revolutionized warfare. History buffs might say the longbow, which shifted tactical advantage on the battlefield from the cavalry to the infantry in the Middle Ages. Or gunpowder, which rendered the longbow's advantages obsolete. Before that, there was the humble saddle stirrup. Though its exact development is unclear, stirrups appeared in Asia around the second century BC before spreading to medieval Europe. The simple addition of foot supports to a saddle increased riders' stability, allowing heavily armored knights to use lances and axes to great effect. Several hundred years later, the ability of Mongol horsemen to fire their arrows while twisting and turning in their saddles gave them a significant tactical advantage over their enemies. As one historian noted, if "traditional mounted troops were like tanks, Mongol-mounted warriors were fighter pilots." This simple evolution in "saddle technology" turned out to be revolutionary in its own way.

At the Naval Undersea Warfare Center (NUWC), our history of innovation may be comparatively shorter, but we have much to celebrate in our 150 years of contributions to undersea technical excellence. When NUWC's predecessor organization, the Naval Torpedo Station, was established in 1869 on Goat Island in Newport, R.I., the facility was the U.S. Navy's first experimental ordnance station for the development of torpedoes and torpedo equipment, explosives, and electrical equipment. Our success since that beginning has depended on integrity, resilience, and courage to think "outside the box" in order to innovate major changes in technologies and capabilities for the Navy.

It took courage 150 years ago to experiment with new, charged warheads; to test spar torpedoes; and to be in the same waters as the brand new self-propelled "Fish" torpedo. Imagine the tremendous courage required to test the first depth chargers, the first homing torpedoes, the first sonar transducers, and the first torpedo computerized fire control systems. What stands out is that many of these advances weren't simply evolutionary; they were revolutionary and helped make the United States Navy win two world wars.

NUWC's enduring relevance to the Navy is linked to our work with academia and industry. During World War II, two university labs that had played a significant role in developing homing torpedoes and improving sonar became the "Sound Lab" in New London, C.T. Their merger to become NUSC – the Underwater Systems Center – in 1970 helped evolve NUWC Division Newport to the full-spectrum undersea warfare research and development organization that we know today. During his visit to Newport for the 150th anniversary celebration, Under Secretary of Defense for Research and Engineering Dr. Michael Griffin emphasized the impact of partnering when he said that, if the United States is going to win the great power competition, government, industry, and academia are going to have to work together just as they did during World War II and the Cold War.

One hundred and fifty years ago, we focused on overcoming the threats to our young Navy. Today, we have expanded our mission beyond the immediate

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environment to now include a focus on delivering tomorrow's Navy and "Navy after Next." Shifts in the global power structure and the acceleration/dissemination of technologies demand that we strive for revolutionary naval capabilities but retain our ability to exploit the evolutionary ones. To achieve our future state, we will draw on what has sustained us for the previous 150 years: the courage to innovate; to challenge the status quo; to look outside of ourselves for great ideas; to collaborate and learn from others; to fail, learn from that failure, and try again; to tell leadership what may be wrong; to conduct unbiased analysis and tell sponsors and program officers the technical truth no matter how uncomfortable or disruptive; and to do what is right for the fleet that we serve, even when it is unpopular.

How does innovating for technical excellence translate into our day-to-day activities? It means that we deliver solutions to the fleet by inventing and applying ideas, technologies, and processes, and that we seek to instill principles of innovation throughout our organization. We perform many roles, including technical design and in-service engineering agents for Navy acquisition programs, technical warrant holders in technical leadership areas, providers of custom-engineered solutions, and undersea warfare (USW) technology consultants/advisors to our warfighters and to other organizations in a variety of areas such as maintenance and industrial base support. It also means that we work in partnership with the best and brightest minds in government, industry, and academia to provide the right products and services for the Navy of today while also supporting USW preparedness for the Navy of tomorrow.

One promising area is virtualization, which NUWC Division Newport has utilized for over a decade for system/subsystem production, trainer systems, and test environments. It has informed approaches required to achieve the future system of systems technology roadmap by virtualizing where it makes sense (not all components or subsystems can be virtualized). This future roadmap builds on virtualization successes with a focus on holistic system of systems architecture improvements and revamps the software development pipeline to address Navy-wide initiatives such as Secure Development Operations (DevSecOps) and Compile to Combat in 24 Hours (C2C24).

We know that we face a number of challenges, including system of systems that can be disrupted by breaking the "weakest link;" the growing importance of artificial intelligence, cyberspace, and the electromagnetic spectrum as enablers for warfighters; ongoing fiscal constraints; and the slow pace of defense acquisition. As Dr. Griffin noted during his Newport visit, the DoD's slow and often cumbersome acquisition processes put the country at a disadvantage. To overcome these challenges, the Warfare Centers are using Other Transaction Authorities (OTA) – a contract vehicle that provides greater flexibility and responsiveness to changing demands – for undersea and surface technologies, expeditionary warfare, and electronic warfare/trusted electronics/ cybersecurity. Other partnership vehicles that enable us to work with our industry and academic colleagues include work for private party agreements, memoranda of agreement, educational partnership agreements, and cooperative research and development agreements, among others.

NUWC Division Newport and its parters from industry and academia continue to provide technical leadership in the advancement of submarine combat system architecture, which will yield opportunities via the Undersea Technology Innovation Consortium (UTIC) OTA. A number of initiatives are designed to provide a more cyber-resilient system that facilitates "speed-to-fleet" delivery of capability. Leveraging extensive experience with virtualization, the NUWC USW Combat Systems team is leading the development of a Virtual Twin (vTwin) to provide a significant reduction in the hardware footprint of the tactical submarine combat control system while maintaining full system capability. This decoupling of hardware from software enables shared system resources and provides an independent test bed for new capabilities. The vTwin initiatives, combined with the recently awarded UTIC "Seamless Submarine Warfare Federated Tactical System (SWFTS)" effort, will contribute significantly to the USW enterprise goal of fielding a cyber-resilient, flexible, and scalable combat system for future submarine classes.

To continue accelerating innovation, we need diversity in our people and approach. Therefore, we are counting on all of you, whether from the government or industry, to cast a wide net and be relentless in looking for ways to improve our Navy's products, systems, and tools while identifying opportunities to go faster. Together, we can continue to shape the Navy's USW capabilities for another 150 years!

DIVISION CHAIR'S MESSAGE

MIKE CORTESE
Chair, Undersea Warfare Division

On behalf of the entire management team of the National Defense Industrial Association's (NDIA) Undersea Warfare Division (UWD), welcome to the Fall Conference. Our goal is to provide you the best classified forum for understanding the Navy's vision, objectives, and plan for maintaining undersea warfare superiority along with the best opportunity to interact with our diverse undersea warfare (USW) community. Please provide feedback on how we are doing and how we can improve.

A special thanks to all of our plenary and technical committee speakers for taking the time to brief our USW community. Your briefs and the resulting discussions are the reason we are here. The information you provide is critical to both our support of the warfighter and the defense of our nation.

As we look to the future, it is clear that our forces will have to maintain the Undersea Dominance that enables Joint Operational Access in contested regions. The U.S. increasingly depends on the undersea for energy and information, and each day more goods are shipped via the sea. At the same time, it is clear that we face many challenges. Anti-Access Area Denial systems and emerging powers are increasingly challenging our Navy, and advanced undersea capabilities are proliferating. Moving forward, resource constraints and improved competitor capabilities will challenge current concepts of operations (CONOPS) in contested areas. To maintain our undersea dominance, we will have to create and employ an effective system of systems. This need is clearly reflected in the theme of this conference, "Preserving Undersea Superiority – A System of Systems Approach". While some elements of these future 'Systems' already exist, they will have to evolve to be able to communicate and command new components of the system. Other elements are in the relatively early stages of development (e.g. large and extra-large Unmanned Undersea Vehicles (UUVs)), and others still probably haven't even been invented yet. This conference will provide a useful forum for us to begin to define these systems, to discuss envisioned CONOPS, and to identify the associated gaps or challenges where industry's help is needed.

Thank all of you for your dedication to USW and attending this year's Fall Conference. The importance and urgency of our effort are great. Growing regional and global threats continue to advance interests, operations, and capabilities that challenge freedom of the seas, nation sovereignty, and many of the freedoms we hold dear. Relationships between non-nation state and nation state actors that hold world views counter to our values continue to evolve with uncertain outcomes. Our warfighters need our focus and dedication to the development the capabilities they require to succeed and preserve our way of life.

In March, I began my two-year tour as Chair of the NDIA Undersea Warfare Division. I would like to thank my predecessor, Mike Tucker, for the opportunity to serve NDIA and the broader USW community in this assignment.

On behalf of the Executive Board, the Advisory Council, and NDIA, thank you and your organizations for your continued support of the National Defense Industrial Association, the Undersea Warfare Division, our warfighters, and these conferences. We hope you enjoy this Fall Conference and look forward to seeing you at the Spring Conference in San Diego, California.

Mike

SPRING 2019 NDIA UNDERSEA WARFARE AWARDS

PIERRE CORRIVEAU, PHD
Chairman, Awards Committee

At this year's Spring Conference, NDIA's UWD was pleased to announce the recipient of the **Vice Admiral Charles B. Martell-David Bushnell Award** as Mr. Howard R. Taylor, Chief Engineer Submarine Sonar Signal Processing, Lockheed Martin Co.; the recipient of the **Vice Admiral Charles E. Weakley Award** as RADM Michael Jabaley, USN (Ret), former Program Executive Officer Submarines; and the recipient of the **Captain George W. Ringenberg Award** as RADM John Padgett, USN (Ret), former Commander Submarine Force, U.S. Pacific Fleet. In addition, we had the pleasure of announcing the recipient of the **Rear Admiral Jack Jarabak Award** as Lt James Davis for his exceptional contributions in the field of Anti-Submarine Warfare.

Unfortunately, RADM Padgett and Lt Davis were unable to attend the Spring Conference. However, they will receive their awards at a later date.

MR. HOWARD TAYLOR

Chief Engineer, Submarine Sonar Signal Processing, Lockheed Martin Co.

The **VADM Charles B. Martell-David Bushnell Award** for exceptional contributions in the field of ASW and/or Undersea Warfare Technology.

Over his 40+ year career, Mr. Taylor has developed innovative sonar techniques, technologies, and systems that have achieved game-changing results for our undersea warfare enterprise. Mr. Taylor's expertise has contributed to significant improvements in the performance of the organic sonars for the submarine fleet, including: AN/BSY-1, MF Active Improvement ADM, Advanced Mine Detection Sonar ADM, HF Chin Array, AN/BQQ-10, Light Weight Wide Aperture Array, Low Cost Conformal Array, and most recently the Large Vertical Array. As the acoustic subsystem architect and chief engineer for system performance, Mr. Taylor has made recent contributions associated with beamforming and CEDAR processing to LCCA and LVA.

When technical challenges threaten our undersea superiority, Mr. Taylor is regularly tapped for special assignment. The demand for Mr. Taylor's expertise far exceeds his availability, requiring prioritization of assignments to only the toughest and most demanding. His expertise in digital signal processing, beamforming (spatial filtering), tracking algorithms (control systems), active and passive sonar performance, and overall sonar system design has led to the development of both ADM and production system capabilities now fully integrated onto Virginia Class and back-fit platforms.

He is a member of the Signal Processing Working Group (SPWG), ARCI Technology Insertion Processing and Network working groups, and previously was a member of the APB Execution IPT (AEIPT) and co-chair of the MF/HF signal processing working group.

For his excellent leadership and unwavering dedication that have significantly benefited our Submarine Force, the Undersea Warfare Division of the National Defense Industrial Association was honored to present this prestigious award to Mr. Howard Taylor.

RADM MICHAEL JABALEY, USN (RET)

Former Program Executive Officer Submarines

The **VADM Charles E. Weakley Award** for meritorious service and noteworthy contributions to effective Government Industry communications in the field of Undersea Warfare.

In his three decades of service, RADM Jabaley has promoted and advanced submarine technology, construction, and acquisition excellence, leading key naval programs to design, build, and support the Virginia and Columbia Class submarines. RADM Jabaley's primary role and lasting contribution has been to build and lead innovative Navy-Industry teams charged with the design and construction of submarines and submarine components as well as the development of cutting-edge undersea technology programs. His leadership has been the catalyst for success in the delivery of state-of-the-art submarines and submarine components to the Navy and the Nation. During his first twenty years of service, RADM Jabaley served with distinction in the U.S. Submarine Force, including as commanding officer of USS Louisville, before joining Team Submarine at NAVSEA. At NAVSEA, he distinguished himself as Virginia Class Program Manager, NAVSEA Deputy Commander for Undersea Warfare, Commander Naval Undersea Warfare Command, Deputy COMNAVSEA, and ultimately as Program Executive Office Submarines (PEO SUB).

His leadership, while COMNUWC and PEO-SUB, included service as the Navy liaison flag officer to the NDIA UWD. His reputation for technical excellence and quality productivity gave him significant influence across a broad range of Government and Industry organizations. RADM Jabaley used this influence to strengthen Navy-Industry bonds and teamwork, and to produce eye watering undersea production excellence and dramatic acquisition cost savings. His candor in identifying areas for improvement crystalized the communication of Navy needs to Industry and issues requiring attention from both Navy and Industry.

In recognition of his noteworthy contributions to advancing the field of Undersea Warfare and promoting effective Government-Industry communications, the Undersea Warfare Division of the National Defense Industrial Association was pleased to present RADM Michael Jabaley with the VADM Charles E. Weakley Award.

RADM JOHN PADGETT, USN (RET)

Former Commander Submarine Force, U.S. Pacific Fleet

The **Captain George Ringenberg Award** is presented to those who, through their service and leadership, have made noteworthy contributions to the Undersea Warfare Division.

RADM John Padgett's leadership and dedication to Undersea Warfare have spanned both his naval and civilian service. He held increasingly responsible roles in the U.S. Navy that culminated in his serving as the 30th Commander Submarine Force, U.S. Pacific Fleet, where he led our submarine forces in the Pacific while maintaining our Nation's Undersea Dominance. Following his active duty retirement in 2003, as a Vice President at General Dynamics Electric Boat, he helped improve our submarine forces via life cycle support on our existing boats and the integration of new advanced capabilities on our Virginia-Class submarines. Outside his professional life, he worked tirelessly as a strong advocate for USW, both as the President of the Naval Submarine League and, for the past fourteen years, as a member of the NDIA UWD. As a UWD Advisory Council member, he continued his advocacy of USW as an active advisor to senior Naval Flag Officers. He promoted the need for the development of a broader USW strategy that encompasses the broad range of different capabilities, systems, and platforms, including intelligence, oceanography, surveillance systems, submarines, and weapons.

As a UWD Advisory Council member, John Padgett contributed significantly to the smooth and efficient execution of the Division's programs. Employing his vast knowledge of USW, coupled with his expertise as both a warfighter and industry leader, he was instrumental in the shaping of the UWD vision. He selflessly devoted his time to provide sage advice and counsel to conference chairs and Division chairmen. His actions throughout his career helped our Nation achieve and maintain undersea dominance. A consummate professional, John Padgett has upheld the highest traditions of the Undersea Warfare Division.

The Undersea Warfare Division was proud to recognize RADM John Padgett, USN (Ret), with the Captain George Ringenberg Award for his outstanding contributions and service to the U.S. Government, the National Defense Industrial Association, and the Undersea Warfare Division.

LT JAMES DAVIS, USN

Academic Achievements in USW Undersea Warfare Technology at Naval Postgraduate School

The **Rear Admiral Jack Jarabak Award** is presented by the UWD in conjunction with the Naval Postgraduate School's Undersea Warfare Executive Committee to recognize a deserving student for their contribution in the field of Undersea Warfare.

This year, the award was presented to LT James Davis, USN, for his personal commitment and academic achievements in the area of Undersea Warfare Technology.

While attending the Naval Postgraduate School from September 2016 to June 2018, LT Davis distinguished himself through outstanding performance in the Undersea Warfare Curriculum. His exceptional research clearly demonstrates his intellectual ability, analytical skills, and mastery of physical oceanography. His thesis, "Effects of Propagating Submerged Objects on Diffusive Staircases," deals with one of the most intriguing and poorly understood phenomena in high-latitude oceanography – thermohaline staircases. His research advances our understanding of the dynamics of thermohaline staircases and their ability to maintain heat transport in the main halocline of the Arctic Ocean, demonstrating that the prospects of detecting moving submerged objects increases dramatically in regions characterized by staircase stratification where hydrodynamic signatures are readily identifiable and can persist for long periods of time. LT Davis's superior performance in this program strongly indicates his great potential for success in improving our undersea warfare posture.

The Undersea Warfare Division, in conjunction with the Naval Postgraduate School, took great pleasure and welcomed the opportunity to recognize the important contributions of LT James Davis, USN, by its award of the 2019 RADM Jack Jarabak Bronze Medal Award.

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 2019 ACADEMIC SPEAKER AWARD

MARK ROTHGEB

Chairman, Academic Fellowship Committee

The NDIA Undersea Warfare Division established the Academic Fellowship Program in 1990 to provide financial aid to PhD candidates at universities closely associated with the Navy's undersea warfare community. The objective of the program 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 derived from the Navy's University Affiliated Research Centers (UARCs), the Naval Postgraduate School (NPS), and other academic institutions. This Fall, we are pleased to host four academic research contributors from different organizations presenting the topics described below.

Colby Cushing is a Mechanical Engineering graduate student at the University of Texas at Austin working on the experimental validation of underwater acoustic metamaterials. He received his BS in Aerospace Engineering at Penn State University with a focus on aircraft function and design. He also worked for General Dynamics Electric Boat designing nuclear submarines in both fluids systems and acoustic signatures. His current research includes deeply subwavelength attenuation panels for remotely operated underwater vehicles, the testing of 2D and 3D pentamode structures, the testing of anisotropic inertial metamaterials, and the testing of underwater Helmholtz resonators for bianisotropic applications. Colby will be presenting on the design, construction, and testing of underwater pentamode metamaterials.

Alexander Roman is a 2012 graduate of the United States Naval Academy with a BS in Mechanical Engineering. Upon commissioning, he served onboard the USS Mobile Bay (CG 53) and USS John Paul Jones (DDG 53). He has spent the last two years at the Naval Postgraduate School studying Undersea Warfare while pursuing an MS in Mechanical Engineering. His presentation will cover Novel Paradigm Supercapacitors and their relationships with super dielectric materials.

Eric Homan is a third year PhD student in the School of Electrical Engineering and Computer Science at Penn State University. His research interests include computer vision, bio-inspired intelligent systems, and hardware acceleration. He has performed research on human-understandable autonomy, robust autonomous vehicles, and perception systems. He is currently working on object recognition for autonomous systems and on information constrained Reinforcement Learning. Eric will present his work on "Platform Health for Robust Autonomous Systems," discussing the use of machine learning to model autonomous system behavior in order to provide improved detection of obstacles and hardware failure.

James K. Starling is a PhD candidate in the Department of Industrial & Systems Engineering at the University of Washington, Seattle. He graduated from the United States Military Academy with a BS in Mathematical Sciences and the Naval Postgraduate School with an MS in Applied Mathematics. He has served in the U.S. Army for over 19 years, most recently at the Mission Command Center of Excellence, Fort Leavenworth, KS. His current work focuses on applying forecasting, simulation, and optimization methods to diminishing manufacturing sources and material shortages (DMSMS) in Navy and DoD applications. His discussion will present two models to assist in determining optimal life of need buy strategies. In particular, the discussion will focus on the different scenarios in which one would consider using one model over the other.

UNDERSEA COMMAND, CONTROL, COMMUNICATIONS, AND COMBAT SYSTEMS COMMITTEE

PAUL ROSBOLT
Chairman

DR. BOB ZARNICH
Deputy Chair

JOHN LINDERMAN
Warfighter Performance Session Chair

Greetings, All! I am looking forward to getting out of the DC heat and up to New London! Any excuse to get out of Washington is a good one. We have some terrific speakers lined up for the technical sessions, including CAPT Mike Boone, Program Manager for Undersea Communications & Integration (PMW 770), and Lee Agin, Deputy Program Manager for Undersea Systems (IWS5). In addition, CAPT Greg Zettler, PMS 425 (Submarine Combat Systems), will present a full hour session on the future of the Submarine Warfare Tactical Federated System (SWFTS) in the age of cloud computing and SECDEVOPS.

Several of our sessions in C4I will focus on the future of USW Command and Control (C2). A key element of the future C2 is Project NAUTICA (Networked Architecture for Undersea Theater Integrated C2 Advantage). Led by PEO IWS 5.0, Project NAUTICA is in its first year of a comprehensive model-based systems engineering (MBSE) effort to identify, decompose, allocate, and address Theater Undersea Warfare (TUSW) C2 requirements. Working in close coordination with Fleet, OPNAV, and other Acquisition stakeholders across the USW community, Project NAUTICA is working to complete its first System-of-Systems Requirements Review (SoSRR) by the end of September to inform POM-22 development this Fall. In FY20, Project NAUTICA will continue to refine existing system acquisition efforts and to identify where innovation is required to close gaps with the ultimate goal of implementing a common integrated C2 system-of-systems architecture at the Fleet's TUSW operations centers.

UNDERSEA MINE WARFARE COMMITTEE

JON TOBIAS
Chairman

ERIC HOLMES
Deputy Chairman

Once again, the Mine Warfare (MIW) Committee is following up an outstanding Spring Conference with some excellent government and industry speakers, including briefs from the Naval Surface Warfare Center's Panama City Division. Significant MIW events over the last six months centered primarily on significant fleet exercises and proofs of concept.

In late March off the Virginian coast, sailors and airmen from four commands embarked HMS Mounts Bay, a 579-foot-long Royal Fleet Auxiliary amphibious transport ship, to experiment with operating U.S. mine countermeasures (MCM) systems from a vessel of opportunity (VOO). Explosive Ordnance Disposal (EOD) Mobile Unit TWO operated Mk 18 Mod 1 Swordfish and the Mk 18 Mod 2 Kingfish mine hunting unmanned underwater vehicles (UUV), and served as task group leadership. Helicopter Sea Combat Squadron (HSC)-2 and HSC-28, which fly the MH-60S Seahawk helicopter, also participated with the Airborne Laser Mine Detection System (ALMDS) and the Airborne Mine Neutralization System (AMNS), both of which are part of the Littoral Combat Ship (LCS) MCM mission package (MP). Finally, LCS Squadron TWO operated two developmental systems that have yet to be delivered to the fleet but are slated to be included in the MCM MP: the MCM Unmanned Surface Vehicle (USV), which conduct mine hunting and sweeping missions, and the Knifefish UUV mine hunting system. The exercise didn't test the effectiveness of the systems to find mines but rather tested whether a single task group could command and control all the people and platforms at once; whether the vehicles could be launched, recovered, and operated together without getting in each other's way; and whether their data could be combined into a single operating picture to allow the task group commander to make decisions about how to clear a minefield. The utilization of VOO allows commanders flexibility in how they combine the right resources to accomplish the MCM mission since MCM is not reliant on a single sensor or platform.

Another event further developed this concept in July when the expeditionary fast transport vessel USNS Spearhead (T-EPF 1) was evaluated as a mother ship for unmanned systems. A portion of this event centered on the ability to operate Knifefish from the 338-foot-long auxiliary ship which is operated by the U.S. Military Sealift Command.

MCM played a significant role in June's BALTOPS 2019. Naval Surface and Mine Warfighting Development Center (SMWDC) commanding officer, Rear Admiral Scott Robertson, led the large task group in the exercise, which included more than 15 MCM ships, 15 UUVs, and more than 70 divers from 11 allied nations. This year showcased several new developments in MIW, including:

- The first time a U.S. flag officer led the MIW task group in the exercise.
- HSC-28 exercising airborne MCM capabilities in the Baltic Sea for the first time in more than a decade.
- The Office of Naval Research and Commander, U.S. Naval Forces Europe, Commander, U.S. Sixth Fleet Science Advisor, and his team exercising new and existing Mk 18 Mod 2 UUV technology, partnering with a German ship for the first time in the Baltic Sea.
- The NATO Naval MIW Center of Excellence integrating with the task group to support the development and refinement of tactics, techniques, and procedures with allied nations.
- Expeditionary Exploitation Unit 1 (EXU-1) based at Naval Surface Warfare Center Indian Head Explosive Ordnance Disposal Technology Division (NSWC IHEODTD) supported the exercise for the first time since its establishment as a command in 2018.

During the exercise, German, Norwegian, and Danish mine clearance divers – alongside U.S. Navy EOD technicians from EOD Mobile Unit EIGHT – gained real-world experience as they disposed of three live World War II-era mines. Divers detonated the mines after receiving permission from the German government.

BALTOPS was also an excellent opportunity for SMWDC's MIW warfare tactics instructors (WTI) to gain practical experience. SMWDC's WTI program develops subject matter experts who teach the fleet the latest and greatest in MIW but are also assigned a more specific subject matter to specialize in. When SMWDC is informed about an emerging technology in development, a WTI who specializes in that technical area is assigned to work closely with the industry developer and write draft tactics as the technology is being designed and tested. Once the technology is delivered to the fleet for prototyping work or fielding, the WTI stays with it to help test out tactics, techniques, and procedures, and refine them based on Sailors' feedback. Though the U.S. Navy is well equipped to teach WTIs about MIW from an academic perspective, international exercises like BALTOPS are invaluable in delivering real-world experience and knowledge from partner nations.

U.S. Pacific Command EOD commands also stayed busy in the first part of this year. In June, EOD technicians assigned to EOD Mobile Unit FIVE and the Japan Maritime Self-Defense Force (JMSDF) conducted IWOTO 2019, an MCM exercise (MINEX) on the island of Iwo To, formerly known as Iwo Jima. An annual event, IWOTO is the largest live MINEX in the Pacific, but this is the first time the U.S. Navy EOD force has been invited to actively participate.

In July, the U.S. Navy, JMSDF, and participants from the Indian Navy took part in MINEX 2JA 2019 off northern Japan. As part of the annual exercise series, U.S. Navy Commander, MCM Squadron 7 and JMSDF Mine Squadron 2 worked throughout the exercise to direct mine clearance tasks for U.S. and JMSDF forces, which included MCM ships, helicopters, and EOD technicians.

Not to be left out, U.S. and U.K. forces conducted routine bilateral MCM training in the Arabian Gulf from June 10 – 20. This recurring series of maritime assurance exercises brought the two countries' gulf-based MCM units together for the third time this year. Participating U.S. units included Commander, Task Force 52, USS Sentry (MCM 3), two EOD Expeditionary MCM platoons, and Helicopter Mine Countermeasures Squadron 15.

As our operational forces continue to train to face real-world challenge, we, the MIW community of interest, challenge you to stay engaged and creative as we work together to improve the development and delivery of warfighting capabilities to those on the tip of the spear.

Naval Aircrewman 1st Class Patrick Miller, assigned to the Dragon Whales of Helicopter Sea Combat Squadron (HSC) 28, operates the common console used for both Airborne Laser Mine Detection System (ALMDS) (pictured) and the Airborne Mine Neutralization System (AMNS) aboard an MH-60S Knight Hawk helicopter. The console controls the ALMDS pod, which collects laser data for initial and requisition minesweeping missions. U.S. Navy photo

UNDERSEA WARFARE VEHICLES COMMITTEE

TOM RUZIC
Chairman

CHUCK FRALICK
Deputy Chair

In this issue, I present a message from Captain Steven Harrison, Program Manager for Undersea Weapons (PMS404) with PEO Submarines. His portfolio includes all heavyweight and lightweight torpedo programs.

MANY OPPORTUNITIES FOR INDUSTRY IN TORPEDOES

It is an exciting and challenging time to work in undersea weapons. Submarines need torpedoes to fulfill their combat missions, and the threat is only getting more dangerous. The Navy needs more and improved torpedoes that perform in the most technically challenging combat environments on the planet. PMS 404 (Undersea Weapons) is charged with meeting these goals and will not succeed without strong industry partners.

PMS 404's primary focus is the production of both Heavyweight Torpedoes (HWTs) and Lightweight Torpedoes (LWTs) to increase inventory and develop new, more capable weapons. For HWTs, the program re-started MK48 MOD 7 production in 2016 after the production line went cold in 1996. Lightweight Torpedoes are wrapping up the U.S. Navy's Full Rate Production (FRP) for the MK54 MOD 0's but will continue production for foreign military sales (FMS) because of the strong demand signal for these capable weapons. For the U.S. Navy, Full Rate Production on MK54 MOD1 is nearing.

Due to the increasing threat and demanding nature of the undersea environment, PMS 404 is working on a number of R&D programs to both improve the current weapons and develop the next generation torpedoes. The first major improvement in the MK48 HWT in 20 years will be TI1, which is an entirely new sonar array and guidance and control section. The goal is to award the development contract for TI1 in FY19. TI2 is an entirely new HWT with extended range, which will be demonstrated in FY21 with Applied Research Laboratory/Pennsylvania State University (ARL PSU) as the design lead. This design will transition to industry for exercise torpedo (EXTORP) prototype production starting in FY22. On the LWT side, we are also developing an entirely new more lethal torpedo, MK54 MOD 2, which began development this FY with in-water prototype testing set for FY23.

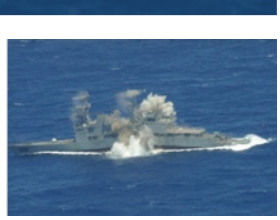
Below is a summary of existing and upcoming major contracts, as well as future development opportunities. In an effort to discuss these projects in more detail with industry and seek feedback on strategies, PMS 404 is hosting a Torpedo Enterprise Industry Day at NUWC on October 29. The announcement can be found on FedBizOps for more details.

HEAVYWEIGHT TORPEDOES (HWT)

- Two Full-Rate MOD 7 production contracts (recompete RFPs in FY20) – Guidance and Control, plus a warhead upgrade kit and propulsion sections with the fuel tank
- New development contract: sonar/ guidance and control section (TI-1) (award in FY19) with full-rate production contract in FY26
- Long range HWT (TI2) – new torpedo being demonstrated in FY21. Acquisition Strategy for transition to industry being finalized – seeking industry feedback. Late FY20 RFP(s) for industry EXTORP prototypes (FY22 awards), follow-on FAR production RFP(s) late FY24 (FY26 awards)
- Pearl Harbor and Yorktown IMA contracts (recompete RFPs in FY22/award in FY23)
- Fiber optic wire communication (UTIC OTA awarded in FY19)

LIGHTWEIGHT TORPEDOES (LWT)

- Recompete MK54 MOD 0 electronics and common parts used on both MK54 MOD 0 and MOD 1 (RFP in FY20/Award FY21 – NUWCDIVKPT lead)
- SBIR Phase III MK54 MOD 1 contract in FY22



- Recompete MK54 MOD 0 array and transmitter contract (RFP FY22)
- New development effort for new LWT (MK54 MOD 2) – four prototype OTAs planned to be awarded through DOTC in late FY19/early FY20. Follow on OTAs through NUWC UTIC in FY23. FAR LRIP RFP(s) in FY22 for award in late FY23.

SOFTWARE (SW) DEVELOPMENT – TORPEDO APB (TAPB) PROCESS

- UTIC OTA and SBIR awards for continuous operational SW development through Torpedo Advance Processor Builds (TAPB) process. We are seeking industry input and involvement to solve a number of undersea weapon challenges.

OTHERS THROUGH NUWC

- MK39 MOD 3 EMATT recompete (FY21 RFP)

FUTURE EFFORTS (NOT YET FUNDED)

- High Altitude ASW Weapon Capability (HAAWC) redesign effort to allow use of MK54 MOD 2 from P8
- HWT: Electric exercise variants for both TI1 and TI2
- LWT: Electric exercise variant for MK 54 MOD 2
- MK30 MOD 1 ASW training target replacement

UNDERSEA WARFARE AVIATION COMMITTEE

GLEN SHARPE
Chairman

MR. BOB KANYUCK
Deputy Chairman

CAPT. DANIEL PAPP, USN
(NAVAIR PMA-264), Navy Liaison

Welcome back to Groton. I hope everyone has had a great summer. I've been looking forward to a great session that builds up existing relationships and forges new ones with subject matter experts from across the USW domain. First off, I would like to thank Captain Doug Belvin for his outstanding service and commitment to the Aviation Committee as the Navy Liaison. On behalf of NDIA, I wish him and his family fair winds; job well done, Sir! Having said that, I would like to welcome Captain Daniel Papp who has assumed the role as the Aviation Committee Navy Liaison. Please join me in welcoming Captain Papp aboard. We are very fortunate to have such professional and dedicated Navy leadership continuing to participate in this committee. Aviation undersea warfare is much more than fixed and rotary wing platforms that drop sonobuoys or deploy dipping sonar, although those are important elements. Advances in acoustic and non-acoustic sensors, weapons, signal processing, testing, tactics, and training are making tremendous strides to keep up with the warfighting advancements of our adversaries.

This committee will continue to provide a venue to discuss solutions to the difficult undersea warfare challenges that our airman face daily, and support the program plans that the NAVAIR acquisition community provides. More specific accomplishments since we last met are provided below and released in the public domain.

AS US NAVY ORDERS MORE P-8A POSEIDON SURVEILLANCE PLANES, ORION SQUADRON FLIES FINAL MISSION

NEW PATROL CRAFT WILL WORK CLOSELY WITH MQ-4C TRITON DRONES

By: Joseph Hammond, *The Defense Post*

The U.S. Navy is phasing out a long-time patrol aircraft in favor of its successor. The Navy placed a new order for the Boeing P-8A Poseidon long-range maritime patrol aircraft this month and is set to replace the P-3C Orion, which is slowly being phased out of service.

The change is about more than swapping propellers for jet engines. The P-8A is designed to be better integrated with the Northrop Grumman MQ-4C Triton – an unmanned aerial system ideal for maritime surveillance.

Iranian air defense forces shot down a version of the RQ-4 Global Hawk – the Triton's predecessor – that was outfitted with Triton technology, and U.S. Central Command later confirmed a Poseidon was nearby after a Islamic Revolutionary Guard Corps commander said the plane and its crew were spared.

Long considered an important part of America's anti-submarine warfare capabilities and often tasked with other maritime missions, the P-3C Orion has proved durable throughout decades of service.

The Orion has been in U.S. Navy service since the Vietnam War and played a key role in several conflicts in the Indo-Pacific. American and Australian P-3Cs flew several intelligence missions in support of Filipino forces in the 2017 battle of Marawi – an extended anti-Islamic State operation in the southern Philippines.

However, the last squadron of P-3C Orion patrol planes are on their final mission. A wing of the venerable craft is currently on a sixth-month rotation between Bahrain and Japan in what may well be their last mission, according to the Pentagon. Patrol Squadron Zero Four began the mission in April.

The P-3C and its propeller engines are being phased out in favor of the jet-powered Boeing P-8. The P-8 was first introduced to Navy service in 2013 and is essentially a militarized version of the civilian Boeing 737-800 airliner. However, unlike the civilian version of the aircraft, the Boeing P-8 is all business – it can carry weapons and electronic intelligence, surveillance, reconnaissance and early warning systems.

Two Northrop Grumman MQ-4C Triton unmanned aerial vehicles at a Northrop Grumman test facility in Palmdale, California, May 21, 2013. Image: US Navy/Northrop Grumman/Chad Slattery

Notably the Poisedon can deploy a range of weapons, including torpedoes, mines, and Harpoon anti-ship missiles. These weapons and the plane's electronic surveillance capabilities can be used in conjunction with the Triton drones.

The U.S. Navy plans to purchase an additional 21 Poseidons (in addition to some 117 prior orders, including 10 ordered in January). Foreign buyers are set to buy a similar number according to Reuters, which has reported that Boeing produces 1.5 of the aircraft per month.

The American-made warplane is also operated by Australia and India, while the United Kingdom, Norway, South Korea and New Zealand all have outstanding orders. New Zealand outlined its plans for the aircraft in a policy document this month.

Canada and Singapore may be considering purchasing the P-8 plane as well. Australia, which has issued purchase orders for the Global Hawk, may pair the two systems as the U.S. Navy has already done, although the first Triton will not be in Australian service until 2023. India, another operator of the P-8, is also considering a purchase of the Triton UAV.

Japan, another operator of the propeller-engined P-3, has developed and deployed their own jet-engined patrol plane, the Kawasaki P-1, rather than purchase the new Boeing-built aircraft. The P-1 is one of only a handful of Japanese weapons systems that have been marketed for export.

For Japan, such aircraft play an important role in keeping China's emerging submarine threat in check. The Indo-Pacific is home to more submarines than any other waters in the world.

"There are 400 foreign submarines in the world, of which roughly 75% reside in the Indo-Pacific region," said U.S. Navy Admiral Philip Davidson in a March appearance before the U.S. Congress. "One-hundred and sixty of these submarines belong to China, Russia and North Korea."

In particular, China's submarine fleet is expanding rapidly and may soon be able to deploy ballistic nuclear missiles. At present China is believed to operates four nuclear-powered ballistic missile submarines, six nuclear-powered attack submarines and 50 conventional attack submarines.

However, both the Orion and Poseidon can fly a variety of other missions, including command and control, intelligence gathering and surveillance.

While the last Orions will be fully phased out of U.S. service by 2023, the plane continues to be operated by several countries around the globe.

The role of the P-3 Orion during the battle of Marawi left an impression in the Philippines, and the Filipino military is keen to acquire several of the P-3Cs if the United States is willing to sell them with their advanced surveillance capability.

"It will be good if we acquire even one P-3 Orion, provided it has all its original equipment. Otherwise, it will just be another transport plane. We will find out if we can get one or two," Philippines Defense Secretary Delfin N. Lorenzana said in May.

This article originally appeared on TheDefensePost.com

US COULD LOSE A KEY WEAPON FOR TRACKING CHINESE AND RUSSIAN SUBS

By: Joe Gould and Aaron Mehta, *Defense News*

WASHINGTON — A key tool in the U.S. Navy's fight against Russian and Chinese submarines weighs eight pounds, is three feet long and it doesn't even explode.

The sonobuoy is an expendable, waterborne sensor that has been air-dropped by the hundreds to detect enemy subs, a go-to capability for America and its allies for decades. The Pentagon wants to buy 204,000 sonobuoys in its fiscal 2020 budget request, a 50 percent spending increase over 2018.

But just as the U.S. military needs them most, this critical capability is under threat, and it's got nothing to do with an enemy nation. Without government investment in the market, the Pentagon says it may no longer have a reliable supplier, according to officials who spoke to Defense News.

Like so many systems in the Pentagon's arsenal, America has just one proven supplier. In this case, it is a joint venture between the United States and the UK called ERAPSCO. The Pentagon says ERAPSCO will dissolve by 2024 and that neither side of the partnership — Sparton Corp., of Schaumburg, Illinois, and Ultra Electronics, of Middlesex in the U.K. — will be able to make the necessary investments to produce the capability independently.

It's an "acknowledged weakness" in the industrial base that required the Pentagon find a solution, said Eric Chewning, a top Pentagon official who was until January the head of the Pentagon's industrial policy office.

Sailors load sonobuoys into a transport trailer. The small sensors are key for U.S. anti-submarine efforts, but production may be threatened in the coming years. (US Navy/Lt. Cmdr Alan Johnson/Released)

As a result, U.S. President Donald Trump in March signed a memo invoking the Defense Production Act to declare domestic production for the five types of AN/SSQ sonobuoys "essential to the national defense" and grant the Pentagon authorities to sustain and expand the capability. The Air Force, in anticipation, issued a market research solicitation to find suppliers beyond ERAPSO.

The Pentagon requires "comprehensive individual production lines ... for the five sonobuoy types, but the two companies would "require assistance to establish independent production lines," said DoD spokesman Lt. Col. Mike Andrews.

"Due to the significant efforts and expenditures, it is unlikely that either the JV partners (or any other entity) will be independently able to make the necessary investments to develop and produce the required sonobuoy demands by 2024," Andrews said, adding that "DoD intervention into the market is necessary."

This article originally appeared on DefenseNews.com

UNDERSEA WARFARE SENSORS COMMITTEE

MICHAEL JANIK
CHAIRMAN

JOSEPH CUSCHIERI
DEPUTY CHAIRMAN

PETER SCALA
PEO IWS 5 NAVY LIAISON

The Undersea Sensors Committee Fall Session received a good number of presentation submissions covering what has now become common for the Underwater Sensors Committee topics, including the traditional undersea sensors and processing for fixed surveillance systems, new sensors and processing for large manned platforms, sensors for unmanned platforms, and sensor materials and transduction. The papers are all well suited and in line with this year's conference them, "Preserving Undersea Superiority – A System of Systems," because the topics highlight the importance of approaching Undersea Sensing from an overall systems viewpoint rather than just the sensor or the processing.

In the spring newsletter, the question asked was, "Is underwater sensors technology keeping pace with requirements?" One can look at two approaches to address this question: the system level and the component level. Let's focus on the system level to be consistent with the theme of this year's Fall Conference.

Arguably, unmanned underwater vehicle (UUV) technology is progressing; vehicle maturity and reliability are improving; higher levels of autonomy are being demonstrated; and unit costs are trending lower on some UUV classes.

As UUV technology readiness improves, new system concepts using multiple, distributed UUV's are being considered and experimentally developed. UUV swarms, operating with collaborative autonomy behaviors, can provide distributed, mobile, and wireless sensor networks that are environmentally adaptive with improved performance and feasibility in regions not practical for fixed or stationary systems.

An important element of the adaptive sensor net solution is the relative positioning of the vehicles in the swarm. While underwater vehicles' autonomy technology is improving and its cost is reducing, navigation sensors remain a significant cost factor. Indeed, improved navigation sensors that reduce navigation error are becoming available, but their cost is still relatively high. Maybe it's a matter of time before a new breed of high-precision, low-cost navigation solutions become available. Potentially, high-precision relative positioning is not necessary. More on this later!

Figure 1 shows an example CONOPs where unmanned systems and manned platforms are teamed to address the challenges of an A2AD environment.

With the advent of new manned-unmanned system concepts, technical challenges and questions arise to be addressed:

- Are unmanned vehicles that can carry sensors sufficiently inexpensive that making the sensor net consisting of hundreds of unmanned vehicles viable?
- How will the unmanned vehicles maintain knowledge of their relative location to each other?
- Is knowledge of the relative location important for the processing of the data collected by the sensor net?
- How will data exfiltration take place?

These questions and many more will lead to the fact that, for the distributed sensors concept, different capabilities and different types of sensors are required, all within the umbrella of undersea sensors. Apart from the detection and tracking sensors that have traditionally been the main component of undersea sensors development and technology, unmanned vehicles may now require reliable undersea communications sensors, undersea navigation sensors, INUs, correlation or doppler velocity logs, and other sensors and processing that will make such an adaptive distributed sensor net concept a reality. These sensors may also be required on manned platforms assuming, for example, that the manned platform is another node or the main node in the network. It is important to mention that the whole sensor suite must be designed for low power as unmanned vehicles still carry batteries for energy.

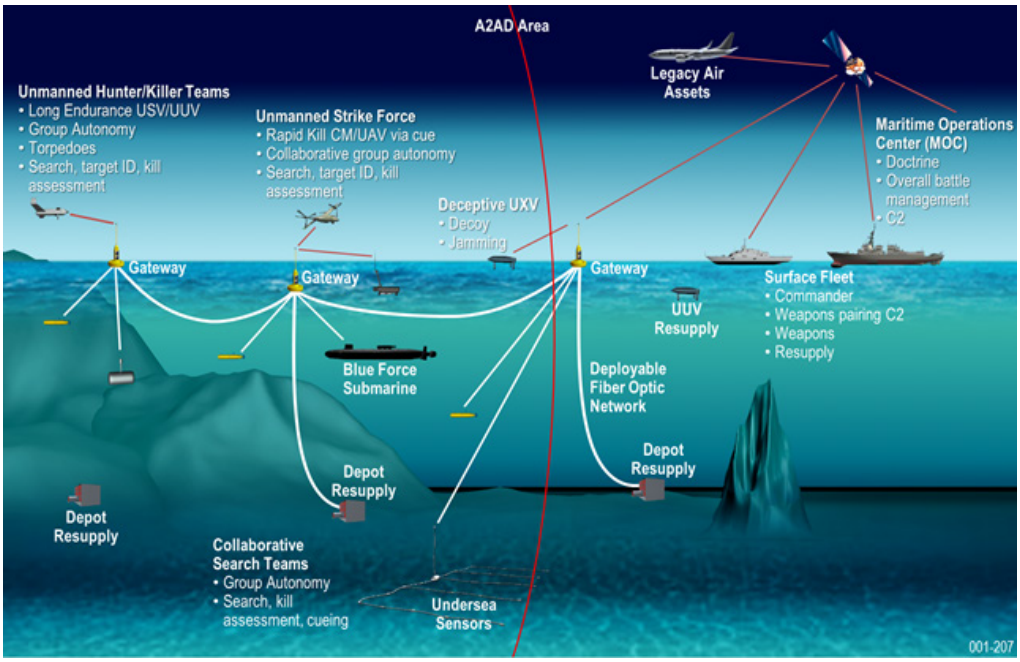


Figure 1. Preliminary Collaborative Unmanned Undersea Vehicle ASW Concept

Figure 2 is a cartoon of what an underwater ASW network may look like with each vehicle autonomy capable of assimilating information about the vehicle, the environment, and the objective to position the node vehicles in a configuration that based on the collected data about environment thus optimizing the detection capability.

Back to the issue of relative position, underwater data communication is slow and at low bandwidth. Therefore, exchanging large volumes of data to keep the relative positioning between the vehicle nodes in a precise configuration may not be practical. That is, apart from the development of other undersea sensors for the collaborative swarm application, new data processing techniques may be required that do not heavily rely on the precise relative positioning of the sensors in the network or new sensors are developed that passively provide the relative position information.

Hence, underwater sensors and underwater sensors data processing may be opening up to a very new and exciting area that will bring new concepts on the way ASW tasks are performed. Since now the solution is not a sensor suite but a system solution, a systems of systems approach may be more in line to reach the objective.

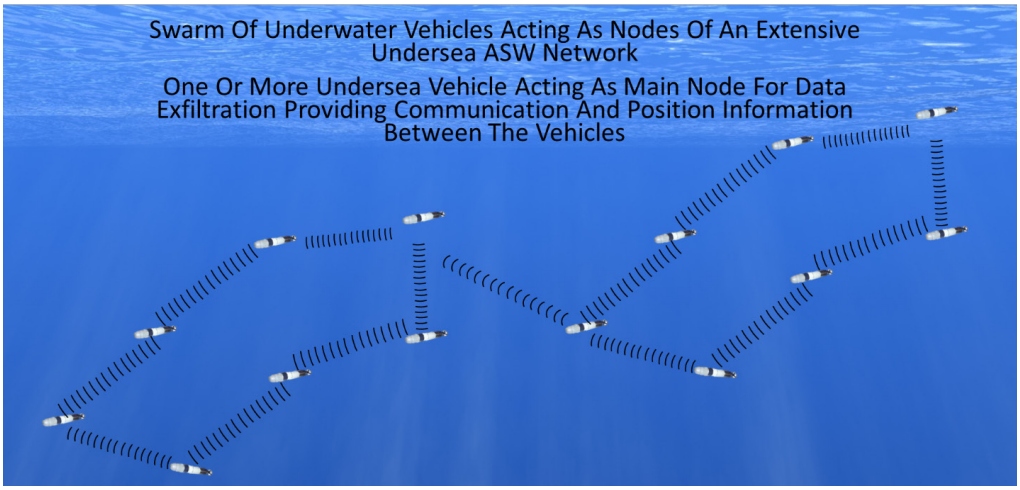


Figure 2. Large Swam Distributed Sensor Concept

CONFERENCE CHAIR'S MESSAGE

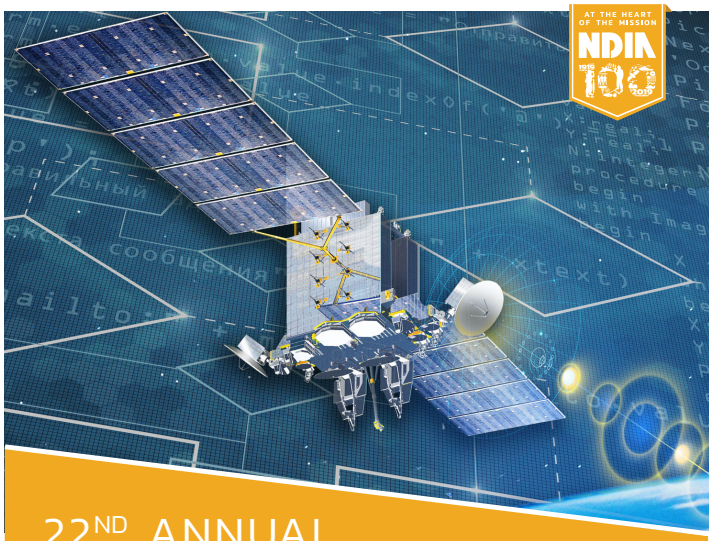
ROBERT DUNN
CHAIRMAN
FALL CONFERENCE

ERIC IRWIN
CO-CHAIRMAN

The Fall Conference's theme, "Preserving Undersea Superiority – A System of Systems Approach," focuses on the capabilities that both present and future undersea warfare systems can bring to an integrated undersea battlespace in support of the U.S. Navy's vision for sustaining undersea superiority now and into the future.

This year's outstanding group of plenary speakers represents the full spectrum of undersea warfare expertise. The plenary session will begin with our keynote speaker, ADM Caldwell, the Director, Naval Nuclear Propulsion Program. Following his keynote and throughout the day, briefs will be presented by the Commander, Submarine Forces; Chief of Naval Research; Program Executive Officer Submarines; Commander, Undersea Warfighting Development Center; Commander, Naval Meteorological and Oceanography Command; Program Manager for Air ASW Programs; Commander, Naval Undersea and Surface Warfare Centers; Program Manager for Unmanned Systems, Office of Naval Intelligence; and the Director, Undersea Warfare Division, N97.

Attendance provides you the opportunity to gain insight into the challenges and capability gaps that the Navy faces across the entire spectrum of the undersea domain. Take advantage of this opportunity to hear our Defense and Navy leaders' views on the issues confronting the Navy-industry-academia team as we navigate the waters of an uncertain future that will present new challenges to sustaining our undersea dominance.



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