

Mastery of the Seas at All Depths: Capability Focus Area—Topics and Subtopics

Starting in 2025, NUWC Division Newport defined a new strategic vision: “Mastery of the Seas at All Depths.” This strategic vision is underpinned by the technologies, capabilities, and other enablers that are essential to NUWC’s role in supporting the Navy for the next decade and beyond. The scope of this vision was concentrated into 11 distinct Capability Focus Areas (CFAs) that highlight the areas where NUWC has the required technical expertise and proficiency to achieve this audacious strategic vision.

This list is intended to serve as a starting point for technical discussions with industry, academic involvement, and all other public-facing engagements.

Capability Focus Area: Undersea Sensing

Mission: Enhance the performance of Naval ASW platforms and systems using a variety of undersea sensors.

- **Hydrophones & Transducers:** Acoustic sensor miniaturization; Novel transduction materials maximizing output in small form factors; Low cost but higher efficiency and higher power projectors; Higher reliability devices under harsh conditions.
- **Towed Systems:** Large multi-line configurations for tactical platforms; Improved multi-line towing methods; Flow noise reduction techniques; Improved handlers for deployment and retrieval with reduced space and weight and higher reliability.
- **Hull Mounted Systems:** Improved methods for array construction; Lighter weight, larger size, more efficient cabling methods; Non-invasive methods for hull inspections behind arrays.
- **Sensors & Anti-Fouling:** Low noise sensors (electrical/flow-induced) across a wide range of frequencies; Innovative anti-fouling methods for acoustic windows and domes; Reduced acoustic loss and noise from acoustic domes; Higher reliability acoustic domes.
- **Signal Processing & AI:** AI-enabled automatic classification of signals; Improved array processing methods for increased gain against noise; Improved automation for large arrays; Low-power signal processing.
- **Power & Telemetry:** Submarine-compatible energy sources & storage for off-board systems; Low-power/weight open-architecture telemetry; Combined sensor and telemetry packages; Improved methods for out-board electronics packages; Through-hull interface connectivity.
- **Active Systems:** High-power, submarine-compatible off-board acoustic sources; Distributed active acoustic arrays.
- **Novel Sensing Systems:** Bio-inspired sensing; Non-acoustic undersea sensors.
- **Fixed Sensor Systems:** Sensor infrastructure and networking; Sensor and system endurance and ruggedization; Anti-fouling methods; Sustained power and battery technology.

Capability Focus Area: Weapon Lethality

Mission: Develop and integrate all-domain capabilities to accomplish USW missions with a mix of weapon types.

- **Autonomy & Behaviors:** Autonomous & multi-weapon behaviors for emerging missions; Navigational accuracy.
- **Vehicle Attributes:** Modular payloads for multi-function platforms; High platform endurance; Low cost/attractable options; Launch and recovery in support of test and evaluation; Low-cost edge computing; Encryption and cybersecurity.
- **Sensors & Signal Processing:** Advanced signal processing & data fusion (AI/ML integrated); Next-generation multi-purpose sonar & transducer design; Alternate operational modes.
- **Materials & Energy:** Advanced warhead materials; Textured ceramics; Alternative battery/energy chemistries; Structural noise reduction materials/techniques.

Capability Focus Area: Assured Communications

Mission: Assured communications to all manned and unmanned systems ensuring delivery of critical data in support of all USW missions.

- **Networking & Data Links:** Adaptive networking & secure data links; Family of 3PT/3PC Tactical Data Links; Multi-modal undersea infrastructure comms; Compression and encryption technology for low data rate, high latency communication paths.
- **Digital Signal Processing & RF Systems:** Small form factor comms & antenna miniaturization; Field programmable gate array (FPGA) based Software Defined Radio (SDR) systems for flexible communications and digital signal processing
- **Quantum Technologies:** Theoretical and experimental components for quantum teleportation, encryption, and entangled systems.
- **Acoustic Communications:** Low Probability of Detection (LPD) and Low Probability of Interception (LPI) techniques; Underwater Acoustic Networking (UAN) protocols; Real-time Doppler compensation and automated ambient noise mitigation algorithms.
- **Cross-Domain Communication Enablers:** Buoys; Towed apertures; Unmanned systems; Multi-modal comms that enable cross domain C2.

Capability Focus Area: Subsea and Seabed Warfare

Mission: Access, operations, and presence at all ocean depths.

- **Power & Energy:** Long-endurance power systems, power transfer systems, and energy solutions for autonomous systems
- **Sensors & Infrastructure:** fixed & mobile sensors, active/passive sonar components, Synthetic Aperture Sonar (SAS), circle-SAS, and related high-resolution imaging technologies for mapping and classification; reliable undersea infrastructure that integrates power and networking.
- **C2 & Decision Support:** secure command and control communications networking systems; long-range acoustic communications; research into acoustic propagation in harsh undersea environments; data management tools, shore-based decision support, and warfighter-centric human/machine interfaces.
- **Autonomy & Search:** general vehicle autonomy, research into trust in autonomy, and AI/ML-enabled detection and classification (search) automation algorithms.
- **Materials & Hardware:** reliable pressure hulls, robust deployment options, and reliable hardware capable of surviving all ocean depths; anti-fouling and environmentally resilient materials and designs.

Capability Focus Area: Platform Defense & Survivability

Mission: Improve survivability of US Naval platforms while executing priority missions.

- **Countermeasures:** Low-cost, off-board devices with multi-function capabilities; Static and mobile operation; Support multiple signal transmission methods and frequency regimes; Apply to both sensors and weapons; Include soft and hard methods; Miniaturize payloads; Advanced platform-water interfaces.
- **Detection:** Embedded threat detection and recognition algorithms.
- **Signature Management & Material Design:** Advanced acoustic and non-acoustic signature monitoring and assessment using automation; Apply to multiple signal transmission methods and phenomena; Advanced, low-cost but high reliability materials for mechanical or electrical interference.
- **Structural Resilience & Damage Mitigation:** Advanced materials and mechanical configurations that improve resilience to kinetic impacts; Lightweight conformal armor and viscoelastic energy-absorbing composites; Ceramic-metallic materials for high-temperature propulsion and ballistic defense.
- **Corrosion and Antifouling:** Barriers, compounds, coatings to prevent metal degradation and reduce hydrodynamic drag from marine growth; Smart coatings for corrosion inhibition; Non-toxic cleaning and/or surface treatment systems; AI-assisted predictive maintenance capabilities.

Capability Focus Area: Undersea Warfare Command & Control

Mission: Provide an interconnected family of command-and-control systems that deliver information and decision advantage to our warfighting commanders.

- **Battle Management:** Multi-level security battle management aids; Allied machine-to-machine cross-domain solutions.
- **C2 Infrastructure:** Resilient data architectures & comms application providers; Rapid capability delivery technology.
- **Edge & Interface:** Lightweight encryption & C2 messaging; Edge computing innovation.
- **Common Operating Picture (COP):** Data fusion; tactical decision aides (TDAs); Decision science and situational awareness.
- **Human System Integration (HSI):** Cognitive science; Visual design heuristics; Warfighter performance and training effectiveness.

Capability Focus Area: EW/EO at Air/Sea Interface

Mission: Control the Electromagnetic and Electro-optical spectrum through the air/sea interface.

- **Sensors & Receivers:** Advanced EW receiver/transceiver technology; Advanced EO/IR sensors for maritime platforms; Pressure tolerant wideband multi-function apertures, Non-traditional EM sensors.
- **AI & Processing:** AI-enabled signal detection, classification, and localization; EM sensor fusion and cross cueing; Advanced signal/image processing techniques, signal classification without a priori knowledge.
- **Effectors & Teaming:** Autonomous cross-domain teaming architectures; Low throughput multiplatform geolocation techniques; Active effects.
- **Advanced Materials:** Custom graphene-based devices for voltage-controlled emissivity; Amorphous silicon-based active recovery of high-speed single-photon avalanche detectors for low-light applications
- **Optical Imaging Tech:** Foundational optical-imaging for infrared systems; simulations for prototype design and development.
- **Data & Machine Learning:** Synthetic and curated data generation to augment real-world ML training data; Automatic target recognition (ATR) in varying atmospheric conditions.

Capability Focus Area: Undersea Robotic & Autonomous Systems (URAS)

Mission: Enable the integration of autonomous undersea systems while providing precise mission capabilities.

- **Autonomy & Planning:** Advanced autonomous behaviors; AI-enabled autonomy and mission planning; Swarming/cooperative behaviors; advanced control methods; system level mission planning and simulation capabilities; advanced sea floor and near surface operations; operations in cluttered environments.
- **Hardware:** Modular payload architectures; Advanced Structures and manufacturing for depth and system design improvements; Advanced materials for corrosion, seawater exposure; Biofouling, stealth, drag reduction.
- **Sensors:** Acoustic sensors and signal processing; multi-modal sensor packages; New and novel non-acoustic sensing capabilities; bio-inspired sensing; AI enabled detection and classification processing.
- **Power & Energy:** Novel electrochemical materials and thermal management systems to extend UUV endurance and sprint speed; Low SWaP/High endurance systems; environmental energy harvesting; bio-inspired propulsion/motion; low power processing and system level power management advancements;
- **Precision, Navigation, & Timing (PNT):** Inertial navigation systems (INS); Improved undersea navigation methods.
- **Communication:** Novel communication modalities for longer range; higher bandwidth data exchange.

Capability Focus Area: Tactical Oceanography

Mission: Apply increased knowledge of the environment to improve tactical use of all undersea warfare systems.

- **Sensing & Prototyping:** Environmental Sensor Prototyping (onboard and offboard); Technical Insertion, and Evaluation; Ruggedized, deployable oceanographic sensors.
- **Data, Modeling, & Simulation:** Algorithms for processing oceanographic sensors and USW system data; Modeling and Simulation of existing and future USW systems and employment tactics; M&S for sensor placement and performance analysis.
- **Decision Support & HSI:** Prototype operator interfaces and decision aids for oceanographic sensor data.
- **System & Performance Analysis:** Analysis of oceanographic impacts on USW system performance and employment tactics.

Capability Focus Area: Cybersecurity

Mission: Protect our network of USW systems and communication paths from advancing cyber threats.

- **Detection & Incident Response:** Situational awareness & response utilizing integrated IDS/IPS, SIEM, and SOAR tools with AI/ML-based host/network recognition; Human-machine interfaces optimized for operator awareness and reduced cognitive load; Cyber fleet support leveraging Generative AI and multimodal models to enhance sailor response to incidents.
- **System Resilience & Countermeasures:** mechanisms to debloat, harden, and diversify software against AI-enhanced malware; Survivable systems focused on capability recovery in degraded states and active configuration management for risk posture.
- **Threat & Vulnerability Modeling:** algorithms and data structures to identify preconditions of exploitability.
- **Architecture & Defense in Depth:** DevSecOps toolchains & CMMC-compliant development pipelines; Zero-trust architectures to protect USW systems against AI-enabled adversarial actors.
- **Risk Management and Compliance:** Cyber kill chain models to shift the Navy ATO paradigm to that of continuous authorization and proactive risk management for ashore and afloat systems.

Capability Focus Area: Digitization

Mission: Create and utilize a digital USW environment and employ advanced AI/ML to further understanding of undersea data.

- **Artificial Intelligence:** Agentic/Resilient AI & real-time edge learning; Multi-agent reinforcement & evolutionary algorithms; AI-based sensor fusion; AI explainability (XAI); Human-AI teaming; 3rd generation Neural Networks (SNN); Defense against Adversarial Attacks and Misinformation
- **Modeling & Simulation (M&S):** Virtual/Constructive simulations for T&E, wargaming, & mission engineering; LVC architectures as enablers for MOC, RAS, and SSW experimentation; M&S for EW comms and effects with physics-based modeling; Digital twins integrating historical and real-time sensor data; Fleet operational readiness models.
- **Infrastructure & Teaming:** Digital thread implementation; Cloud/edge computing for maritime environments; Multi-Level Security (MLS) and Cross Domain Solutions (CDS) for higher/mixed classification; Human-machine teaming tools.