

NAVY 12/1/2019 Preview SBIR 20.1 Topic Index

ADAPT Topics – N201-X01 to N201-X02

- N201-X01 ADAPT - Advanced, Agile Manufacturing of Limited-Production Swarming Unmanned Systems (UxS) to Support Humanitarian Assistance and Disaster Relief (HADR) Operations
- N201-X02 ADAPT - Naval Depot Modernization and Sustainment

Standard Topics – N201-001 to N201-087

- N201-001 Broadband for Photonic Receiver
- N201-002 Focused Directed Energy Antenna System (FoDEAS) for Long-Range Vehicle/Vessel Stopping with reduced overall system size, weight, power consumption, thermal cooling, and system cost (SWAP/C2)
- N201-003 Powered Paraglider with Increased Capabilities
- N201-004 Small High-Speed Amphibious Role-Variant Craft (S.H.A.R.C.)
- N201-005 Wireless In-Ear Sensors for Warfighter Monitoring
- N201-006 Inclusion Detection in Steel for Bar Stock, Gears, and Bearing Components
- N201-007 Long-Range Maritime Battle Damage Assessment
- N201-008 Augmented Reality and Aircraft Wiring
- N201-009 Software Framework for Integrated Human Modeling
- N201-010 Compact Source for Focused and Tunable Narrowband Radio Frequency
- N201-011 Minimization of Chronic Neck Pain in Military Aircrew and Vehicle Occupants
- N201-012 Multi-Octave, High Power Efficiency Active Electronically Scanned Array (AESA)
- N201-013 High Power Quantum Cascade Lasers in the Spectral Range between 3.8 and 4.1 Microns
- N201-014 Compact Long-Wave Infrared Hyperspectral Imager with Monolithically Integrated Tunable Optical Filter
- N201-015 Autonomous and Intelligent Aircraft Maintenance Technologies
- N201-016 Mid-Wave Infrared Fiber Amplifier
- N201-017 Modernization of the Laser Event Recorder
- N201-018 Dynamic Digital Spatial Nulling Algorithms for Tactical Data Links
- N201-019 Spatial Data Comparison for Markerless Augmented Reality (AR) Anchoring
- N201-020 Development of Agile Laser Eye Protection (LEP)
- N201-021 Cargo Handling Software for Navy and Marine Aircraft
- N201-022 Big Data Mining for Maritime Situational Awareness
- N201-023 Alternate Sled Track Braking Mechanism
- N201-024 Augmented Reality Headset for Maintainers
- N201-025 Ship Rapid Damage Assessment System
- N201-026 Manufacturing Composite External Volumes with Enhanced Underwater Collapse Performance
- N201-027 Artificial Intelligence Software-Based Autonomous Battle-space Monitoring Agent for a Distributed Common Operational Picture Software Subsystem
- N201-028 Surfzone Optical Imaging
- N201-029 Affordable Radar Antenna with Electronic Elevation Scan and Multiple Beams
- N201-030 Automated Configuration Deployment and Auditing
- N201-031 Digital Mission Planning Tools for Air Cushion Vehicles
- N201-032 High-Efficiency Wideband Linear Power Amplifier
- N201-033 Real-Time Adaptive Data Model and Dynamically Extensible Markup Language for Distributed Common Operational Picture
- N201-034 Low-cost, Expendable Surface Ship Threat Countermeasure
- N201-035 Advanced Compact Shipboard High Temperature Superconducting (HTS) Cable Terminations
- N201-036 Dynamic Loadable Module Architecture and Applications Program Interface for a Distributed Common Operational Picture Subsystem
- N201-037 Multi-platform Real-time Synchronization and Coherency Algorithms and Architecture for a Distributed Common Operational Picture Subsystem
- N201-038 Multi-aperture Active Metrological Sensor for Submarines

N201-039 Power Dense Single Core Three-Phase Transformer
~~N201-040~~ [Navy has removed topic N201-040 from the 20.1 SBIR BAA]
 N201-041 Bridge-to-Bridge Radio for Unmanned Surface Vehicles
 N201-042 Rolling Shutter and Fast Panning Effects Mitigation
 N201-043 Holistic Integration of Air Anti-Submarine Warfare Capability for Effective Theater Undersea Warfare

 N201-044 2 micron Wavelength Kilowatt Class High Energy Laser/Amplifier
 N201-045 Development of a Debris Prediction Method for Hardened Structures
 N201-046 Through-Hull Underwater Submarine Communications
 N201-047 Modular Architecture Framework Model and Application Program Interface for Common Core Combat System

 N201-048 MK 48 Torpedo Composite Fuel Tank
 N201-049 Towed Array Position Estimation System
 N201-050 Real-time Insights for Combat System Integration and Testing
~~N201-051~~ [Navy has removed topic N201-051 from the 20.1 SBIR BAA]
 N201-052 Wide Band Large Aperture Beam Director Head Window
 N201-053 Development of New Generation Earth Covered Magazine (ECM) Structure Design using Composite Materials

 N201-054 Coordinated, Layered Defense Capabilities of Multiple Torpedo Countermeasures
 N201-055 Coaxial Insulated Bus Pipe for High Energy Application
 N201-056 Data Exchange Subsystem Architectural Framework, Algorithm Set and Applications Program Interface for Common Core Combat System

 N201-057 Software Ecosystem Architectural Model and Application Program Interface for Common Core Combat System

 N201-058 Affordable and Efficient High-Power Long Wavelength Infrared Quantum Cascade Lasers
 N201-059 Automated Management of Maritime Navigation Safety
 N201-060 Unmanned Passive Navigation without GPS
 N201-061 Mine Countermeasures Unmanned Surface Vehicle Common Deploy and Retrieve System
 N201-062 Hydrophone Incorporating Open Architecture Telemetry
 N201-063 SUBSAFE Electrical Hull Penetrator Connectors for Directed Energy (DE) Weapon Systems
 N201-064 Digital Theater-level System Model for Cyber Security Analysis
 N201-065 Element-Level Digital Communications Array
 N201-066 Acoustically Transparent Mid-Frequency SONAR Projector
 N201-067 Kinematic Contact Tracking Using Hybrid Features
 N201-068 Compact High-energy Efficient System for Removing Carbon Monoxide from Ambient Air on Submarines and Other Closed Manned Environments

 N201-069 Low-cost, High Efficiency, and Non-rigid, Perovskite-based Single-junction or Tandem Solar Cells

 N201-070 Sensors and Autonomy for Unmanned Maritime Missions
 N201-071 Ultra-Fast Metastable Implant Activation System for Selective Area Doping of III-Nitrides
 N201-072 Aligned Nanotube Reinforcement of Polymer-matrix Laminates
 N201-073 Low Phase Noise Laser for Radio Frequency (RF) Photonics
 N201-074 High Power Microwave (HPM) Waveform-enhancing Sub-nanosecond Semiconductor Pulse Sharpener

 N201-075 Enabling Technologies for Marine eDNA Sampling
 N201-076 At-Scale Detection of Hardware Trojans on Chip Circuits
 N201-077 Machine Clustered and Labeled Decision Tracks Derived from AI-enabled Intent Recognition
 N201-078 Small-scale Health Monitoring Device for In-tube Environment Monitoring
 N201-079 Extremely Accurate Star Tracker
 N201-080 Remote Telescope Control Software (RTC SW) System
 N201-081 Automatic Coding Standards Validation Tool
 N201-082 Visible to Near-Infrared Integrated Photonics Development for Quantum Inertial Sensing
 N201-083 High Performance Natural Composite
 N201-084 Remote Telescope Control Hardware (RTC HW) System
 N201-085 Machine Learning-Based Data Analysis
 N201-086 Avionics Packaging Technology

N201-087

High-Power Superluminescent Diodes for High-Precision Interferometric Inertial Sensors

NAVY 12/1/19 Preview SBIR 20.1 Topic Descriptions

ADAPT Topics – N201-X01 to N201-X02

N201-X01 TITLE: ADAPT - Advanced, Agile Manufacturing of Limited-Production Swarming Unmanned Systems (UxS) to Support Humanitarian Assistance and Disaster Relief (HADR) Operations

TECHNOLOGY AREA(S): Battlespace

ACQUISITION PROGRAM: NAVAL Shipyards, Fleet Readiness Centers (FRC), Marine Corps Logistics Command (MARCORLOGCOM)

OBJECTIVE: Volatilities in global weather and geo-political climate are increasing the frequency and magnitude of natural and manmade disasters. Providing rapid response to affected areas is critical to saving lives, as the immediate aftermath of a disaster presents the greatest risks to survivors and to first responders. The highly dynamic environments resulting from debris and infrastructure destruction creates a significant challenge in moving supplies into and survivors out of disaster zones. The Navy and Marine Corps seek to develop and demonstrate rapid, distributed, on-demand manufacturing of unmanned systems capable of supporting multiple payloads dependent on the situation.

DESCRIPTION: The Department of the Navy (DON) seeks to develop and demonstrate rapid, distributed, on-demand, small-scaled, domestic manufacturing of unmanned systems capable of supporting multiple payloads depended on the situation. DON intends to collaborate with innovative small businesses for technologies and methods related to the following Focus Areas:

1. Agile manufacturing on-demand solutions for Unmanned Systems (UxS) products
2. Control systems for unmanned platforms to include either Group 1 – Unmanned Aircraft Systems (UAS) or conversion of manned watercrafts into Unmanned Surface Vehicles (USV)
3. Notional payload concepts based on using commercial-off-the-shelf (COTS) technologies

1. Agile manufacturing on-demand solutions for UxS products: define and develop customizable systems with the ability to fabricate close to the point-of-need. This includes access to manufacturing of components and assemblies across multiple facilities to accommodate surge requirements. This includes supply chain authentication and management required for the rapid local UxS assembly.
2. Control systems for unmanned platforms to include either Group 1 – UAS or USV: develop reconfigurable control systems demonstrating the ability for self-swarming organization and redistribution, fratricide-collision avoidance, and waypoint-based navigation. These systems must be rapidly tailorable to enable the conversion and use of any available assets as UxS under emergency conditions.
3. Notional payload concepts based on using COTS technologies: demonstrate capability for rapid acquisition and configuration for modular payloads to enable rapid response in Humanitarian Assistance and Disaster Relief (HADR) operations. Needed capabilities include communication, improved situational awareness, supply delivery, and victim extraction.

PHASE I: Please add the primary Focus Area number you are proposing to as a prefix to the Phase I Proposal title.

Proposers will develop and demonstrate an initial functional prototype meeting at least one primary Focus Area of the three Focus Areas listed under this topic. However, a proposer may choose to include secondary Focus Area(s) within the proposal submission. Technical proposals are limited to 5-pages and must provide sufficient information to allow assessment that the initial prototype demonstrated at the end of Phase I will function in a relevant environment in a manner meeting the specified capability. This information may include, but is not limited to, detailed designs, component and system laboratory testing, or a minimum viable product (MVP) [Ref. 1]. Ideally, the Technology Readiness Level (TRL) [Ref. 2] at the start of Phase I will be TRL 4-5 with the functional prototype at or near TRL 6 at Phase I completion. At the end of Phase I, the initial functional prototype will be demonstrated, a

detailed report on prototyping test results, and detailed plans for the small-scaled manufacturing of the prototypes will be provided to the Government. Proposals must include a discussion of the dual-use defense and commercial market opportunities for the technology being proposed, including a preliminary assessment of commercial market potential. Phase I period of performance shall not exceed 4 months, and the total fixed price shall not exceed \$200K.

PHASE II: During Phase II, the functional prototype from Phase I can be further developed and refined into an operational prototype based on defense and commercial customer feedback. Phase II will consist of three Rounds of funding with progression between Rounds contingent upon meeting defined milestones. For this topic, proposers must meet defined milestones for each Round to be considered for the next Round. Full details for Phase II proposal requirements will be provided to Phase I awardees; however, general descriptions for Phase II Rounds I, II, and III are provided below:

Round I. Demonstration of Viability – Round I further builds on the Phase I functional prototype to meet DON user's needs. Round I is limited to a firm fixed price of \$500,000 and the period of performance is not to exceed 6 months. During this Round, the proposer will focus on moving beyond proving basic achievement of meeting DON needs to meeting all of the usability features required for integration and deployment. The proposer will produce no-less-than 100 units of the prototypes under consideration. The proposer will be expected to work with actual end users and systems integration personnel to ensure that requirements beyond technological performance of the prototype are identified (e.g., Human System Interface, logistics, training, maintenance, installation). The proposer will use feedback from DON users, systems integrators, and other potential defense and commercial beneficiaries and stakeholders to modify and adapt its prototype to meet defense operational and technical needs and to meet potential dual-use commercial applications. At the end of Round I, the prototype must demonstrate operational and/or commercial viability. The proposer must recommend test procedures to demonstrate viability and an appropriate facility for the test; however, the Government is not required to use the proposed testing procedures or facilities. It is very likely that Government personnel will be present for the demonstration. Only those firms that produce technologies suitable for testing and demonstration of operational and/or commercial viability will be eligible for continuation to the next Round and additional funding. The Government reserves the right to fund some, none, or all of the Round I participants into Round II depending on the availability of SBIR funds and the capabilities of final Round II prototypes to meet DON needs.

Round II. Pilot Testing in an Operational Environment – Round II, if funded, is limited to a firm fixed price of \$1,000,000 and the period of performance is not to exceed 9 months. During Round II, the proposer will produce no-less-than 320 units of the prototypes under consideration, and meet with DON command stakeholders and operational end users to conduct pilot tests of fully functional prototypes in an operational environment. These tests are designed to be performed using DON operational personnel in real end user environments and scenarios. All testing will be coordinated with DON command and operational stakeholders. Results of this testing will inform stakeholders on the capabilities of the developed technology and the probability for its deployment in an operational environment. During Round II, the SBC will use feedback from DON users, systems integrators, and other potential defense and commercial beneficiaries and stakeholders to adapt their prototype to optimize defense operational and technical benefits and to provide optimal dual-use commercial market fit. Only those firms that produce technologies suitable for further testing in anticipation of DON deployment into an operational environment and/or commercialization in the private sector will be eligible for continuation to the next Round and additional funding. The Government reserves the right to fund some, none, or all of the Round II participants into Round III depending on the availability of SBIR or non-SBIR funds and the capabilities of final Round II prototype operational testing.

Round III. Operational Test and Evaluation in Multiple User Scenarios - Round III is intended for additional operational testing, if required, using multiple prototypes and users simultaneously in a DON operational environment. This Round may require delivery of no-less-than 1,000 prototypes and/or licenses of the technology for testing purposes. If non-government personnel are utilized as part of the testing, appropriate Non-Disclosure Agreements will be obtained to protect against disclosure of the proposer's intellectual property (if properly marked). The proposer may be required to support the conduct of the tests, but the operation of the prototypes in the test must be capable of being performed by the Government. SBIR funding, if available for Round III, will require non-SBIR Government or private funds included as a 1:1 Cost-Match, with SBIR funds not to exceed \$1,500,000 under the 1:1 Cost-Match. The required number of end users and prototypes as well as the operational scenarios to

be run are not yet defined. Therefore, this Round is currently undefined.

PHASE III DUAL USE APPLICATIONS: Given the need for these capabilities at numerous sites, the Federal Government will coordinate funding to maximize benefit for affected sites. Depending on financial estimates, a phased procurement may be required to reach full implementation at the necessary sites. Coordination between the Government and the provider will be required during Phase III to ensure support and proper proficiency of the solution is in place prior to completion of the effort.

Finally, the Federal Government sees the development of these capabilities as benefiting industrial maintenance activities in partnership with the Navy. The ability to keep critical assets in operation is a common need for which the Navy is seeking willing partners.

REFERENCES:

1. Minimum Viable Product: https://en.wikipedia.org/wiki/Minimum_viable_product
2. Technology Readiness Levels: <https://www.army.mil/e2/c/downloads/404585.pdf>
3. Information on Business Accelerator Pilot opportunity with H4XLabs for ADAPT Phase I Awardees (defined in Business Accelerator Services section in Proposal Submission Instructions for ADAPT Topics). <https://www.h4xlabs.com/sbir>

KEYWORDS: Unmanned Systems; UxS; Unmanned Aircraft Systems; UAS; Unmanned Surface Vehicles; USV; Humanitarian Assistance and Disaster Relief; HADR

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-X02 TITLE: ADAPT - Naval Depot Modernization and Sustainment

TECHNOLOGY AREA(S): Battlespace, Human Systems

ACQUISITION PROGRAM: NAVSEA Naval Shipyards, NAVAIR Fleet Readiness Centers (FRC), USMC Logistics Command (MARCORLOGCOM)

OBJECTIVE: The Department of the Navy (DON) sustainment community is urgently seeking modern tools, solutions, and processes to reliably and safely get DON assets back in the field as quickly as possible. Technologies for maintaining and sustaining ships, aircraft, and ground vehicles have advanced significantly in the past 50 years. Yet, the DON sustainment community has struggled to identify, pilot, and integrate those same technological advances into public shipyards, fleet readiness centers, and ground vehicle depots. As DON platforms increase in complexity and scale, demand outstrips the capability of current maintenance systems resulting in multi-year delays of national assets, such as the USS Boise.

DESCRIPTION: DON seeks modern tools, solutions, and processes to reliably and safely get assets back in the field as quickly as possible and intends to collaborate with innovative small businesses within the following and related

Focus Areas:

1. Expeditionary Depot Capability (Command, Control and Communications)
2. Artificial Intelligence (AI)-Generated Work Instructions (Artificial Intelligence/Machine Learning)
3. Self-Healing Data Collection Using Artificial Intelligence (AI) (Artificial Intelligence/Machine Learning)
4. Robotics Material Handling (Command, Control and Communications)
5. Integrated Global Logistics Network to Allow Model-Based Enterprise (MBE) (Command, Control and Communications)
6. Global Parts Tracking System (Command, Control and Communications)
7. Facility Health Monitoring and Prioritization (Command, Control and Communications & Autonomy)
8. Master Command and Control for Multiple Activity Visibility (Command, Control and Communications)
9. Cold Spray Technology Advancements (Command, Control and Communications)

1. Expeditionary Depot Capability (Command, Control and Communications): The Navy desires the capability to operate modular and air droppable maintenance machinery remotely to enhance resiliency in deployed environments. The Navy is currently limited by its fixed number of maintenance depots at specific locations. Capabilities are specialized at these “brick and mortar” locations, which forces naval platforms to return to these sites or to send teams out to the affected platform(s). Remotely operated maintenance systems will maximize naval forces’ ability to remain forward deployed by reducing time in fixed facilities (e.g., depot facilities, dry docks), reducing travel time to and from the facilities, and using the specialized labor at a safe stand-off from deployed locations.

2. Artificial Intelligence (AI)-Generated Work Instructions (Artificial Intelligence/Machine Learning): Certain repairs on naval platforms happen with such infrequency that mechanics cannot execute the repairs without extensive re-learning/re-engineering. Institutional knowledge is not effectively transferred, especially since seasoned mechanics rotate faster than these infrequent repairs occur. Mechanics faced with one of these repair scenarios often can only recall the anecdotal protocols from the previous one or two repairs. Furthermore, there is no systematic way to know whether recent repairs qualify as best practices. By establishing a repair data system to capture infrequent repairs, the naval maintenance community can analyze the data (via root cause analyses) to create and share best practices. In a future state, this could enable work instructions to be automatically generated with a high fidelity further accelerating the planning and execution of work.

3. Self-Healing Data Collection Using Artificial Intelligence (AI) (Artificial Intelligence/Machine Learning): Large swaths of data have been compiled and can provide invaluable insights if data entry errors can be corrected. Human correction of the errors (e.g., USS Abraham Lincoln to CVN72) is not efficient/effective nor predictive in nature. AI algorithms can groom or heal the (meta) data to make it more useful in trending deficiencies and corrective actions across multiple platforms. Navy seeks an automated self-healing data collection system to effectively correct inaccurate entry of parts numbers, and track/identify the root cause for repeated reports of faulty equipment.

4. Robotics Material Handling (Command, Control and Communications): The Navy needs to integrate commercial advancements in robotics technology at its depot locations to improve material movement. Trained labor is consumed querying inventories, traveling to different locations, searching warehouses, and returning to the work site before actually using their skills to restore a platform. Solutions to locate and deliver parts to work sites would enable skilled labor to focus on trade-specific efforts.

5. Integrated Global Logistics Network to Allow Model-Based Enterprise (MBE) (Command, Control and Communications): As each Navy depot builds its own digital model for resource planning and facility layouts, the depots have generated their own datasets with unique standards. The Navy needs the ability to track facility capacity (e.g., equipment, tooling) across the enterprise in the event repair efforts need to be re-allocated. Standards need to be established to ensure datasets can be integrated enterprise-wide. While individual depot planning models are likely effective at a local level, in aggregate, this limits decision makers’ ability to track and compare resource planning at an enterprise level.

6. Global Parts Tracking System (Command, Control and Communications): Locating and delivering repair parts currently consumes hundreds of man-years of effort to affect combat platform maintenance. Naval depots seek an efficient way to track parts across various depots to enable automated picking and shipping to support maintenance operations.

7. Facility Health Monitoring and Prioritization (Command, Control and Communications & Autonomy): Facility managers lack the tools to monitor the health status of various infrastructure. They seek an integrated facility health monitoring system that will be able to track real-time health status of buildings, identify and prioritize areas for repair, and predict where future failures might arise.

8. Master Command and Control for Multiple Activity Visibility (Command, Control and Communications): Depots

and distributed maintenance workers do not have a common operating picture or common process guide to conduct operations and receive real-time feedback on efforts. Navy seeks a way to track naval depot maintenance capacity and specialties enterprise-wide to optimize resource allocation.

9. Cold Spray Technology Advancements (Command, Control and Communications): Naval depots seek additional cold spray technology advancements to address structural metallic repairs and create robust, portable systems to reduce repair time and effectively execute larger area repairs in deployed/austere environments. Metallurgical analyses, powder development and system design advances are facets to the advancements required aboard ships, inside ground vehicle compartments, and for other applications.

PHASE I: Please add the primary Focus Area number you are proposing to as a prefix to the Phase I Proposal title.

Proposers will develop and demonstrate an initial functional prototype meeting one primary Focus Area of the nine Focus Areas listed under this topic. However, a proposer may choose to include secondary Focus Area(s) within the proposal submission. Technical proposals are limited to 5-pages and must provide sufficient information to allow assessment that the initial prototype demonstrated at the end of Phase I will function in a relevant environment in a manner meeting the specified capability. This information may include, but is not limited to, detailed designs, component and system laboratory testing, or a minimum viable product (MVP) [Ref. 1]. Ideally, the Technology Readiness Level (TRL) [Ref. 2] at the start of Phase I will be TRL 4-5 with the functional prototype at or near TRL 6 at Phase I completion. At the end of Phase I, the initial functional prototype will be demonstrated and a detailed report on prototyping test results will be provided to the Government. Proposals must include a discussion of the dual-use defense and commercial market opportunities for the technology being proposed, including a preliminary assessment of commercial market potential. Phase I period of performance shall not exceed 4 months, and the total fixed price shall not exceed \$200K.

PHASE II: The functional prototype demonstrated at the end of Phase I will be further developed and refined into an operational prototype based on defense and commercial customer feedback. Phase II will consist of three Rounds of funding with progression between Rounds contingent upon meeting defined milestones. For this topic, proposers must meet defined milestones for each Round to be considered for the next Round. Full details for Phase II proposal requirements will be provided to Phase I awardees; however, general descriptions for Phase II Rounds I, II, and III are provided below:

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systems integrators, and other potential defense and commercial beneficiaries and stakeholders to adapt their prototype to optimize defense operational and technical benefits and to provide optimal dual-use commercial market fit. Only those firms that produce technologies suitable for further testing in anticipation of DON deployment into an operational environment and/or commercialization in the private sector will be eligible for continuation to the next Round and additional funding. The government reserves the right to fund some, none, or all of the Round II participants into Round III depending on the availability of SBIR or non-SBIR funds and the capabilities of final Round II prototype operational testing.

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PHASE III DUAL USE APPLICATIONS: Given the need for these capabilities at numerous sites, the Federal Government will coordinate funding to maximize benefit for affected sites. Depending on financial estimates, a phased procurement may be required to reach full implementation at the necessary sites. Coordination between the Government and the provider will be required during Phase III to ensure support and proper proficiency of the solution is in place prior to completion of the effort.

Finally, the Federal Government sees the development of these capabilities as benefiting industrial maintenance activities in partnership with the Navy. The ability to keep critical assets in operation is a common need for which the Navy is seeking willing partners.

REFERENCES:

1. Minimum Viable Product: https://en.wikipedia.org/wiki/Minimum_viable_product
2. Technology Readiness Levels: <https://www.army.mil/e2/c/downloads/404585.pdf>
3. Risk Management Framework Information Document (Uploaded to SITIS 11/XX/2019)
4. Information on Business Accelerator Pilot opportunity with H4XLabs for ADAPT Phase I Awardees (defined in Business Accelerator Services section in Proposal Submission Instructions for ADAPT Topics). <https://www.h4xlabs.com/sbir>

KEYWORDS: Artificial Intelligence; AI; Machine Learning; ML; Data Analytics; Autonomy; Command, Control, and Communications; Robotic, Model Based Enterprise; Sensors, Industrial Internet of Things, IIOT; Cold Spray; 5G

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

Standard Topics – N201-001 to N193-149

N201-001 TITLE: Broadband for Photonic Receiver

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PFM CES, PMIS, Multi-Function Electronic Warfare (MFEW) ACAT IV-M POR

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative and operationally suitable consolidated (minimized size and weight) antenna solution for sensing and transmitting broadly across the electromagnetic spectrum.

DESCRIPTION: Marine Corps Systems Command (MCSC) provides vehicle-mounted Electronic Warfare Systems (EWS) for geo-locating, direction finding, and countering threats on the ground and in the air. In order for these systems to be maximally effective against the breadth of potential threats, they must be able to sense and defeat a variety of complex threat signals across the electromagnetic spectrum at once.

With the emergence of ultra-wideband photonic receiver technology that can very rapidly process, de-conflict, and identify threats across the entire frequency range of the electromagnetic spectrum, there comes a need for complimentary broadband antenna hardware to sense threats and transmit to defeat them. Current antenna technologies are limited in frequency range and thus multiple antennae are required to cover broad ranges, especially at the lower end of the frequency range.

Requirements for the Broadband Antenna for Photonic Receiver are as follows: Demonstrate a broadband antenna for a photonic receiver in the frequency range from DC to 20GHz (threshold), CD to 80+GHz (objective). This should be achieved with threshold of 4 antennae with a preference that multiple antennae occupy the same physical space. Antennae that occupy the same physical space will be considered one antenna, even if they are electromagnetically multiple antennae. No single antenna should exceed a 1ft cube in size. The total weight for the antennae solution must not exceed 50lbs (threshold) with an objective of 10lbs. As a threshold, the composite antennae solution must both receive and transmit across the entire frequency range. As an objective, it should be able to receive and transmit simultaneously at the same frequency. The antenna must have a $\pm 45^\circ$ field of view (threshold). Viable solutions must have a flat gain response within each octave of less than 1dB gain (threshold), less than 0.5dB gain (objective). Small regions of non-flatness (up to 3dB off the gain) are acceptable so long as they can be adequately characterized and assumed within the antenna pattern. A preference is provided to a systems with a gain response better than unity (0 dB) over the frequency range. The broadband antenna is intended to be used as part of a vehicle-mounted expeditionary EWS, so it should be water resistant and capable of functioning on the move. The system should be designed to meet MIL STD 810H, but testing of prototypes is not included in the scope of the research. The solution must use standard radio frequency interfaces to easily integrate with PORs and the required frequency interfaces need to be defined in any proposal. A preference is provided to minimizing the number and type of interfaces needed to cover the entire frequency range.

The Phase I effort will not require access to classified information. Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and the Marine Corps in

order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop concepts for a broadband antenna that can be integrated with a photonic receiver and vehicle-mounted EWS, and that meets the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs and establish that the concepts can be developed into a useful product for the Marine Corps. May establish feasibility through modeling and simulation. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction and includes specification for a prototype.

PHASE II: Develop a scaled prototype integrated with representative receiver(s) that cover the frequency range for evaluation purposes in an actual or simulated electromagnetic environment representative of the breadth, volume, and complexity of an operational electromagnetic environment. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for integration with an electronic warfare system as the front-end antenna. Demonstrate system performance through prototype evaluation and modeling or analytical methods that demonstrate the preprocessing capability with a test case for each of the three objectives listed in the description above. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop a ruggedized broadband antenna for integration and evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

As the communications industry grows and advances in capability exponentially, antenna technology remains an important enabler to maximize performance while minimizing cost and footprint. The developer of this broadband antenna could potentially market the solutions or products derived lessons learned to the communications industry.

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KEYWORDS: Electronic Warfare; Electromagnetic Spectrum; Broadband Antenna; Photonics; Receive and Transmit; Sensing; Flat Gain Response

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-002 TITLE: Focused Directed Energy Antenna System (FoDEAS) for Long-Range Vehicle/Vessel Stopping with reduced overall system size, weight, power consumption, thermal cooling, and system cost (SWAP/C2)

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Directorate

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Focused Directed Energy Antenna System (FoDEAS) using high power microwave (HPM) – (wideband) frequencies to electronically attack threat vehicle and vessel engines and embedded threat electronics. Provide long-range, non-lethal vehicle/vessel stopping capabilities with a wideband HPM antenna that incorporates frequency carve-outs that allows the use of this Non-Lethal Weapon (NLW) without interference to or with critical communication, navigation, and/or radar (frequencies) systems.

DESCRIPTION: Typical directed energy weapon (DEW) systems that employ high-power microwaves to electronically attack and disable/neutralize critical electronics on-board vehicle or vessel targets rely on a high peak power narrow band (single frequency) waveforms. These HPM DEW often employ a very large (~ 10-15 foot diameter) and heavy (> 150 pound) high gain (25 – 30 dBi) antenna system. These large/heavy narrow band antenna systems are designed to accommodate 10's to 100's of Megawatts of high peak power and they achieve their high antenna gain and resulting high beam directivity via their large antenna diameters [Ref 1]. These HPM DEW systems produce short duration waveform pulses of energy that disable control electronics embedded in threat vehicle/vessel engines. A second class of HPM DEW systems are HPM systems that operate by employing waveforms that are composed of multiple frequencies in a (full) single waveform. These HPM weapons system are called wideband HPM weapons. These wideband HPM sources have several advantages over narrow band sources (e.g., klystrons or magnetrons source which tend to be bulky, heavy, expensive, and require significant maintenance costs). Wideband HPM sources generate their power/waveforms by employing various high-speed switching technologies that drive smaller, lower power vacuum-tube devices or semiconductor switches [Ref 2] but they also typically project this power using omni-directional antenna systems [Ref 3]. These omni-directional wideband antenna systems are often more effective at neutralizing the electronics on-board vehicle and vessel engines (as there are more frequencies available to interact with critical electronic components) but as they are omni-directional (non-focused – non-directional), they do so typically at shorter ranges [Ref 4]. Typically, the most effective wideband HPM counter-electronic frequencies fall with the 100 MHz to 900 MHz and 1 – 3 GHz (VHF/UHF) wavebands.

So shorter effective ranges based on typical omni-directional antenna systems is the first key disadvantage to employing wideband HPM DEW systems. Wideband HPM sources pose a second problem in that given their most effective counter-electronic capabilities fall in the 100 MHz to 900 MHz and 1 – 3 GHz frequency ranges, these exact frequency ranges are where several key military and commercial communications, navigation, and radar system operate at specific single frequencies. Thus, these wideband HPM systems could interfere with these systems and impede the operation and performance of these other systems. An example of this would be frequency bands used by global positioning systems (GPS). Deployment of vehicle stoppers using compact wideband technology can

be greatly accelerated by the development of such systems with frequency ‘carve-outs’ of the order of 20 MHz centered around critical frequencies such as those used for GPS. This will enable the directed and targeted use of this technology on hostile vehicles without interference with other critical systems either in an urban environment or in a battlefield.

PHASE I: Analyze, select, and define a compact/lightweight wideband high power microwave source technology that operates in the 100 – 900 MHz or 1-3 GHz frequency ranges. Develop a corresponding compact/lightweight HPM antenna technology development plan and complete an HPM antenna technical design that handles the HPM source power requirements and also incorporates frequency ‘carve-outs’ to allow for non-interference operation with specific DoD and commercial communication, navigation, and/or radar (frequencies) systems as defined in references [4] and [5]. The prototype design in Phase II shall be compliant with the following basic system prototype MIL Standards: MIL-STD-810 (Environmental Engineering Considerations); MIL-STD-461 (Electromagnetic Interference (EMI)); and MIL-STD-881 (Prototype Specifications). Ensure that the overall size and weight of the proposed system (HPM source and antenna system) is less than 350 pounds, has an antenna diameter less than 1.5 meters, and provides a peak field intensity that can stop vehicle and vessel engines at ranges of 250 meters or more. Develop a Phase II plan.

PHASE II: Develop a scaled wideband HPM/Antenna System prototype for test and evaluation to determine its capability in meeting the performance goals defined in the Phase II development plan and the JNLWD/Marine Corps requirements for a long-range Vehicle/Vessel Stopper system. Demonstrate the system prototype performance through prototype evaluation against a Government-owned vehicle and vessel engine target set (located at Naval Surface Warfare Center Dahlgren Division) and by modeling/analytical methods over the required range of parameters including numerous deployment cycles. Based on evaluation results, refine the prototype into an initial design that will meet Joint Service requirements. Prepare a Phase III development plan to transition the technology to the JNLWD and support a transition to a Joint Program Office within the DoD.

PHASE III DUAL USE APPLICATIONS: Support the JNLWD/Marine Corps in transitioning the technology for Joint (to include Marine Corps) use. Develop this long range compact HPM vehicle/vessel stopper prototype for evaluation to determine its effectiveness in an operationally relevant environment. Support the JNLWD/Marine Corps for test and validation to certify and qualify the system for Joint DoD use.

A compact, long--range vehicle/vessel stopping capability has significant commercial applications beyond the DoD. Other government agencies, such as the Department of Justice (DoJ) and the Department of Homeland Security (DHS), have vehicle and vessel stopping missions. Local civilian law enforcement, specifically has these type of missions to support both port security and vehicle interdiction (car chases). Currently overall system size, weight, and cost have hindered the use of these systems by these agencies. This SBIR topic specifically addresses overall system size, weight, power consumption, thermal cooling, and system cost.

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KEYWORDS: Directed Energy; High Power Microwaves; HPM; Ultra-wideband; Wideband HPM; Vehicle Stopper; Vessel Stopper; Non-Lethal Weapons; NLW

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N201-003 TITLE: Powered Paraglider with Increased Capabilities

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: Airborne Reconnaissance Equipment

OBJECTIVE: Develop a powered paraglider capable of launching reconnaissance forces from naval shipping and transiting to shore.

DESCRIPTION: Current powered paragliders (PPGs) are generally used as recreational vehicles in the United States and Europe with most of the manufacturing taking place in Europe. Current PPGs are generally either foot or wheel launched. PPGs in the United States are regulated by the Federal Aviation Administration (FAA) under Federal Aviation Regulation (FAR) Part 103: Ultralight Vehicles. FAR Part 103 limits PPGs to operating during hours of daylight, weigh less than 254 pounds empty, have a fuel capacity not exceeding 5 U.S. gallons, are not capable of more than 55 knots of calibrated airspeed at full power in level flight, and have a power off stall speed which does not exceed 24 knots calibrated airspeed.

A PPG's major components consist of a fabric wing, harness, cage, propeller, and motor. Current commercial PPGs could be improved in various areas to meet the Marine Corps requirements. Technologies from outside the commercial PPG environment could be merged to increase performance and/or automation. Developing a PPG capable of transporting a person and 80 lbs. of equipment could replace current non-powered parachutes. The PPG must include reliability and safety systems for personnel use as well as a methodology for ship launches. Proposed approaches can utilize parameters outside FAA FAR part 103. Proposed PPGs should meet the following performance specifications:

Launch method: Threshold (T) Foot launched

Flight ceiling: (T) 5,000 feet Mean Sea Level (MSL), Objective (O) 10,000 ft. MSL

Weight capacity not including PPG: (T) 105-300 lbs., (O) 105-330 lbs.

Range: (T) 165 nautical miles (nm), (O) 220 nm

Propulsion: (T) internal combustion engine, (O) Electric

PHASE I: Develop concepts for a PPG meeting the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs and establish the concepts for development into a useful product for the Marine Corps. Establish feasibility through material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones and that addresses technical risk reduction.

PHASE II: Develop a prototype for evaluation. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the PPG. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop a PPG for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

PPGs with increased capabilities outside FAA FAR part 103 could be used by other agencies for a less expensive alternative to drones, helicopters, and other aircraft. PPGs with increased capabilities may also have use on the recreational market.

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KEYWORDS: Paraglider; Electric; Motor; Ultralight Vehicle; Powered; Engine

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N201-004 TITLE: Small High-Speed Amphibious Role-Variant Craft (S.H.A.R.C.)

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: Mines and Countermeasures (MCM)

OBJECTIVE: Develop a small high-speed watercraft that can serve as a littoral surface connector capable of delivering smaller autonomous, remote, and manned vehicles and systems; and would have a rail system to attach modular mission packages for operations directly from the vessel or decking that supports vehicles containing modular mission packages. This solution supports the President's National Defense Strategy by providing:

- Joint lethality in a contested environment
- Forward force maneuver and posture resilience
- Advanced autonomous systems
- Resilient and agile logistics

Per the Commandant's Guidance this solution provides for:

- Expeditionary Advanced Basing Operations (EABO)
- Littoral Operations in a Contested Environment (LOCE)
- Naval Integration
- Mine Countermeasure Forces
- Amphibious Capability
- Lethal Long-Range Unmanned Systems
- Stand-In Forces
- Affordable Cost
- Deceiving the Enemy

DESCRIPTION: A "21st century Higgins Boat" capability is needed to serve as littoral connectors to support the landing of smaller remote autonomous systems for expeditionary advanced base operations. The development and proliferation of long-range precision weapons by peer competitors—China and Russia—have changed amphibious warfare by pushing ships farther from the coastlines. Both the long-range capability and low cost of these weapons require the DoD to develop smaller faster littoral connectors to deliver low-cost, autonomous systems. This platform would enable the delivery of smaller land vehicles, weapon systems, fuel bladders, water, and electric generation equipment. These payloads could be offloaded to support long-term advanced naval bases or operated from the watercraft to support short term Expeditionary Advanced Bases (EABs). The modular payloads could also include unmanned aerial systems (UAS) and unmanned underwater systems (UUS) launchers that could deliver unmanned systems distant from the shoreline.

Multiple commercial high-speed watercraft exist in the market that meet some of the specifications listed below. They are essentially current versions of World War II Higgins Boats. These partially meet the specifications and through moderate engineering can meet a significant portion of the requirements.

The parameters of the vessel include the following:

- Width of deck and front ramp 60 inches at narrowest point
- Length of deck from aft to stern 156 inches
- Must have a deck rail system to tie down modular mission packages
- Able to power external modular mission packages
- Payload capacity 10,000 lbs.
- Range ~200 nautical miles at full throttle with max payload
- Speed >25 knots at payload capacity
- Draft <30 inches when fully loaded
- Able to land and unload vehicles onto land without use of dock
- Capable of autonomous/remote control operation

PHASE I: Develop concepts for an improved smaller high-speed amphibious role-variant craft that meets the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs and establish that the concepts can be developed into a useful product for the Marine Corps. Establish feasibility through material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Develop a scaled prototype for evaluation. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the smaller high-speed amphibious role-variant craft. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop smaller high-speed amphibious role-variant craft for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

The system has the ability to support commercial logistics operations. One potential application could be the movement of equipment and supplies between off-shore energy production platforms: oil, wind turbines, wave-motion. It may also be used to offload cargo from ships to shore.

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KEYWORDS: High Speed Watercraft; Landing Craft; Small Surface Connector; Utility Craft; Amphibious Craft; Utility Watercraft; Littoral

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-005 TITLE: Wireless In-Ear Sensors for Warfighter Monitoring

TECHNOLOGY AREA(S): Biomedical, Human Systems

ACQUISITION PROGRAM: NAE Chief Technology Office

OBJECTIVE: As a means to monitor factors contributing to warfighter readiness, develop wireless sensors that can be integrated into commercial off-the-shelf (COTS) earplugs to enable continuous in-ear monitoring of warfighter noise exposure and physiological status.

DESCRIPTION: Hearing protection devices are mandatory for warfighters operating in noisy environments to reduce their exposure to potentially damaging noise levels. These hearing protection configurations often involve the use of earplugs. Earplugs used by warfighters range from COTS, disposable, universal-fit foam earplugs to reusable, custom-molded earplugs fit to the individual. Communications and Active Noise Reduction (ANR) technologies incorporated into in-ear hearing protection are working, but the earplug could serve as a platform to collect a large amount of valuable data from the warfighter via the ear. Data to collect includes: noise dosimetry, head vibration/bone conduction effects, ear canal pressure, head acceleration, and physiological data such as heart rate, body temperature, and pulse oximetry.

The Navy seeks a cost-effective system to collect warfighter data from the ear using wireless sensor capabilities. The initial focus of this SBIR effort should be binaural in-ear noise dosimetry, with the capability for the system to integrate additional sensors to capture supplementary types of data mentioned above. The sensors should be miniaturized to easily fit deep (beyond the second bend) inside most ear canals and capable to be used with a variety of earplugs (e.g., COTS foam/flange, custom fit). The proposer should conduct analysis to ensure it is safe for human in-ear use with potential risks and mitigations identified. Methodologies used to ensure safe-for-human use should be presented. A description of insertion and removal processes should be provided. The miniature wireless sensors should be durable enough for repeated use, but cost-effective so that they may be replaced if damaged or lost. The system should be acoustically transparent so as not to alter the noise attenuation of the earplug, thus allowing for accurate analysis of the earplug performance.

The rate of data collection for the system should allow for continuous monitoring of the warfighter, with the data transmitted wirelessly to a recording device to capture exposure vs. time for subsequent analysis, with the preferred ability to conduct live monitoring of data when desired. All components of the system worn on the head must fit under helmets (HGU-68/P, HGU-84/P, and HGU 56/P) and earmuffs (Aegisound DC2, Aegisound Argonaut, David Clark maintainer headsets, David Clark aviation headsets) without interfering with the attenuation properties of these devices. The proposer should clearly identify and discuss any expected calibration process of the entire system, including sensors. For noise dosimetry applications, the dynamic range of the system must comply with, but not be limited by, ANSI S1.25. Consideration should be made on collecting both in-ear and external continuous noise levels [70 – 140 dB], as well as capabilities to collect noise doses in impulse noise environments [140-170 dB peak sound pressure level (SPL) ambient noise]. The device must be suitable for aviation and shipboard environments. Initial focus should be on compatibility with universal and custom fit earplugs (ex. Sound Guard, EAR Classic, Elvex Quattro, Westone solid custom molded, and Westone CEP tips). Consideration would be given to a multi-sensor suite built into an earplug for use with the system as a long-term solution.

It is preferred that reusable components of the system not exceed \$1,000 per unit and any small in-ear components or disposable units should not exceed \$150. It is understood that prototypes and low quantity production of the system may be higher than these limits. The projected cost of the production units will be given careful consideration. The proposer should provide a cost-benefit analysis for anything exceeding these values.

Note: If required, NAVAIR will provide Phase I performers with the appropriate guidance for human research protocols so that they have the information to use while preparing their Phase II Initial Proposal. Institutional Review Board (IRB) determination as well as processing, submission, and review of all paperwork required for human subject use can be a lengthy process. As such, no human research will be allowed until Phase II and work will not be authorized until approval has been obtained, typically as an option to be exercised during Phase II.

PHASE I: Design wireless in-ear noise dosimeters for use with readily available COTS earplugs. Demonstrate proof of concept of critical features of the design through computational modeling or experimental testing. Outline concept for additional monitoring capabilities. Develop integration and calibration methods, and cost estimates. The Phase I effort will include prototype plans to be developed under Phase II.

Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II, should it be required.

PHASE II: Develop and produce ten functional prototype wireless in-ear noise dosimeters and demonstrate/validate their performance with several types of COTS earplugs (foam, flange, custom-molded). Expand upon and investigate the concept of miniaturized wireless sensors beyond noise dose monitoring to cover other forms of personnel monitoring that could be done via the ear. Develop lifecycle cost and supportability estimates of such sensors.

Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II, should it be required.

PHASE III DUAL USE APPLICATIONS: Transition technology into production via sales to the Department of Defense and through commercial sales.

Wireless earplug sensors and the data obtained from them would be invaluable to both military and civilian communities that seek methods to monitor personnel in the field and evaluate real-world performance and safety of COTS earplugs. Further development in miniaturized wireless dosimeters and other sensors (sensors for blood pressure, temperature, heart rate, blood oxygenation, stress, etc.) would have many applications in numerous industries in the civilian sector.

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KEYWORDS: Dosimetry; Monitoring; Hearing Protection; Sensor; Wireless; Earplug

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-006 TITLE: Inclusion Detection in Steel for Bar Stock, Gears, and Bearing Components

TECHNOLOGY AREA(S): Air Platform, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMA231 E-2/C-2 Airborne Tactical Data System

OBJECTIVE: Accurately determine the inclusion content of steel bar stock, gear, and bearing components in finished or semi-finished states by non-destructive means i.e., without the use of traditional destructive method of cross-sectioned specimens.

DESCRIPTION: The Naval aviation community, as owner and operator of aerospace systems, continuously seeks improvement in the manufacturing arena. The Navy occasionally faces issues with inclusions in aerospace components made from high-grade steel. The Navy seeks an innovative, cost-effective, accurate, preferably hand-held, non-destructive technology that would allow inspection of high-grade steel components for inclusion content without destroying the material. This would increase the possibility of identifying non-conforming material and parts early in the production process, minimizing the work expended. For components, the proposer should create a focused method to identify inclusions in critical targeted areas of the load carrying components, which would result in a decrease in the cost to the Government or original equipment manufacturers (OEMs) by removing the need to inspect suspect components by destroying potential conforming components. The innovative technology should be capable of measuring and determining the position of the inclusion content of steel material by non-destructive means. Accuracy targets are requested in the 0.001" particle size with full volume inspection of the material. Maximum material thickness is expected to be no greater than 14" round steel bar stock. Particle location determination is requested within the inspected material. The ability to inspect complex geometries, like gear teeth, is required. The information provided to the operator when using the method should be instantaneous in order to provide feedback on the specific targeted area of material. This method must have the ability to be used in environments including steel manufacturing sites, component production sites and repair facilities. If not possible to be hand-held it will need to be portable enough to allow use on installed components or components outside of stationary or lab-type environments.

Current destructive methods start with a polished sample coupon of material followed by a microscopic visual inspection, or a computer-aided surface inspection. Neither method reviews the material used in the component itself. Only a small section of material is reviewed relative to the component produced. Existing non-destructive methods, like eddy current or CT scan, do not provide the fidelity required to categorize the material to the level desired. The depth of penetration and sizes of particles that can be detected limit the usefulness of the current non-destructive inspection (NDI) technology.

Although not required, it is highly recommended to work in coordination with the OEM to ensure proper design and to facilitate transition of the final technology.

PHASE I: Design and develop a concept for a non-destructive technology allowing a determination of inclusion content within steel bar stock or components. Conduct a breadboard demonstration of the concept. Include size, distribution, and location of inclusions within the bar stock or within identifiable component regions - all desired characteristics for determination - plus inclusion material identification, which is a secondary goal for determination.

The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a prototype with the capability of the non-destructive detection of inclusions with blind steel samples. Ensure that the demonstration includes production size and grade steel stock. For steel components, demonstrate with in-process (partially finished) and post-production components. Aim for inclusion sizes down to 0.001". Meet the requirement for rapid, near instantaneous analysis of the steel material in the

intended environments, which are steel manufacturing sites, component production sites, and repair facilities.

PHASE III DUAL USE APPLICATIONS: Perform final testing that would include on the ground evaluation in fleet/repair/production environments. Transition a fleet ready device or a commercial offering on an inspection device. The intent is to provide higher levels of steel cleanliness verification. With verification of the cleanliness of steel material and components, there is the potential for either longer duration of use with existing designs or higher power density components.

Successful technology development would benefit steel manufacturing, engine/transmission component manufacturers, and construction industries.

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2. Zhang, L. and Thomas, B. "Inclusions in Continuous Casting of Steel. XXIV National Steelmaking Symposium." Univ. of Illinois at Urbana-Champaign, pp. 138-183. http://ccc.illinois.edu/PDF%20Files/Publications/03_Mexico_Nov_Inclusion_review_v5a_updated.pdf

KEYWORDS: Inclusion; Steel; Inspection; Material Cleanliness; Non-Destructive Detection; Sub-Surface

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-007 TITLE: Long-Range Maritime Battle Damage Assessment

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA290 Maritime Surveillance Aircraft

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop innovative radar-based imaging approaches to perform long-range battle damage assessments of ships.

DESCRIPTION: The timeliness, accuracy, and completeness of battle damage assessments (BDA) is critical to the success of any military engagement. BDA have traditionally utilized relatively short-range optical sensors onboard aircraft operating in close proximity. However, the safe airspace access required to observe the target at close range is not possible in anti-access/area denial situations. BDA utilizing long-range radar tracking and imaging is an alternative. Radar does not provide the level of high resolution and high definition consistent with human visual

characteristics. As a result, there is a need for innovative approaches to extract comparable information from radar returns for the BDA of ships at sea from ranges that may exceed 50 nautical miles (nmi). Gross changes such as the vessel going dead-in-the-water or rotating antennas ceasing operation are easily discernable with radar. More challenging is determining if the vessel is listing and what type of external structural damage has occurred. Advances are needed in single and multi-channel inverse synthetic aperture radar (ISAR) imaging techniques. Advantages of interferometric ISAR should be considered, as some fielded radar systems are capable of supporting that mode. Consideration should be given to scenarios that allow imaging to be underway immediately prior to weapon impact, at the time of the impact, and at various times after impact. Transition of this product is to be as an appliance within the Navy's Minotaur control application.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Utilize self-generated simulated data to develop single and multi-channel (possibly interferometric) ISAR imaging approaches capable of providing ship BDA comparable in respects to that possible from short-range (20 km or less in mid-latitude oceanic environments) visual imagery. (Note: While computational resource restrictions will not be imposed in Phase I, the product will ultimately be hosted on existing Navy maritime surveillance platforms such as the P-8A, MQ-4C, MQ-8B and MH-60R.) The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further design and develop the concept identified in Phase I. Working with the sponsor, prepare an at-sea airborne radar collection plan for use during a Navy live fire missile exercise involving a target ship and remote airborne collection platform. Utilize the collected data to mature the techniques explored in Phase I. Provide a complete assessment of the approaches and develop a transition plan.

Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Mature the algorithms to be suitable for transition to Navy maritime surveillance radar systems or as a capability within the Navy's Minotaur control application. Possible dual use applications include long-range ship imaging and status assessment by organizations like the Coast Guard or possibly commercial radar satellite providers.

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KEYWORDS: Battle Damage Assessment; BDA; Long Range Imaging; Ship Imaging; Inverse Synthetic Aperture Radar; Maritime Surveillance; Radar

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-008 TITLE: Augmented Reality and Aircraft Wiring

TECHNOLOGY AREA(S): Air Platform, Electronics, Materials/Processes

ACQUISITION PROGRAM: PMA275 V-22 Osprey

OBJECTIVE: Design and develop the enabling technology to allow universal tagging/marketing and database architecture for aircraft wiring identification, visualization, and comparison via a hardware agnostic Augmented Reality (AR) solution.

DESCRIPTION: Ongoing NAVAIR efforts, from production installations to DEPOT maintenance events, require the inspection of thousands of wires, harnesses, connectors, etc. The continually expedited timelines required for these events, paired with the limited human capacity to quickly locate, identify, and correlate those wires to as-is or desired state, has the potential to negatively impact timelines, quality, safety, and readiness.

Current AR systems, including Microsoft HoloLens, Google Glass, and other handheld applications, utilize marker-based or markerless location-based approaches to determine a subject field of view (FOV), query a database for relevant digital information related to that marker or location, and overlay the digital information within a user's field of view. While current methods are effective for some broad commercial applications, they do not possess the necessary fidelity and/or robustness for effective use on aircraft installed wiring systems. Current marker-based approaches have not been validated to meet MIL-W-5088 [Ref 4] and MIL-M-81531 [Ref 5]; markerless location-based FOV solutions lack the visual acuity within confined and complex aircraft spaces. Specific challenges include: variations in harness depth when multiple harness are stacked together within particular aircraft location; camera fidelity and software recognition of individual wires strung through an exposed bundle; and longevity/legibility of potential marker application due to dirt, aircraft fluid, and other debris present during normal military aircraft operation. The goal is to develop a solution that can perform with one or both of the identified methods for FOV identification and overlay, or develop a currently unknown and more appropriate solution. For a marker-based solution, [Ref 4] and [Ref 5] would be met in a manner facilitating marker utilization with no additional manpower requirements from maintainers to find and clean all appropriate markers. For a location-based solution, the proposer should use relative position in the aircraft for FOV identification and overlay. Both of these FOV solutions would need to be paired with a visual hardware and software system sensitive enough to identify proper vs. improper harness routing (based on a 3D model) per [Ref 3] as well as wire type identification for exposed bundles per [Ref 3]. The Navy seeks a solution to quickly identify non-conformances in harness routing for maintainers from production teams, organizational maintenance personnel, and DEPOT artisans and that is hardware agnostic. Additionally, this will improve the execution of engineering change proposals, aircraft-capability upgrade modifications, and major DEPOT Planned Maintenance Intervals (PMI) or Integrated Maintenance Planning (IMP) events like providing immediate updates to aircraft databases to reflect changes. This would allow the AR platform to immediately highlight non-conformances or discrepancies in harness routing, material selection, and issues often missed by human quality assurance personnel. Marking technologies should conform to wire/cable markings requirements outlined in NEMA WC27500 Aerospace and Industrial Cable [Ref 1], SAE AS22759 Aerospace Wiring [Ref 2], and SAE AS5942 Marking of Electrical Insulating Materials [Ref 4]. This would be ideally suited for new acquisition platforms and support equipment as well as any platforms or support equipment preparing to undergo major modifications.

PHASE I: Design, develop, and determine the feasibility of a proposed marking/location-based approach as well as database integration opportunities. Ensure that the marking technologies conform to wire/cable markings requirements [Refs 1, 2, 4]. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further develop a prototype and demonstrate its application on uninstalled aircraft wiring harnesses within aircraft representative spaces. If available, demonstrate the capability on existing platform and/or platform representative examples, leveraging actual 3D design models and installed harnesses.

PHASE III DUAL USE APPLICATIONS: Perform final development and testing for any marking applicability to include conformance testing to applicable SAE/MIL-STDs. Support final system application testing onboard aircraft with full system test, in coordination with NAVAIR Test and Evaluation.

With the proliferation of AR, digital visual acuity systems, point cloud generation, and artificial intelligence-/machine learning/deep learning-backed virtual visual overlays, the commercial potential for this technology spans any production or modification industry requiring the ability to mark and reference small components vs. individual markers/locations. These industries include the aircraft, automobile, vessel, solar, battery, microprocessor, industrial bulk material, and computer.

REFERENCES:

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KEYWORDS: Aircraft; Wiring; Wire; Marking; Augmented Reality; Visualization

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-009 TITLE: Software Framework for Integrated Human Modeling

TECHNOLOGY AREA(S): Biomedical, Human Systems, Information Systems

ACQUISITION PROGRAM: PMA276 H-1 USMC Light/Attack Helicopters

OBJECTIVE: Design and develop an open Application Programming Interface (API) and data fusion framework for the integration of current and future commercial human modeling software; and that has the ability to incorporate the output of commercial off-the-shelf (COTS) digital human modeling and medical modeling software to create a

whole-body simulation of a human.

DESCRIPTION: Digital human modeling (DHM) efforts in the DoD have primarily been used to assess ergonomic and human factors situations. The current commercial software on the market is highly specialized toward providing human analysis for narrow tasks and situations. It does not, contrary to the name, typically model the whole human system. The result of this software specialization is a plethora of part-task analysis software that operates mostly independently. Each software by itself is unable to inform the larger picture and holistically model the human system.

For example, existing ergonomic software incorporates anthropometric survey data to accurately model humans with diverse size and shapes. However, the software does not incorporate a variety of other factors that can affect the interpretation of an ergonomic analysis. Combining anthropometric data with musculoskeletal modeling data and injury modeling data would enable the generation of a highly accurate human reach envelope for both normal and abnormal human avatars. Likewise, dehydration data, hypoxia data, and other stressor data can be combined to provide a more accurate cognitive task analysis for humans operating under abnormal conditions and in stressed environments.

The goal of this SBIR topic is not to replace existing software, but to enhance the ability of the existing software packages to leverage data developed from each other by developing an architectural framework that can incorporate the output of COTS digital human and medical modeling software to build a detailed digital representation of a human. As a more developed and accurate digital representation of a physical human begins to develop, this software can provide input for these existing software packages to provide more accurate task analysis results.

Previous attempts at exploring this issue have met with limited success [Ref 1]. This project should build on previous efforts to form the architecture and underlying framework for a system that would enable the interpretation and storage of human modeling data to be usable on a variety of consumer computer hardware. The proposer should convert the data that is output from various COTS software into an interface agnostic format, easily transformed to other industry formats. For example, the anthropometric and posture data developed in an ergonomics-focused software could be exported into this developed open standard and then be imported into another ergonomic software package, either through the software's support of this open standard or through the transformation of the open standard to a proprietary standard that this software supports. Through this, the project would enable additional functionality in existing COTS software without modification of the underlying software. In addition, this storage of data in an interface agnostic format would allow for the standard representation of a human's physiological state and enable the creation of standard medical use cases, such as through the incorporation of existing open human body modeling standards [Ref 2].

PHASE I: Identify the major factors and attributes that are essential for generating a basic digital model of the human body and its associated components. Identify the initial software packages that will provide the input and output of this human model. Design, develop, and demonstrate a simple proof of concept framework that can ingest at least two sources of data, create a human model, and export the data for use in a COTS task analysis software. The Phase I effort will include prototype plans to be further developed under Phase II.

PHASE II: Develop an extensible and scalable framework for current and future modeling software. Develop the API for ingesting and exporting data from the human system model, and also the graphical user interface (GUI) for examination and manipulation of data stored in the human model. Integrate the major modeling packages task analysis software into the previously developed framework. Identify and incorporate sources of physiology data to better inform the human model.

PHASE III DUAL USE APPLICATIONS: Refine the framework and continue to add capability, in terms of both functionality and support of existing and future COTS software. Develop capability to support modeling in the private industry.

This SBIR topic will result in a framework that will enable cross-collaboration between COTS software. This framework will enhance the value of existing software packages, promote development of new features, and enable interoperability between software packages. Potential use by forensics or the medical community where human

modeling would be useful.

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KEYWORDS: Medical Modeling; Digital Human Modeling; Statistical Models; Physiology; Data Fusion

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-010 TITLE: Compact Source for Focused and Tunable Narrowband Radio Frequency

TECHNOLOGY AREA(S): Air Platform, Electronics, Weapons

ACQUISITION PROGRAM: NAE Chief Technology Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a compact source outputting a very high power burst of energy in a narrowband and tunable frequency region, which can be carried by a rotary wing aircraft in a small pod and can be utilized for such applications as directed energy high power microwave and electronic attack tactical jamming to disturb, deny, and damage. Perform spectrum agile high-power and short-interval transmissions to advance emerging electronic attack and directed energy weapons through benefits in size, weight, and power (SWaP).

DESCRIPTION: Electronic dominance, specifically airborne, in radio frequency (RF) requires both high power transmissions and frequency agility while maintaining minimal size and weight. Typical approaches to spectrum dominance such as electronic warfare (EW) and high-power microwave (HPM) prove to require a large payload capacity but offer a myriad of frequencies and power levels. Jamming weapons such as pods under fixed wing and rotary aircraft also can perform with spectrum capabilities from 100 MHz to 18 GHz [Ref 1] at various duty cycles. Recent advances in HPM sources coupled with nonlinear transmission lines (NLTLS) have seen gigawatt-class peak radiators in a wide frequency spectrum with low duty cycle [Ref 2]. Use of gyromagnetic NLTLS for HPM generation from 500 MHz [Ref 3] to 5 GHz [Ref 4] is typical. Advances in solid state and traveling-wave tube (TWT) amplifiers have shown kilowatt class outputs in frequencies over 5GHz in compact sizes. The Navy seeks a middle ground solution between HPM and EW for the development of a high-power jammer able to provide

prolonged saturation and preferably physical destruction of RF seeker electronics.

Successful technology development should result in an extremely high-power and frequency-tunable jammer source, coupled to an antenna with directivity. Integration of this system must be designed into a pod carried fixed or rotary wing aircraft; pod parameters will be provided in Phase I. The prime power, or power input to the jamming system, will be limited by the pod and associated aircraft link power, such that, to meet the input power requirements of the source, some form of stored energy is required within the pod. The proposer should describe HPM and EW narrowband sources and associated antenna performance parameters in terms of frequency, bandwidth, effective radiated power (ERP), duty cycle/factor, efficiency, and directivity. The ERP objective goal is 10 MW with a threshold goal of 1 MW with a 20° beamwidth threshold goal, 5° objective goal. The duty-cycle objective goal is 20% with a threshold goal of 1%, with the understanding that energy storage is a requirement due to input power constraints, and effects on dwell time. The proposal must consider supplied input power negligible compared with on-state power demand, requiring all energy to be supplied from energy storage. The technology must operate in a tunable frequency span of 300 MHz to 1 GHz threshold, 30 MHz to 5 GHz objective while having a bandwidth at tuned frequency of 5% threshold, 1% objective. Pulse width of the jamming pulse will affect bandwidth.

KEY PARAMETERS

- Tunable Frequency: 300 MHz to 1 GHz / 30 MHz to 5 GHz (Threshold/Objective)
- Bandwidth at tuned frequency: 5% / 1% (Threshold/Objective)
- High power transmitter: 1 MW ERP / 10 MW ERP (Threshold/Objective)
- Duty-cycle: 1% / 20% (Threshold/Objective)
- Efficiency: 60% / 80% (Threshold/Objective)
- Directivity: 20° beamwidth / 5° beamwidth (Threshold/Objective)

PHASE I: Investigate the art of the possible for narrowband, very high power, RF tuning and delivery. Identify vulnerabilities in target system electronics for several candidate systems (communication, radar). Develop a conceptual design for a middle ground pod jamming solution between EW and HPM meeting the requirements in the Description. Include methodology and potential prototype performance that will demonstrate the proposed concept with the output pulse parameters as described. Conduct a sub-scale component demonstration. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop detailed designs for a prototype system that improves performance parameters that meet Navy requirements as specified in the Description. Build a prototype system, according to this design, that meets threshold parameters at a minimum. At a Navy test facility demonstrate that the prototype delivers, or is scalable to deliver, the requisite power and RF spectrum to damage three candidate systems at tactically relevant and significant ranges as agreed upon by Government sponsor and proposer. Report performance results.

PHASE III DUAL USE APPLICATIONS: Finalize development based upon Phase II outcome and transition to appropriate platforms and commercial industries. Advanced electronic attack and HPM techniques have been used for counter-improvised explosives and counter-unmanned aerial vehicles systems, which benefits the defense industry. Advanced NLTLs will enhance the telecommunication industry by easing requirements of amplifiers.

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KEYWORDS: Amplifier; Directed Energy; DE; Electronic Warfare; EW; High Power Jammer; High Power Radio Frequency; HPRF; High Power Microwave; HPM; Narrowband; NB; Next Generation Jammer; NGJ; Non-Linear Transmission Line; NLTL; Pulse Repetition Frequency; PRF; Radio Frequency; RF; Solid State; Traveling-Wave Tube (TWT)

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-011 TITLE: Minimization of Chronic Neck Pain in Military Aircrew and Vehicle Occupants

TECHNOLOGY AREA(S): Biomedical

ACQUISITION PROGRAM: PMA276 H-1 USMC Light/Attack Helicopters

OBJECTIVE: Design and develop computational models to understand and analyze acute and chronic neck pain for combat air vehicle pilots and occupants taking into consideration the interaction between seating systems, posture, and body-borne equipment and the generation of neck pain. Included in this effort is the requirement to develop an aircrew specific neck pain scale.

DESCRIPTION: Pilots and crew of combat air vehicles, including fixed-wing attack, fighter, and rotary-wing aircraft, can be exposed to inertial and task position stressors that generate pain. Repeated painful exposures with or without tissue damage are precursors to pain sensitization and chronic pain. Chronic pain leads to reduced operational readiness and long-term medical treatment. In his 25 SEPT 2017 letter, VADM Shoemaker called for "research to better understand, prevent and treat the musculoskeletal consequences of helicopter service." The Navy needs a means of protection to minimize the development of chronic neck pain while maintaining short duration, high onset acceleration protection afforded by ejection and crashworthy seating. Equally important, though less well understood, is the contribution of long-duration, static/quasi-static loading to chronic pain development. Current seating systems designed to be a 'one-size-fits-all' with minimal adjustability were intended for short and moderate duration exposures. Aircraft seating systems encompass a range of seat back angles from 0 degrees (vertical) to 17 degrees pitched back and seat pan angles from 0 degrees (horizontal) to 12 degrees pitched-up. Seated postures vary ranging from long periods holding the same position while visually scanning the area or instruments through turning to look over their shoulders ("check six" position). All the while, aircrew are restrained in their seats for missions as long as 12 hours and must be able to reach switches and controls overhead, behind, to the side, and in front of them. Aircrews are often outfitted with performance enhancement devices that are mounted to the helmet, e.g., night vision devices, that increase the load and moment on the cervical spine.

An optimal protective approach would take into account variability of operator anthropometry; the physical, inertial loading exposures of air combat vehicles [Ref 3]; the task posture of the operator (often hunched forward with right elbow on the thigh); the relevant specific neck/spinal anatomy; head-support mass and its center of mass; and the

mechanisms of pain associated with neck pain. The Navy has a strong need to analyze and quantify the influence of various mechanical stressors (vibration from 1 to 20 Hz, buffeting [Ref 3]) on pilot injury potential and to develop novel designs of occupant seating and restraint systems that reduce spinal injury and chronic pain risk to all aircrew sizes during routine and catastrophic events. Computational models and parametric simulations are required to determine potential contributors to acute and chronic operator neck pain and the specific pain mechanisms involved. Given the challenge of relating mechanical stresses to associated pain, it is suggested that proposers include a neurologist experienced working with pain patients as a consultant. Computational models should be structured such that recommendations toward improvements to seating (position, seat-back angle), helmet (weight and center of mass), and restraint systems (e.g., combined shoulder / lap belt), postures [Ref 6] and operational guidelines are possible. The models should also be able to determine the predicted design(s) efficacy.

Customized versions of rating scales/questionnaires for aircrew, such as an aircrew specific Neck Disability Index (NDI), would be helpful for healthcare providers who serve aviators in order to better and more quickly recognize complaints, identify the problem, and monitor the efficiency and effectiveness of treatment. Unfortunately, NDI does not include any occupation-related neck pain questions and under-reports the severity and disability of flying-related neck pain [Ref 1]. A customized version of a pain rating scale is required due to their occupational challenges in military environment and the need for operational readiness. Higher expectations and needs exist for military aviators with regard to medical fitness compared to civilian aviators due to the many extreme situations they may face, ranging from combat missions requiring helmets with night vision or cuing systems, high-G emergency handling to Survival, Evasion, Resistance, and Escape (SERE) situations.

PHASE I: Design, develop, and determine the feasibility of using human biomechanical models to expose a simulated occupant to inertial and positional stressors, simulating the effect on the neck and onset of pain and predicting the spinal sensitization and pain time course. Develop a preliminary aircrew neck-pain scale. The Phase I effort will include plans to be developed under Phase II.

PHASE II: Develop a human biomechanical model accounting for anthropometric variation of military population (5th to 95th percentiles for height and weight), including gender-related factors. Include models of seating (geometry and cushions), restraints, cockpit geometry, and protective clothing / equipment; the target platform includes fast jet tactical aircraft (e.g., F/A-18). Validate the combined model against published data, including but not limited to the references listed below. Use the model to analyze existing operational procedures and propose improved operational guidelines. Validate the aircrew neck-pain scale. Develop a prototype of the most promising protective concept that provides adaptive seating, comfort and adjustability for the maximum range of anthropometric sizes. Conduct experimental testing and evaluation.

PHASE III DUAL USE APPLICATIONS: Conduct operational unit evaluation of the prototype and implement necessary design changes. Re-evaluate the predicted performance based on implemented changes and revise the prototype based on results of evaluation until desired optimum protection is achieved.

In addition to operators of land and sea combat vehicles, operator neck pain is a problem in the commercial transportation field. Such a protective capability would be valuable in mitigating the development of pain and chronic neck pain for operators of commercial air, land and sea vehicles. Commercial shipping, air and trucking industries could all benefit from the developed technology.

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KEYWORDS: Neck Pain; Human Modeling; Neck Pain Scale; Anthropometric Variants; Neck Pain Stressors; Adaptive Seating

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-012 TITLE: Multi-Octave, High Power Efficiency Active Electronically Scanned Array (AESA)

TECHNOLOGY AREA(S): Air Platform, Electronics, Ground/Sea Vehicles

ACQUISITION PROGRAM: NAE Chief Technology Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop electronically steerable radio frequency (RF) transmitters over multi-octave bandwidth yet with optimum power efficiency to achieve simultaneous multi-octave bandwidth high-efficiency performance.

DESCRIPTION: Electronically steerable RF transmitters are highly demanded in battlefield communication and electronic warfare systems. Traditional approaches are mostly based on phased arrays in which phase shifters are used to steer the antenna beam and power amplifiers are used to provide the transmitted power. Such architectures, however, suffer in several aspects when multi-octave operations are needed. The grating lobes of antenna array may appear at the higher end of the operating band and destroy the aperture efficiency while the mutual coupling between the antenna elements in the lower end of the band may negatively affect the antenna to transmitter impedance match and thus the radiation efficiency. On the other hand, the trade-off between bandwidth and efficiency in any RF transmitter often must be made according to the famous Bode-Fano limit, which indicates that a good impedance match to a high-Q load cannot be achieved over a wide bandwidth. For this reason, multi-octave

RF power amplifiers (PA) are usually not efficient as the existence of transistor parasitics limits the impedance match bandwidth unless a sub-optimal impedance matching condition is used. Similarly, in antenna systems, the form factor constraints often require high-Q, narrow band antenna elements rather than broadband antennas. Multi-octave impedance match to a single antenna is usually impossible. A conventional Ultra-Wide Band (UWB), electronically steerable RF transmitter can thus not be efficient for the above reasons, which in turn limits its maximum operating power for a fixed design of heat dissipation. Tunable components that may tune the matching between antenna and power amplifier to adapt to its operating frequency have been proposed. These components are mostly in the form of switches or variable capacitors made of microelectromechanical systems (MEMS) or phase change material, which may suffer limited power handling and add additional power loss caused by the tuning mechanisms.

Develop a novel, power-efficient, multi-octave electronic steering antenna array architecture that integrate power amplifier and antennas simultaneously for both bandwidth and efficiency while using a power amplifier network to generate a phase slope required for electronic scanning.

PHASE I: Design, develop, and demonstrate an efficient transmitter and antenna array architecture that allows efficient transmission of RF signal with more than 40 dBm power and with the overall system power efficiencies over 50% from 2GHz to at least 4GHz, preferably 8GHz, while being electronically steerable over at least +/-45 degrees. Identification of the appropriate electronics technologies and antenna design must be made during this phase, with feasibility demonstrated through simulation results. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further develop and perform hardware demonstration of the Phase I concept and the predicted performance in a small scale, with aperture size equivalent to four to eight element phased array. Ensure that the minimum antenna gain will be no less than the ideal aperture gain by 3dB. Prepare the metrics of evaluation that include a chart of power efficiency as a function of both frequency and scanning angle.

PHASE III DUAL USE APPLICATIONS: Integrate Phase II designs to test installed on an aircraft platform with a goal of maintaining RF performance from Phase II in an installed aircraft environment. Successful technology development would benefit airborne- and ground-based radar systems, aviation, and large communication base stations.

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KEYWORDS: High-Bandwidth; High-Efficiency Antenna Array; Multi-Octave Transmitter; Integrated Antenna Array With Power Amplifiers

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-013 TITLE: High Power Quantum Cascade Lasers in the Spectral Range between 3.8 and 4.1 Microns

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA272 Tactical Aircraft Protection Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop quantum cascade lasers in the in the 3.8-4.1 micron wavelength range with high output power and brightness.

DESCRIPTION: High-power, cost-effective, compact, and reliable mid-wave infrared (MWIR) Quantum Cascade Laser (QCL) platforms operating in the continuous wave (CW) regime are highly desirable for current and future Navy applications. Individual QCLs emitting within the 4.6-5 micron wavelength band with about 5 Watts CW output power and a wall-plug efficiency of about 20% at room temperature (RT) have been demonstrated [Ref 1]. Another shorter MWIR spectral band between 3.8 and 4.1 microns is of interest for Naval applications. The atmospheric transmission in this band is about 45% to 50% higher than that of the 4.6-5 micron spectral band. Furthermore, when QCLs emitting in both of the MWIR bands are beam-combined, higher emission power of QCLs in the 3.8-4.1 micron wavelength band [Ref 2] could alleviate the emission power, and their size, weight, and power (SWaP) dissipation requirements of QCLs in the 4.6-5 micron wavelength band. Despite their importance, very little technology development and advancement have been made for QCLs emitting in the 3.8-4.1 micron MWIR band, in stark contrast to their counterparts in the 4.6-5 micron band.

Therefore, the QCL performance in the 3.8-4.1 micron band significantly lags those in the 4.6–5 micron band. The highest reported continuous wave wall-plug efficiency is less than 7% [Ref 2] and typical CW optical power for commercial state-of-the-art 4-micron QCLs is less than 1 Watt (W) [Ref 2]. The performance and thermal characteristics of the QCLs in the shorter end of 4 micron spectral range are significantly poorer compared to those at the 4.6 micron range due to the following critical factors.

1. To accommodate the larger transition energies (shorter emission wavelengths), strong confinement of carriers in QCL active regions is necessary to curtail excessive carrier leakage through parasitic energy states located above the upper laser level. Strong carrier confinement requires deeper wells and taller barriers, which in turn creates highly strained epitaxial layers, which need optimized crystal growth conditions to prevent misfit dislocations within the laser core.
2. The high strain layers (with strain >1.5%) layers throughout the QCL core region [Ref 2] result in significantly lower thermal conductance [Ref 3] which, in turn, gives rise to wide electroluminescence spectra and subsequently high threshold-current densities, as the temperature of the active region rises [Ref 2].
3. Factors (1) and (2), combined with inherently higher drive voltages, have led to the CW power and wall-plug efficiency values of the QCLs in the 3.8-4.1 micron band to being only a small fraction of those of the QCLs in the

4.6-5 micron band.

Therefore, in order to significantly increase the CW power and wall-plug efficiency of 3.8-4.1 micron-emitting QCLs, compared to those so far obtained from conventional-design QCLs, it is the goal of this program to develop new active-region designs, similar to the shallow-well [Ref 4], the step-taper-active structure [Ref 5], or other innovative structures that will deliver temperature insensitive and CW output power device performance in the 3.8-4.1 micron wavelength range that is comparable to lasers operating in the 4.6 to 5 micron band. It is also the goal of this program to demonstrate greater than 1,000 hours laser lifetime performance. If active cooling of the laser is necessary, cooling using thermal-electric cooler technology for room temperature operation is highly preferable.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design a QCL emitting in the 3.8-4.1 micron wavelength range at room temperature with 5 W minimum CW power, 15% minimum CW wall-plug efficiency, and nearly Gaussian beam with beam propagation ratio (M2) less than 1.5 showing a path to meeting Phase II goals. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the QCL design from Phase I. Fabricate and fully characterize prototype QCLs in the 3.8-4.1 micron wavelength band with the minimum performance levels reached. Demonstrate a QCL prototype to meet all requirements. Demonstrate a QCL lifetime >1,000 hours with the performance criteria stated in Phase I.

It is probable that the work under this effort may become classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the high performance QCLs with the specifications stated in Phase II for DoD applications in the areas of Directed Infrared Countermeasures (DIRCM), advanced chemicals sensors, and Laser Detection and Ranging (LIDAR). The DoD has a need for advanced, compact, high performance MWIR QCL in Band IVA (3.8 – 4.1 micron) of which the output power can readily be scaled via beam combining for current and future generation DIRCMs, LIDARs, and chemicals/explosives sensing.

The commercial sector can also benefit from this crucial, game-changing technology development in the areas of detection of toxic gas environmental monitoring, and non-invasive health monitoring and sensing.

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KEYWORDS: Quantum Cascade Lasers; QCL; Band IVA; Band IVB3.8 Micron; 4.1 Micron; Mid-wave Infrared; Continuous Wave

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-014 TITLE: Compact Long-Wave Infrared Hyperspectral Imager with Monolithically Integrated Tunable Optical Filter

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA263 Navy and Marine Corp Small Tactical Unmanned Air Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a battery operated ultra-compact long-wave infrared hyperspectral imager (HSI) with monolithically integrated tunable optical filter for detecting targets and threats in cluttered environments.

DESCRIPTION: Recent technological advances have made long wave infrared (LWIR) hyperspectral imaging (HSI) in the 8-12 micrometer wavelength range into a viable technology in many demanding military application areas where materials can be identified by their spectral signatures [Refs 1, 2]. In particular, the operational utility of HSI for detection, recognition and identification of hard-to-detect targets in environments cluttered with background noise is especially critical. Spectral imaging can aid the detection, acquisition and tracking of a potentially camouflaged, low-signature target, such as an unmanned aerial vehicle (UAV) during counter-UAV surveillance, etc., with significantly improved accuracy that cannot otherwise be detected using more conventional imaging means. LWIR spectral range is advantageous for penetrating fog, dust, and aerosols.

Conventional HSI systems [Refs 1, 2] tend to use large, bulky optical elements, such as a Michelson interferometer or other tunable optical filter components to spectrally resolve the input optical signals, and therefore usually have the characteristics of significant size, weight, and power (SWaP) consumption, mechanical complexity, as well as non-compliance with military specifications. Furthermore, the mechanical mechanism of the conventional tunable filtering system gives rise to slow spectral speed and thus, slow imaging speed. As a result, conventional HSI systems do not lend themselves to the field applications that require handheld portability and faster response times.

The goal of this effort is to develop a compact, LWIR HSI system based upon the monolithic integration of a tunable optical filter with a large-format LWIR focal plane array (FPA). The FPA should be based on either II-VI Mercury Cadmium Telluride materials, or III-V strained layer super lattice (SLS) structures. The tunable optical element can be a micro-electro-mechanical systems (MEMS)-based tunable Fabry-Perot filter or other hyperspectral tunable filter monolithically integrated with the FPA. The development effort also needs to include the necessary read-out and programmable electronics integrated with the monolithic FPA and tunable filter ensemble to enable real time spectral image processing.

System required parameters include:

1. Tunable wavelength range: 8-12 microns
2. Array size: at least 320 x 256 pixels
3. Pixel pitch: 12 microns or less
4. Tunable filter peak transmission: >55%
5. Tunable filter full-width at half-maximum: 500 nm or less
6. Tunable filter out-of-band rejection: > 15:1
7. Pixel-to-pixel wavelength variation across the FPA: < 4%
8. System weight with batteries: < 6 pounds
9. System size < 60 cubic inches

PHASE I: Design, develop, and demonstrate a compact LWIR HSI with monolithically integrated tunable optical filter to meet specifications identified in the Description. Analyze and model to identify the performance and limitation of proposed technologies. Identify any additional optics and electronics required for the HSI system configuration and operation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the designs from Phase I. Provide updated analysis and models for any design improvement. Fabricate and characterize a system prototype to meet design specifications. Demonstrate prototype and provide an operating manual for laboratory and field-testing.

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the compact hyperspectral imager with monolithic tunable optical filter based on the final design for Naval applications in the areas of target detection, recognition, and identification.

The commercial sector can also benefit from this compact hyperspectral imager with fast response time in the areas of detection of toxic gases, environmental monitoring, and noninvasive health monitoring and sensing.

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KEYWORDS: Hyperspectral Imager; Target Detection; Target Identification; Target Recognition; Long-Wave Infrared; Tunable Filter

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-015 TITLE: Autonomous and Intelligent Aircraft Maintenance Technologies

TECHNOLOGY AREA(S): Air Platform, Human Systems, Materials/Processes

ACQUISITION PROGRAM: NAE Chief Technology Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop autonomous Artificial Intelligence (AI)-based systems to work with or alongside aircraft maintainers to reduce manning and/or to augment the abilities of aircraft maintainers.

DESCRIPTION: There is a need to support reliability and maintainability of aviation assets that will directly reduce life cycle costs by augmenting or replacing manual operations. The Navy has demonstrated use of smart algorithms combined into optical detection systems to detect, identify, and quantify defects and damage. Augmented reality (AR)/virtual reality (VR) are used in industry today to greatly enhance maintenance and training, and are tools for doing both remotely. The Navy has recently experimented with AR/VR technologies for improved training. In the Navy's Fleet Readiness Centers, robotics are currently used for industrial processes such as coatings removal, coatings application and thermal spray metal repair application to increase precision, quality, and throughput. The Navy has recently demonstrated an autonomous mobile-portable robotic metallization system for on-aircraft maintenance that has shown the effectiveness of such technology deployed to Intermediate level maintenance. All of these technologies have proven to benefit all levels of aircraft maintenance. The next step is to combine AI algorithms, sensors, AR/VR, and/or robotics to develop smart autonomous systems or tools.

The Navy seeks the development of technologies specifically for the aircraft maintenance community to perform functions such as material inspection, non-destructive inspection, coatings inspection and repair, and training. A specific need exists in the maintenance, inspection and repair of special coatings that require precision, where the current methods are manual. The Navy also seeks the development of an AI system to map out damaged areas such as in corrosion maintenance; repair by removing precise layers of coating and then reapply precise layers of coating; and catalog historical data. Autonomous or Intelligent "smart" technologies have the potential to give artisan capabilities to intermediate or field-level aircraft maintainers, utilizing AR/VR to autonomous robots.

The technology, if wearable or handheld, must be minimal size, minimal weight, and the most power. Ideally, if worn or held, it should be lightweight and easy to use, compact as much as possible, ergonomic, and as long of a battery life as possible or self-powered as this technology will be used in the field. These features are also preferable for a robotic system, but a robotic system must be able to maneuver, manipulate, or traverse around fixed-wing aircraft, rotary-wing aircraft, or unmanned aircraft, of all Type/Model/or Series (TMS). If an autonomous system, it should be capable of finding, fixing, and finishing with minimal or no human interaction.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth

by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Assess current aircraft maintenance practices such as cleaning, coatings removal, non-destructive inspection, and corrosion assessment. Determine areas that are candidates for autonomous maintenance, integration of AI, or other smart-based systems such as AR tools. Design, develop, and demonstrate feasibility of an approach. Perform an analysis of alternatives and benefit analysis to meet the requirements laid out in the Description. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, construct, evaluate, and demonstrate a prototype autonomous AI-based technology or an AR/VR tool or technology for aircraft maintenance based upon the conclusion of Phase I. Perform demonstration of the technology on indicative aircraft structures or test on mock-ups of unmanned aerial systems, fixed-wing aircraft, or rotary-wing aircraft. Demonstrate prototypes in a lab environment with the anticipation of deployment to the field.

Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Demonstrate and evaluate the technology on a demonstration aircraft. Transition the technology into an active Marine Corps Squadron or Navy Squadron, or Fleet Readiness Center/Depot, for implementation into the Navy. The technologies developed would apply directly to the commercial aviation industry, general aircraft maintenance, as well as potential broad application in the coatings industry.

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KEYWORDS: Autonomous; Artificial Intelligence; Virtual Reality/Augmented Reality; Robotics; Sustainment; Readiness

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-016 TITLE: Mid-Wave Infrared Fiber Amplifier

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA272 Tactical Aircraft Protection Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a high-power mid-wave infrared (MWIR) fiber amplifier for quantum cascade lasers (QCLs) capable of output power scaling up to 1 kilowatt (kW).

DESCRIPTION: High power mid-wave infrared (MWIR) laser sources in the wavelength range of 4.6 to 5 micrometers are of great interest in defense applications. A major limitation to developing these sources is the lack of materials that lase directly in the MWIR. Materials that do lase directly in the MWIR are either inefficient, require cryogenic cooling, or have other challenges. Correspondingly, most high-power laser systems in this wavelength region rely on the use of nonlinear conversion processes, resulting in low efficiencies and high size, weight, and power (SWaP). Recently, QCLs [Ref 1] have emerged as a viable direct source, offering MWIR lasers for naval infrared countermeasure (IRCM) applications with increased performance. However, relatively low electrical-to-optical efficiencies of these QCL devices have resulted in approximately over 75-80% of the electrical energy input to the QCL dissipated as heat.

Future-generation IRCM systems and missile defense may benefit from the use of MWIR IRCM lasers with kW capability. None of today's commercially available QCLs and beam combining schemes are capable of delivering up to and beyond kW output power levels with diffraction limited beam quality. It is therefore the goal of this SBIR topic to further the development of MWIR rare earth-doped fiber amplifiers [Ref 2] for QCLs that potentially will reach kW level in continuous wave regime with excellent beam quality ($M2 < 1.5$) and high slope efficiency. The successful demonstration of a MWIR fiber laser amplifier for QCL devices would serve to advance any application requiring higher power QCL performance.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design and analyze a best-performance MWIR fiber amplifier architecture in the wavelength range of 4.6 to 5 micrometers. Demonstrate fiber-based amplification of a QCL based on the best available rare earth-doped chalcogenide fiber and laser diodes or fiber lasers to pump the amplifier in a bench top experiment. Provide the first-light fiber amplification power-scaling results and show path to meeting Phase II goals. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the rare earth-doped chalcogenide fiber design and transition the Phase I laser to an all-glass, monolithic fiber amplifier architecture that is capable of producing up to 1 kW output power. Completely characterize the fiber amplifier architecture, in terms of gain at 4.5 micron, slope efficiency (percentage of the signal power with respect to pump power), and gain bandwidth. Demonstrate the developed prototype.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the high power MWIR fiber amplifier for DoD applications in the areas of Directed Infrared Countermeasures (DIRCM), advanced chemicals sensors and laser detection and ranging (LIDARs). The DoD has a need for advanced, high-power MWIR laser sources of which the output power can readily be scaled for current- and future-generation DIRCMs, LIDARs, and chemicals/explosives sensing.

The commercial sector can also benefit from the crucial, game-changing technology development in detection of toxic gases, environmental monitoring, and non-invasive health monitoring and sensing.

REFERENCES:

1. Bai, Y., Bandyopadhyay, N., Tsao, S., Slivken, S. and Razeghi, M. "Room Temperature Quantum Cascade Lasers with 27% Wall Plug Efficiency." *Applied Physics Letters*, 2011. <https://aip.scitation.org/doi/10.1063/1.3586773>
2. Jackson, S. "Towards High-Power Mid-Infrared Emission from a Fibre Laser." *Nature Photonics*, Vol. 6, No. 7, July 2012, pp. 423-431. https://www.researchgate.net/publication/258686064_Towards_High-Power_Mid-Infrared_Emission_from_a_Fibre_Laser

KEYWORDS: Quantum Cascade Laser; QCL; Thermal Load; Scaling; Mid-Wave Infrared; MWIR; Brightness; Fiber Amplifier

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-017 TITLE: Modernization of the Laser Event Recorder

TECHNOLOGY AREA(S): Battlespace, Biomedical, Human Systems

ACQUISITION PROGRAM: PMA202 Aircrew Systems

OBJECTIVE: Design an aircraft or aircrew-mounted device to detect and alert when targeted/irradiated by a laser, and record laser-strike characteristics (e.g., wavelength, power, pulse duration, etc.), as well as the global positioning system (GPS) location at the time of detection.

DESCRIPTION: Laser strikes on both military and commercial aircraft have been on the rise since 2005. The Navy is interested in developing a device that can alert aircrew when they have been lased, as well as gather particular laser parameters of importance. The Navy had such a device, the Laser Event Recorder, but that device used now obsolete equipment/technology and no longer manufactured.

Develop a device with the following capabilities:

- Identify the wavelength of the laser strike (desired operational range = 190 - 2000 nm)
- Record the power/energy of the laser strike
- Record the time and duration of strike (if pulsed, measure the pulse lengths as low as one nanosecond (ns) and pulse repetition frequency (PRF))
- Capture a high resolution image and/or video of the source
- Determine the angle of arrival with respect to aircraft orientation and altitude
- Record the GPS coordinates
- Record data on removable media (such as an SD card)
- Device should keep false positives to a minimum
- Device should have a minimum field of view of 50 degrees in the horizontal and 40 degrees in the vertical

Additionally, there is a need to provide a visual notification (such as a light or text indicator) to alert the aircrew that they are receiving laser radiation. The total weight of the device can be no more than 300 grams (g) and the total volume no more than 100 cubic centimeters (cm³). Ruggedize the device to pass requirements in MIL-STD-810H [Ref 1] and pass the electronic interference requirements in MIL-STD-461G [Ref 2]. The device will require mounting to aircraft windscreen via suction cup or on the aircrew via either a Velcro patch or strap. All displays and indicators must be Night Vision Goggle (NVG) compatible in accordance with MIL-L-85762A [Ref 3]. The device must be powered via rechargeable battery and be capable of operating continuously for a minimum of eight hours.

PHASE I: Design and develop a concept for the device in accordance with the parameters and requirements in the Description. Demonstrate feasibility of the designed concept. The Phase I effort will include detailed prototype plans to be developed under Phase II.

PHASE II: Continue development of the concept proposed in Phase I and design and demonstrate a prototype device to address all parameters. Include planning, design for either aircraft or aircrew mounting, and perform preliminary testing for ruggedness.

PHASE III DUAL USE APPLICATIONS: Finalize designs and the technology with an emphasis on manufacturability. Transition final technology to end users and platforms. Successful technology development will

have commercial applications in both law enforcement and commercial aviation sectors.

REFERENCES:

1. Department of Defense. MIL-STD-810H Environmental Engineering Considerations and Laboratory Tests. Everyspec, 2019. http://everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810H_55998/
2. Department of Defense. MIL-STD-461G Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. Everyspec, 2015. http://everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-461G_53571/
3. Department of Defense. MIL-L-85762A Lightning, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible. Everyspec, 1988. http://everyspec.com/MIL-SPECS/MIL-SPECS-MIL-L/MIL-L-85762A_6500/

KEYWORDS: Laser Strike; Incident Radiation; Laser Event Recorder; Laser Warning System; Laser Detection; Hazard Analysis

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-018 TITLE: Dynamic Digital Spatial Nulling Algorithms for Tactical Data Links

TECHNOLOGY AREA(S): Air Platform, Battlespace, Electronics

ACQUISITION PROGRAM: PMA263 Navy and Marine Corp Small Tactical Unmanned Air Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and/or innovate new or current algorithms including derivatives of space-time adaptive processing (STAP), space-frequency adaptive processing (SFAP), and key elements for nulling-aware routing for application on tactical data links to improve the communication range, interconnectivity and anti-jamming resistance. Document, assess, rank, recommend and report any algorithms based on applicability, performance and integration complexity to military communications and data terminals. Pursue feasible candidate(s) for a potential transition into Multifunctional Information Distribution System Joint Tactical Radio System (MIDS JTRS) terminals during Phase II prototyping efforts.

DESCRIPTION: Adaptive null steering was pioneered in the early 1960's [Refs 1, 2, 3, 4] in the context of side-lobe cancelation (SLC) for the purpose of suppressing radar receiver interference and jamming. The ability to

control the phase and amplitude of received signals on each channel of an antenna array makes it possible to implement various types of adaptive analog or digital processing techniques. This capability has been extensively used in analog, digital and hybrid analog/digital antenna systems to suppress jammer signals in radar and communications systems. Extension of these techniques to multi-element antennas to cancel multiple interference sources has occurred.

Many modern and legacy communications links have relied on dual antenna solutions for antenna diversity to improve the quality and reliability of a wireless link, but only a few protocols leverage null-steering due to platform constraints. Most platforms, mobile and non-mobile, rely on single or dual antenna systems for transmission and reception capability, placed in a number of different geometries. Adversarial nodes with 3D moment capacity pose a significant threat to these networks as an adversary can position itself to attack the crucial links [Ref 4]. Mobility of platforms and interferences sources make nulling decisions difficult as the null could be placed such that signals of interest are also affected.

The Navy needs innovative adaptive and deterministic steering algorithms to process dual digitized inputs, based on two separated antennas implemented in a Field Programmable Gated Array (FPGA) to improve by 30 – 60 dB, communications resilience in a contested environment. Additional antennas may be supported, but two will be assessed for optimality. Algorithms should also be able to accept and provide angle of interests of multiple interfering signals to allow for high-order media access control and routing protocol utilization for optimally steering gain. Analysis and simulations that allow for comparison of performance on proposed new algorithm and/or innovated application of current algorithms and estimates of the computational requirements should accompany the research. The interference removal should not degrade the link compared to a non-null steering setup. Algorithm parameters should be developed and identified that will be used for a future link layer algorithm that allows for cooperative nulling, allowing trades to be made between nulling adversarial and friendly nodes to preserve interconnectivity and data dissemination capability.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

Although not required, it is highly recommended to work in coordination with the original equipment manufacturer (OEM) to ensure proper design and to facilitate transition of the final technology.

PHASE I: Develop, design, and demonstrate the feasibility of new or existing innovative dual antenna processing techniques for tactical data links and establish the base figure of merit: geometries supported, null depth, ability to adapt to prevent friendly nulling. As part of the Phase I effort, simulations are required to establish the Figure of Merit (FOM) for the proposed algorithms by both the Offeror and the Government. FOMs allow for both offeror and government to have a single standard unbiased test methodology to validate algorithms FOMs, as each algorithm offer different performance for different interference sources. In the Phase I, the offeror will assume multiple interferences sources exist. MIDS JTRS is a NSA certified type 1 encryption system; hence, information assurance (IA) compliance will apply during the Phase II and subsequent transition efforts. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Produce, deliver, and implement (in software) prototypes for the proposed algorithms, encompassing both the design of the algorithms and anticipated affects. Conduct evaluations by testing the algorithms against signal sets. MIDS JTRS is a NSA certified type 1 encryption system; hence, information assurance (IA) compliance will apply during the Phase II and subsequent transition efforts.

The Government, at its discretion, may also provide threat signal data for testing. Independent testing at a Government facility at Government expense may be performed. Performance of the algorithms will be judged based

on the base figure of merits assumed above. Prepare a Phase III development plan to transition the technology for Navy and potential commercial use.

Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the algorithms to Navy use. Refine further the algorithms, software code, validation, documentation, and IA compliance. Perform test and validation to certify and qualify software and firmware components for Navy use. Implement the capability in the form of fast, efficient algorithms that, once proven, can be coded in software-defined radios.

Spatial nulling algorithms have increasing application in the area of dense enterprise wireless local area networks and commercial antenna systems and cellular communication. Spatial nulling technology potentially has wide commercial applications to address LTE, 5G, WIFI technology deployment due proximity with other interferers, spectrum challenges, etc.

REFERENCES:

1. Howells, P. W. Intermediate Frequency Side-Lobe Canceller. Morrisville: United States Patent Office, 1965. <https://patents.google.com/patent/US3202990A/en?q=3202990>
2. Howard, D. Side-lobe Canceling System for Array Type Target Detectors. Oxon Hill: United States Patent Office, 1969. <https://patents.google.com/patent/US3435453A/en>
3. Durboraw, I. Clutter Compensated Sidelobe Cancelling Communications System. Scottsdale: United States Patent Office, 1983. <https://patents.google.com/patent/US4381508A/en?q=4381508>
4. Tsujimoto, I. Side-lobe Cancellation and Diversity Reception Using a Single Array of Auxiliary Antennas. Tokyo: United States Patent Office, 1994. <https://patents.google.com/patent/US5369412A/en?q=5369412>
5. Bhunia, S., Regis, P., & Sengupta, S. Distributed Adaptive Beam Nulling to Survive Against Jamming in 3D UAV Mesh Networks. Computer Networks, 83-97. Tsujimoto, I. (1994). Side-lobe Cancellation and Diversity Reception Using a Single Array of Auxiliary Antennas. Tokyo: United States Patent Office, 2018. <https://patents.google.com/patent/US5369412A/en?q=5369412>

KEYWORDS: Data Links; Software Defined Radios; Space-Time Adaptive Processing (STAP); Space-Frequency Adaptive Processing (SFAP); Digital Nulling; Figure Of Merits (FOM)

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-019 TITLE: Spatial Data Comparison for Markerless Augmented Reality (AR) Anchoring

TECHNOLOGY AREA(S): Human Systems, Information Systems

ACQUISITION PROGRAM: PMA251 Aircraft Launch & Recovery Equipment (ALRE)

OBJECTIVE: Develop a software solution to localize an augmented reality (AR) headset user within a space by making a comparison between spatial mapping data collected live from the headset and scanned/modeled data collected at an earlier time and stored on the device. The proposed solution should work with an existing, commercially available AR headset.

DESCRIPTION: The Navy and Marine Corps currently have several efforts underway looking at applying AR technology to provide maintainer guidance, and improve maintenance-action success rate and repair time. Many current commercial off-the-shelf (COTS) AR hologram anchoring solutions make use of the device's onboard camera and fiducial marker detection to localize a user in space and overlay instructions, animations, warnings, schematics, and technical data but these solutions are limited by the chosen device's camera quality and computational power. Target-based solutions also mandate that a physical marker be placed on the piece of equipment to be detected, which is unacceptable in a number of maintenance environments. More powerful image and object recognition technology exists that foregoes the need for a fiducial marker but these solutions are heavily dependent on the upload of government data to proprietary cloud services which severely restricts utilization due to both government data sensitivity and cyber limitations on internet access.

The need exists for a method of anchoring holographic overlays in space without the need for internet/cloud access and physical markers. Ideally, this solution would extract a bounding box of a piece of equipment using key feature set comparisons between a computer aided design (CAD) model/3D scan file and real-time spatial mapping room scans generated by the chosen AR device. Some system of aligning the live spatial mapping data with the stored digital twin would allow for the precise and accurate placement of holographic overlays anywhere within the user's scanned region without any dependency on camera functionality. Such a solution would need to achieve 90% precision and accuracy for equipment of varying size and complexity (from 1 to 500 cubic feet) while providing very limited performance degradation (maintaining 60 frames per second) on the device. This solution must also be capable of identifying the same piece of equipment in multiple and varying room spaces (i.e., identification independent of the space itself and the equipment's location within the space). Integration of the solution with the Unity Game Engine or other common AR application authoring tools is required and full documentation of all programming Application Program Interfaces (APIs) is expected to allow for future government developer use/interfaces.

PHASE I: Design, develop and demonstrate feasibility of a software to meet the requirements provided in the Description. Design a high-level software and use a simplified example of the methodology as a proof-of-concept. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Build and demonstrate a prototype system for a chosen AR headset and test in both interior and exterior environments to highlight capability in lighting conditions that range from bright sunlight to darkness in all weather conditions.

PHASE III DUAL USE APPLICATIONS: Further develop the solution on chosen AR device. Transition as Support Equipment within other Navy-developed applications.

Development of a software tool for environment/model alignment and hologram anchoring that foregoes the need for an off-premises cloud backend will be marketable to aircraft, automobile, and heavy equipment manufacturers along with all other companies that have sensitive/proprietary models they do not wish to cover with fiducial markers or upload to a private entity's servers.

REFERENCES:

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2. Dow, E. M., Farr, E. M., Gildein, M. E., II, & Vaughan, M. J. U.S. Patent No. US 10,169,384 B2. Washington, DC: U.S. Patent and Trademark Office, 2019. https://www.researchgate.net/profile/Eli_Dow/publication/330090603_Augmented_Reality_Model_Comparison_and_Deviation_Detection/links/5c2ce07192851c22a3554b5c/Augmented-Reality-Model-Comparison-and-Deviation-

Detection.pdf?origin=publication_detail

KEYWORDS: Augmented; Mixed; Reality; Spatial; Fiducial; Hologram

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-020 TITLE: Development of Agile Laser Eye Protection (LEP)

TECHNOLOGY AREA(S): Air Platform, Biomedical, Human Systems

ACQUISITION PROGRAM: PMA202 Aircrew Systems

OBJECTIVE: Design and develop “agile” laser eye protective filters that operate independent of the incident wavelength in real time. Additionally, optical transition technologies, such as photochromic or electrochromic sun protection, may be developed.

DESCRIPTION: With the recent increase in laser strikes on aircraft, the need exists to protect the eyes of our Navy aircrews. Current Laser Eye Protection (LEP) technology uses fixed filters that reject specific wavelength bands. This SBIR topic seeks to develop filter technologies that can reject any laser regardless of wavelength in the Ultraviolet (UV), Visible (VIS), and Near Infrared (NIR) wavelength ranges (190-2000 nm).

The “agile” filter technology needs to protect from both continuous wave (CW) and pulsed lasers having pulses as low as one nanosecond (ns). The device must provide at least an optical density (OD) of three while providing as much transmittance as possible. The solution needs to be physically compatible with existing aircrew helmets and oxygen masks as well as spectrally compatible with a full color display such as a commercially available LCD/LED computer monitor. Keep weight to a minimum with a goal of not more than 350 grams. If a visors solution is proposed, it must meet as many of the requirements detailed in MIL-DTL-43511D [Ref 1] as possible. If a spectacle solution is proposed, it must meet as many of the requirements in MIL-PRF-32432A [Ref 2] as possible. Both visor or spectacle solutions must have a base curvature of at least 6 diopters. If a powered solution is proposed, the device needs to be battery powered and operate continuously for a minimum of eight hours.

In addition, the Navy has an interest in designing and developing transition visors or spectacles that can adapt to varying lighting conditions (bright noon sun vs. overcast). The device must have a maximum photopic transmittance of 85% and a minimum photopic transmittance 15%. It should transition in less than 1 second (s) when worn behind a windscreen/ canopy and must be compatible with existing helmets and oxygen masks. If a visor solution is proposed, it must meet as many of the requirements detailed in MIL-DTL-43511D [Ref 1] as possible. If a spectacle solution is proposed, it must meet as many of the requirements in MIL-PRF-32432A [Ref 2] as possible.

PHASE I: Design, develop and demonstrate feasibility of filter technologies that detail the specific characteristics of the filters (weight, transmittance (photopic and scotopic), OD, optical power, maximum lens curvature, etc.). The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Developed and demonstrate prototype filter technology and work with the Navy for laboratory testing and user assessments.

PHASE III DUAL USE APPLICATIONS: Further refine and finalize technology from Phase II with an emphasis on manufacturability. Technologies developed through this effort are expected to have commercial applications in law enforcement, commercial aviation, construction, manufacturing, medical, and educational facilities among others.

REFERENCES:

1. Department of Defense. MIL-DTL-43511D Visors, Flyer's Helmet, Polycarbonate. Everyspec, 2006.
http://everyspec.com/MIL-SPECS/MIL-SPECS-MIL-DTL/MIL-DTL-43511D_15101/

2. Department of Defense. MIL-PRF-32432A Military Combat Eye Protection (MCEP) System. Everyspec, 2018.
http://everyspec.com/MIL-PRF/MIL-PRF-030000-79999/MIL-PRF-32432A_55832/

KEYWORDS: Laser Protection; Photochromic; Liquid Crystal; Tunable; Frequency Agile; Electrochromic; Vision Protection; Optical Limiter; Nonlinear Optics

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-021 TITLE: Cargo Handling Software for Navy and Marine Aircraft

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA261 H-53 Heavy Lift Helicopters

OBJECTIVE: Develop innovative software to assist aircrew in loadmaster duties and generate cargo configurations to achieve sufficient cargo restraint for Navy and United States Marine Corps (USMC) aircraft using handheld devices.

DESCRIPTION: The Navy is in need of a software tool that can design, evaluate, and display cargo-loading configurations to ensure restrained cargo is to the Navy required parameters within aircraft. This solution should be capable of autonomously designing the most effective and efficient cargo-loading configuration that meets all loading requirements without the use of additional tools and display this information to the user.

Aircraft cargo transportation is a complex mission requiring an understanding of aircraft limitations, cargo space dimensions, tie-down locations, aircraft center of gravity (CG), equipment limitations, and safety of personnel being transported, each of which are unique to different aircraft. This software must be capable of addressing each of these elements when designing, displaying and evaluating cargo-loading configurations.

The loading considerations listed above are detailed in Cargo Loading Guides (CLG). Crewmembers are trained to varying levels of competence in each platform's specific CLG. Each platform's CLG is different, some platforms contain specific cargo configurations, while others detail strategies to meet Navy or Marine Corps cargo requirements. Deficiencies of CLGs, gaps in training, and degradation of skill or knowledge of personnel, may introduce human error to crucial CG and tie down calculations that could result in aircraft damage, cargo damage, passenger injury, crew injury, failure of the mission, or loss of aircraft.

By providing means to evaluate and design cargo configurations within Navy or Marine Corps requirements and display certified cargo loading configurations this project will address the listed deficiencies, improve the safety of crewmembers and cargo, and expedite the cargo transportation process.

The software must provide a graphical user interface (GUI) to input and display air vehicle type and dimensions, cargo type and dimensions, desired cargo storage location within the aircraft, restraint requirements, available restraint equipment, and the location of available tie down rings. This software must integrate onto the Marine Air Ground Tablet (MAGTAB), requiring the software to be built in the Android Knox Software Development Kit (SDK). It must be usable by Navy and Marine Corps services and for heterogeneous platforms, both manned and unmanned.

PHASE I: Develop and demonstrate the feasibility of an innovative software for a handheld device that can display multiple unique aircraft loading spaces and aircraft tie down locations, measure and input unique cargo dimensions and locations within the aircraft, and calculate restraint provided by tie down provisions. Exhibit capability to display CLG publications and use a notepad and calculator tool within the software. Establish performance goals and approach for Phase II with emphasis on user interface and generation of optimized tie down patterns. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype software tool, deployed on a hand-held device and operating system including, but not limited to, Android OS, that can measure a unique cargo's dimensions, locate its tie down rings, and generate an optimal tie down pattern that meets Navy and Marine Corps requirements and provides cargo placement that does not exceed aircraft limitations, provided by the Government. Exhibit capability to display, evaluate and generate cargo configurations across different cargo loading zones and aircraft requirements. Demonstrate capability to save and display known and newly developed cargo configurations for different aircraft. Develop performance metrics for the prototype and path forward.

PHASE III DUAL USE APPLICATIONS: Evaluate the ability to integrate adaptive cargo loading analysis capability into software for implementation on the MAGTAB and assess the system performance against the metrics developed during Phase II efforts. Transition to appropriate platforms.

The implementation and improvement of measuring tools integrated onto hand-held devices is a commercially viable product that has use cases not limited to construction, auto mechanics, landscape architecture, landscaping, architecture, asphalt, mechanical contracting, heating, ventilation, and air conditioning (HVAC), industrial engineering, and manufacturing engineering. This project will also have the potential for application to commercial aircraft and transport vehicles with unique cargo loading zones requiring tie downs and weight and balance considerations for shipping companies such as FedEx or United Parcel Service (UPS).

REFERENCES:

1. MIL-STD-1791C, DEPARTMENT OF DEFENSE INTERFACE STANDARD: DESIGNING FOR INTERNAL AERIAL DELIVERY IN FIXED WING AIRCRAFT (23-OCT-2017) http://everyspec.com/MIL-STD/MIL-STD-1700-1799/MIL-STD-1791C_55770/

2. MIL-STD-1366E, DEPARTMENT OF DEFENSE: INTERFACE STANDARD FOR TRANSPORTABILITY CRITERIA (31 OCT 2006) http://everyspec.com/MIL-STD/MIL-STD-1300-1399/MIL-STD-1366E_2979/

3. MIL-STD-209K, DEPARTMENT OF DEFENSE INTERFACE STANDARD FOR LIFTING AND TIEDOWN PROVISIONS (22 FEB 2005) http://everyspec.com/MIL-STD/MIL-STD-0100-0299/MIL-STD-209K_22319/

KEYWORDS: Cargo; Loading; Tie-Down; Handling; Software; Restraint

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-022 TITLE: Big Data Mining for Maritime Situational Awareness

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA263 Navy and Marine Corp Small Tactical Unmanned Air Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop innovative techniques to mine big data sources for information to use as reference knowledge by Situational Awareness (SA) applications for improving Maritime Situational Awareness (MSA).

DESCRIPTION: MSA applications have a need for sustainable sources of reference knowledge. A robust tactical surface picture requires the mining and effective utilization of massive amounts of information suitable for ingestion by machine learning (ML) engines. Gathering the desired understanding of the tactical situation can be resource intensive and difficult to sustain without the assistance of ML engines to make sense of it. This SBIR topic seeks to explore the feasibility of satisfying this need through the exploitation of big data sources. For U.S. Navy maritime operations, the MINOTAUR Family of Services (MFoS) is the means by which we plan to correlate and fuse sensor data, producing an integrated display shared across air, sea and subsurface platforms, and command centers. The desired result is a coherent battlespace awareness, fusing tactical sensors with national data to support synchronized actions in the maritime environment. Optimally leveraging this huge amount of information at the individual platform level to contribute to this shared tactical picture is extremely challenging without additional tools to make sense of it all. This is particularly true on airborne platforms where operators must manage multiple sensor systems simultaneously. MFoS populates and maintains a Tactical All Source Repository (TASR) containing vessel tracks derived from multiple cooperative and non-cooperative sensors, associated radar and optical imagery and electronic warfare information. In addition, MFoS captures, as available, vessel classification and identification information made by cooperative broadcast, by electronic interrogation, by operators or operator aids. While the accumulation and display of all of this information is quite efficient, quickly understanding its tactical relevance is challenging particularly with regard to detecting or predicting threatening or anomalous behaviors. Ultimately, the goal is to understand who is operating in your area of responsibility, what are they doing, and if they pose a threat, in the most efficient manner possible.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and

operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DSS and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and demonstrate the ability to interface with one or more existing sources of big data and examine/demonstrate the feasibility of the following:

- Algorithms for automating the curation of knowledge from big data sources
- Algorithms for automating the aggregation of curated knowledge
- Algorithms for automatically extracting the information types required by MSA applications.

Detailed knowledge of MFoS TASR data sources and presentation is unnecessary during Phase I to develop and assess proposed approaches. Only a general understanding (comparable to that provided in the Description above) on the nature of data contained within TASR is needed. Use publicly available sources of big data, not necessarily maritime in nature, as a surrogate in Phase I. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Mature the Phase I-developed algorithms and architectures and apply them for use with the MFoS TASR. The Government will provide exemplar data files to support this development. Utilize the style guidelines provided to maintain uniformity of information presentation with the MFoS operating environment. Establish a lifecycle maintenance plan. Develop requirements for and conduct performance assessments of the tool.

Work in Phase II may become classified. Please see Note in Description section.

PHASE III DUAL USE APPLICATIONS: Integrate the technology into the Navy's MFoS application utilizing its TASR as the source of big data. Big data mining would benefit a wide range of commercial applications ranging from exploring trends in social media to analysis of financial systems.

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1. Challa, J. S., Goyal, P., Nikhil, S., Mangla, A., Balasubramaniam, S. S., & Goyal, N. DD-Rtree: A Dynamic Distributed Data Structure for Efficient Data Distribution Among Cluster Nodes for Spatial Data Mining Algorithms. 2016 IEEE International Conference on Big Data (Big Data) (pp. 27-36). Washington DC: IEEE. <https://ieeexplore.ieee.org/document/7840586>
2. Sun, P., Xu, L., & Fan, H. RHAadoop-Based Fuzzy Data Mining: Architecture, Design and System Implementation. 2016 IEEE International Conference on Big Data Analysis (ICBDA) (pp. 1-52). Hangzhou, 2016: IEEE. <https://ieeexplore.ieee.org/document/7509796>

KEYWORDS: Big Data; Information Analysis; Analytics; Minotaur; Tactical All Source Repository; Maritime Situational Awareness

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-023

TITLE: Alternate Sled Track Braking Mechanism

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: PMA280 Tomahawk Weapons Systems

OBJECTIVE: Develop a replacement sled braking mechanism for Supersonic Naval Ordnance Research Tracking (SNORT) that requires less setup time, and does not have the associated regulatory compliance and recurring cost issues as the existing SNORT water brake system.

DESCRIPTION: The water braking system used at the SNORT currently includes a diesel-powered water pump that delivers water to approximately the midpoint of the track. The water then flows downhill and recirculates back into the 600,000-gallon storage pond at the north end of the track. Baffles and dams, placed manually in the concrete foundation trough between the rails, slow the water down and increase the water height. Rocket sleds typically have a probe or scoop incorporated into their structure to interface with the water. The length of the probe is set to start contacting the water as the rocket motor propulsion is tailing off. Most sleds with water brake probes are stopped on the track and reused. Occasionally, the water braking system only provides separation between sled stages resulting in all sleds destroyed at the end of the track.

Maintaining, calibrating, and operating the existing water braking system is costly and has several areas requiring regulatory compliance. The diesel engine driven water pump is located in an underground vault which is designated a confined space. The confined space requires constant monitoring for hazardous atmospheric conditions such as the presence of Carbon Monoxide or low Oxygen levels. Annual calibration and maintenance costs are approximately \$5,000. The engine requires an air permit to operate and the underground storage tank requires a permit. Inspectors must regularly log, and report on these permits, requiring escort of inspectors which is time consuming and costly. Annual permit and inspection costs are approximately \$5,000. Certified inspectors are required to perform repairs, adding additional cost and complexity. Calibration and checkout of the water brake system is very time consuming because of the lag time between taking measurements, adjusting water flow rate, and waiting for the new flow rate to propagate through the two miles of track. This cycle takes approximately 2 hours. Water-profile adjustment costs are approximately \$2,000 per year. Adjusting the water profile is difficult and has led to most changes being made to the sled probe or scoop and using the standard water profile. This approach can cause sub-optimal design constraints on the sled design or velocity/acceleration profile of the sled. Usually the result is high braking loads incorporated into the sled design adding weight, cost, and complexity. The goal is to design a new innovative braking mechanism without the drawbacks described above.

The braking mechanism should meet the following requirements:

- a) Be a passive system with no outside inputs. Electricity, water, fuel, or coolant.
- b) Maximum of 21,600 feet of braking length.
- c) Equal or lower weight and drag penalties on the sled-side of the braking mechanism compared to existing probe designs. Spade brake example; 45 lbs. brake weight, 0.85 drag coefficient, 41,000 lbs. maximum braking force. High speed brake example; 110 lbs. brake weight, 0.85 drag coefficient, 95,000 lbs. maximum braking force. Detailed specifications will be provided to Phase I performers.
- d) Fit into or around the existing track foundation for the trackside portion of the braking mechanism. The concrete foundation trough is nominally 41.625" wide, 26" deep (measured from top of rail), and has 6" 45 degree chamfers on both bottom corners.
- e) Operate in desert climate without severe (greater than 10%) performance penalties. Direct sunlight, high winds, blowing dust, occasional rain, with ambient temperature ranging from 10°F to 120°F
- f) Adjustments to braking profile made without precision equipment (alignment lasers, surveying equipment). Simple gauge bars or lightweight alignment fixtures are allowable.
- g) Adjustments to braking profile completed by two personnel in under 2 hours per each mile of braking length.
- h) Consumables (if any) costing less than \$1,000 per use.
- i) Reinstallation of consumables (if any) completed by two personnel in under 1 hour per each mile of braking length.
- j) Consumables (if any) may not damage the track or introduce hazardous waste cleanup requirements.

- k) Deceleration requirement; decelerate from velocities ranging from 1 to 3,000ft/s over a maximum distance of 10,000 feet
- l) Braking force requirement; maximum of 100,000 lbs reaction load on sled tailorable from 100% down to 10% over the entire braking distance.

PHASE I: Design, develop, and demonstrate feasibility of replacement braking mechanism for SNORT as outlined in the Description. Characterize climate dependent performance penalties if any. Develop software model to simulate braking performance. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Finalize, test, and demonstrate a full-scale prototype of the replacement braking mechanism. Test braking capability with representative sleds as well as adjustment, maintenance, and repair time. Develop the testing campaign in coordination with the Government. Incorporate braking simulation into the Government's sled-velocity calculation software.

PHASE III DUAL USE APPLICATIONS: Transition technology to platforms/industry after verifying the system meets program specific requirements and all the performance requirements as outlined in the Description.

Braking technologies have applications in the transportation and entertainment sectors. Transportation uses include various forms of rail transit systems. Entertainment uses are roller coasters and other rides that need braking.

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2. Jang, S.-M., Lee, S.-H., & Jeong, S.-S. Characteristic Analysis of Eddy-Current Brake System Using the Linear Halbach Array. IEEE Transactions on Magnetics (pp. 2994-2996). IEEE, 2002. <https://arc.aiaa.org/doi/abs/10.2514/6.2015-2163>
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4. Wang, P., & Chiueh, S. Analysis of Eddy-Current Brakes for High Speed Railway. IEEE Transactions on Magnetics (pp. 1237-1239). IEEE, 1998. <https://ieeexplore.ieee.org/abstract/document/1042435>

KEYWORDS: Eddy Current; Sled; Sled Track; Rails; Braking; Deceleration

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-024 TITLE: Augmented Reality Headset for Maintainers

TECHNOLOGY AREA(S): Human Systems, Information Systems

ACQUISITION PROGRAM: PMA251 Aircraft Launch & Recovery Equipment (ALRE)

OBJECTIVE: Design and develop an augmented/mixed reality headset device able to integrate with current Navy Information Assurance (IA) infrastructure and can be usable at the Organizational (O-), Intermediate (I-), and Depot (D-) levels of maintenance aviation activities for the Navy and Marine Corps.

DESCRIPTION: There are several efforts, ongoing and planned, to develop technologies and functions that allow for augmented/mixed reality (AR/MR) devices to be applied to Navy and Marine Corps Maintainer use cases. Several of these efforts have proven successful in being able to view maintenance procedures on Commercial-off-the-Shelf (COTS) devices and being able to connect maintainers to engineering subject matter experts (SMEs) to assist in complex and irregular maintenance actions. To enable these functions and all of the existing and future capabilities provided by MR technologies, a hardware asset that meets the requirements of the Navy and Marine Corps network [Refs. 3, 4] and cyber infrastructure is necessary.

Although several COTS headsets currently exist, the Navy and Marine Corps environmental, cybersecurity, and data infrastructure requirements are unique and not addressed or targeted by existing augmented reality hardware. Existing MR hardware hosts standard operating systems and require a wireless connection to the internet to access several of its applications and to enable several features. Furthermore, existing hardware does not allow for DoD Common Access Card (CAC) readers or any secure methods of accessing the device using multifactor authentication. The proposed solution needs to allow all functionality within the headset (i.e., spatial cognition, displaying indications, sensor input, etc.), with a target Field-of-View of 50 degrees or more, weigh no more than 600 grams, and operate without requiring a network connection or having location information available.

A headset hardware solution is needed that allows the AR technology to be applied to the Navy and Marine Corps Maintainer use case, without needing to make changes to the current infrastructure. To enable this, a device that meets environmental requirements at each of the maintenance levels is required. The device would need to be ruggedized and marinized, without interfering with the maintainers visibility during their maintenance action and would also need to contain a display that is viewable in different maintenance locations (i.e., restricted data areas, weather conditions, and lighting conditions including direct sunlight). Furthermore, the device would need to perform its functions for 6-8 hours continuously without recharging.

The conditions required are as follows:

MIL-STD-810G Environmental Conditions, Methods 501.5, 502.5, 509.5, 516.6
Display viewable in direct sunlight and during night operations
EMI Compliance: MIL-STD-461E

HERO Compliance: OD 30393 HERO Design Guide

A method of enabling two-factor authentication is necessary, since the device will contain secure data in the form of maintenance procedures, drawings, and models. Current COTS AR headsets do not provide a method for securely accessing the devices, other than entering a password.

Finally, the device host Navy security software on its operating system (OS), without reducing the functionality and performance of the actual device. Therefore, the OS would need to meet all of the cyber requirements of our operating systems [Refs. 3, 4], and be supportable for release of new versions and updates. Furthermore, the integration of the headset into the Navy security system should minimize the following latency sources: Off-host delay, Computational delay, Rendering delay, Display delay, Synchronization delay, and Frame-rate-induced delay.

A secondary objective would be for the software enabling this solution to be packaged hardware-agnostic, for use on different iterations and versions of AR devices. Existing COTS AR devices require connection to a third-party network to function properly. The Navy is looking for a device tailored to fit the use case of the Navy and Marine Corps maintainer.

PHASE I: Design and demonstrate feasibility of a solution to address the requirements in the Description. Provide an Analysis of Alternatives with several conceptual designs defining and addressing each of the requirements listed in this Description. The designs must show software architecture as well as plans for accomplishing the two-factor authentication. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design, develop, and demonstrate a prototype meeting the requirements in a lab or live environment. Work with the NAVAIR cybersecurity to ensure the development aligns with the cyber requirements and with a Navy internal development team to align the effort with software applications being developed and installed on this hardware solution. The hardware will be loaded with applications and will undergo functional testing, including Electromagnetic interference (EMI), environmental, and shock/drop tests.

PHASE III DUAL USE APPLICATIONS: Support the testing of the developed solution at Organizational, Intermediate, and Depot levels of maintenance sites for completion of test, and transition to appropriate end users.

This SBIR topic provides benefits to the private sector by opening up the market to a far more customizable mixed/augmented reality headset. Current COTS configurations are severely restricted in terms of cyber capabilities and environmental qualifications. A ruggedized headset can easily have applications in a number of more complex factory environments. Improvements to visibility in high lighting conditions has applications to all other COTS headsets. This solution will be used in the defense and maintenance industries, with the possibility of providing benefits to the healthcare and automotive industry as well due to the added security capability.

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2. Department of Defense Test Method Standard. MIL-STD-461E: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. EverySpec, 1999. http://everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-461E_8676/
3. Risk Management Framework (RMF) for DoD Information Technology (IT)F: http://www.dtic.mil/whs/directives/corres/pdf/851001_2014.pdf
4. Risk Management Framework: <https://rmf.org/>

KEYWORDS: Augmented; Mixed; Reality; Head-mounted display (HMD); Display; Headset

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-025 TITLE: Ship Rapid Damage Assessment System

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMS 407, Surface Ship Modernization. Robust Combat Power Controls FNC

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Ship Rapid Damage Assessment System to rapidly determine actionable information after a damage event occurs on board a naval vessel that will reduce the time and cost to effect repairs on that vessel.

DESCRIPTION: In order to facilitate the rapid repair of ships after major damage events such as grounding, collision, or battle casualty, it is critical to be able to immediately assess the location and extent of the damage. In addition, assessing the impact to ship mobility and its ability to provide resources, such as electrical power and cooling, in near real time is vitally important. Currently, critical time is lost while a damaged ship is transported to a shipyard where repair work will be performed. Only a fundamental visual and operational assessment of ship condition is evaluated to determine need for immediate return to a ship repair facility with no measures available to evaluate structural or electrical damage, which can propagate after a casualty event because of a lack of understanding of the ship's integrity. Rapid assessment through a Ship Rapid Damage Assessment System of the damage will allow for the pre-positioning of critical assets, the procurement of long lead-time items required for repair, and the initiation of other required planning activities taking place prior to the ship's arrival at the repair facility. The net effect is considerable shortening of the time that a Fleet asset is out of service after a major critical event.

It is anticipated that, in order to provide this capability, existing surviving data acquisition and sensor systems onboard naval platforms can be utilized in conjunction with the addition of new robust sensor systems and the development of advanced Artificial Intelligence (AI) reasoning methods that can synthesize the data provided from the sensor systems into a composite estimate of battle damage or other major casualties. This will provide information that is not easily determined but would have a significant impact on the time or cost to repair the platform if it were known in advance of the arrival of the ship at the repair facility. Early initial data collection contributes to advance planning and early information transfer to repair facilities, enabling cost and time-savings in production planning, parts ordering, and cost estimation. The proposed system must assess the location and extent of damage from grounding, collision, or battle casualty as well as the impact to mission and capability in near real time in order to facilitate the rapid repair of ships after suffering major damage.

The proposer will have to evaluate the problem of rapid damage assessment with the goal of determining what information is actionable and would serve to create efficiencies if it were available in the time between the occurrence of a significant damage event on board a naval platform, and the time it arrives at a repair facility. The Government will not provide data from damage events and it is the responsibility of the performer to obtain suitable data sets. The company will recommend test fixtures and methodologies to support performance, environmental, shock, and vibration testing and qualification.

It should be noted that the ship may not have power or other services available post a damage event. The proposed system must have the ability to be self-powered or adaptable to external power systems throughout the critical information chain required for an initial damage assessment.

Work produced in Phase II may become classified or the prospective contractor may require access to secure information to conduct its work. Note: The prospective contractor(s) must be U.S.-owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret-level facility and Personnel Security Clearances, in order to perform on advanced phases of the project as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and

its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of the contract.

PHASE I: Develop a concept for a Ship Rapid Damage Assessment System meeting the parameters identified in the Description. Demonstrate technical feasibility through modeling, analysis, and bench-top experimentation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Demonstrate the technology using simulated data generated by the proposer. Based on lessons learned in the technology demonstration, further refine, fabricate, and deliver a complete advanced prototype that will pass Navy qualification testing for demonstration and characterization of key parameters and objectives. Recommend test fixtures and methodologies to support performance, environmental, shock, and vibration testing and qualification. Working with the Navy, demonstrate the Ship Rapid Damage Assessment System capability on a relevant system to support improved system operations. Provide detailed drawings, code and specifications in Navy defined format.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use on current and future Navy ships. Develop the Ship Rapid Damage Assessment System for evaluation to determine its effectiveness in an operationally relevant environment. Support the Navy for test and evaluation to certify and qualify the system for Navy use.

Potential use of the system includes other Naval Ships, Coast Guard, and commercial ships. Other high integrity commercial and military systems requiring fail-safe operation can benefit from this technology.

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KEYWORDS: Battle Damage Assessment; Sensors for Ship Damage Assessment; Structural Health of Damaged Ships; Rapid Repair of Ships; Artificial Intelligence; Machine Learning

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-026 TITLE: Manufacturing Composite External Volumes with Enhanced Underwater Collapse Performance

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 397, COLUMBIA Class Submarine Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an ability to manufacture high-quality composite pressure housings for external volumes (EVs) with an enhanced hydrostatic pressure collapse performance by understanding how filament winding methods and materials can be used to control the collapse response.

DESCRIPTION: In order to adhere to Navy submergence requirements (MIL-STD-1688, MIL-STD-278, or other relevant commercial standard), all components and systems must be evaluated to assess their susceptibility to the underwater environment. Components external to submarine pressure hulls, such as EVs, are particularly difficult to evaluate due to the high potential for material flaws to cause catastrophic collapse under hydrostatic pressure loading. The catastrophic collapse of EVs can result in the release of a radiated pressure pulse that can negatively affect nearby components and other EVs. Composite materials provide unique characteristics and increased flexibility for application-specific customization. The Navy has successfully leveraged the benefits of composite materials for use as EV pressure housings, which are often used to isolate components from exposure to the harsh marine environment. The Navy seeks an enhanced understanding of how manufacturing methods affect material flaw distributions and subsequent collapse failure of EV composite pressure housings due to underwater hydrostatic pressure loading.

The Navy lacks a knowledge of how filament winding techniques (e.g., width of winding strip and overwrap frequency) and materials (e.g., glass fiber reinforcement strength) affect the quality and hydrostatic collapse response of composite pressure housings. To quantify part quality, non-destructive methods will be used to measure flaw distributions and document shape quality measurements. Manufactured composite pressure housings will be selected for hydrostatic pressure collapse testing to determine which methods and quality parameters have the greatest effect on housing failure. Additionally, to aid the Navy with numerical collapse predictions, manufacturing procedures will be developed to create flat filament wound material characterization samples, which are representative of the housing materials. Material characterization samples will also be assessed for quality and tested to better quantify the flaw distribution that is present in the as-manufactured housings. By identifying which manufacturing methods have the most control over the collapse pressure of composite housings and developing manufacturing methodology to create representative material characterization samples, the Navy will have enhanced control over the response and prediction of collapse for EVs with composite housings.

PHASE I: Investigate the effects filament winding methods, such as width of winding strip and overlapping frequency, have on housing quality. Cylindrical glass fiber reinforced composite pressure housings will be manufactured with a diameter and length between 6 inches and 36 inches. Only one- or two-part shapes (diameter and aspect ratio combinations) will be developed during Phase I, while multiple winding methods will be investigated. Part flaws will be quantified using non-destructive scanning methods (e.g., ultrasound) to measure size, distribution, and location of flaws. Shape quality will be quantified using techniques such as out-of-roundness and thickness measurements. Once high-quality manufacturing methods are obtained, with minimal flaws and acceptable shape measurements, a best practices and lessons learned guide to manufacture composite pressure housings will be developed. The Phase I Option, if exercised, will continue to investigate additional filament winding techniques that may result in high-quality, low-cost parts.

PHASE II: Building on lessons learned during Phase I, determine the effects of manufacturing composite housings with a variety of glass fiber types (e.g., E-glass, S-glass, S-2 glass, etc.). Quantify part and shape quality of the housings. Facilitate Navy performed hydrostatic collapse testing of the housings manufactured during Phase I to quantify how quality, winding method, and glass fiber properties influences the housing collapse performance. Develop a capability to manufacture flat filament wound material characterization samples. Execute instrumented quasi-static and high-strain rate characterization of the filament wound materials. Manufacture a variety of parts from small-scale to large-scale with the previously identified best manufacturing methods and materials, and collapse tested to provide evidence of how scale effects quality and performance. Expand manufacturing capabilities to EVs, which consist of other fiber types (e.g., carbon fiber) and hybrid designs (e.g., composite wrapped metallic cylinders) to add to the manufacturer's ability to produce a wide range of Navy EVs.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning this technology to a wide variety of other military and non-military undersea applications including, but not limited to, oil and gas extraction, exploratory work for deep-sea mining, and scientific exploration. These deep-sea activities are continually becoming more common due to decreases in terrestrial resources and improvements in marine technologies. As composite-housed components become more prevalent across all fields, the ability to design and manufacture them for increased safety by mitigating hydrostatic collapse is essential to continue safe human exploration and operations in the harsh environment of the deep sea.

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KEYWORDS: External Volumes; EVs; Submarines; Composites; Hydrostatic Pressure Collapse; Filament Wound Composite Shells

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-027 TITLE: Artificial Intelligence Software-Based Autonomous Battle-space Monitoring Agent for a Distributed Common Operational Picture Software Subsystem

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an Artificial Intelligence (AI) Software-based Autonomous Battle-space Monitoring Agent (SABM) with the capability to augment or assist combat systems console operators in maintaining Situational Awareness (SA) of tactically relevant changes occurring within the ship's Area of Responsibility (AOR).

DESCRIPTION: The current AEGIS Combat System implementation does not include a comprehensive distributed (that is, multi-platform) capability for capturing the complete battle-space operational, environmental, and tactical picture in a coherent integrated manner. Currently available commercial systems and software that might be considered for adaptation to partially address the Navy's combat systems requirement for advanced situational awareness (e.g., the FAA Air Traffic Control System hardware and software) are dated in their designs. Their ability to integrate, support, or coordinate with stand-alone (i.e., autonomous) DoD-sourced or 3rd-party software applications in a real-time manner is minimal or non-existent. Additionally, the currently available commercial technology mentioned above is limited in that it lacks the capability to track, identify, and manage complex air, surface, and subsurface entities and threats present in a combat environment. Since no viable commercial alternatives exist or can be adapted to address these needs, it becomes necessary for the Navy to pursue a different avenue of exploration.

The Navy needs an AI Software agent intended to function within the AEGIS Combat System (BL10 or later) and a Common Core Combat System (CCCS) prototype combat system implementation and associated Distributed Common Operational Picture (DCOP) subsystem. A new capability needs to be developed within AEGIS to present a Common Operational Picture (COP) to the combat system's watch stander. The capability will provide the watch stander with complete SA. The technology will include detailed engagement-quality track data, identification data from various sources, estimated platform sensor or weapons capabilities derived from organic and non-organic databases, and observationally-derived behavioral data for each tactically relevant entity within the battlespace. The subsystem must be modular in nature and support the sharing of the COP across all participating platforms within the battlegroup in a manner that insures the data coherence of the COP on every platform. In order for such an AI-based software application to function within AEGIS, a DCOP software subsystem must be integrated within the AEGIS Combat System, or alternately, a suitable set of ancillary data collection algorithms must be developed to acquire the relevant data needed for the AI algorithm from data sources currently available within the AEGIS Combat System.

An AI-based autonomous SABM, when operating within an appropriate CCCS Ecosystem software environment or equivalent, and when given data access to a CCCS DCOP implementation or AEGIS equivalent, will provide the Combat System (CS) watch stander with an autonomous SA monitoring capability focused on augmenting the ability to successfully execute the mission. SABM will perform analytical monitoring tasks utilizing data derived from a combat-system supported accessible DCOP subsystem capable of providing both detailed real-time observable and known historical parameters exhibited by all observable battle-space entities within the AOR. The solution technology must be an architectural model, software framework and Algorithm description, with an outline for a functional SABM implementation.

AI has significantly advanced with the development of "Deep Learning" algorithms [Ref. 4]. These algorithms have led to the commercial development and deployment of several software AI products, such as Siri, Cortana, and Alexa, which endeavor to assist individuals in accomplishing routine daily tasks with a minimum of confusion, reduction in required time, or specifically directed research. Implementing an autonomous software agent battle-space monitor within a CCCS/DCOP (or equivalent AEGIS-based) combat system that leverages currently existing AI algorithms similar to the ones mentioned above [Refs 2, 3] could be extremely advantageous. Such an autonomous agent, utilizing the development of new combat-systems focused AI-based analytical algorithms, will advance the ability of CS watch standers to monitor dynamically changing tactical environments. The autonomous

nature of such a software agent will allow it to function without the need for CS watch standers to constantly reconfigure the agent manually to adapt it to dynamically changing battle-space conditions.

Multiple independent SABM Agent instances, executing both within the organic ship CCCS Ecosystem as well as within non-organic CCCS Ecosystems (for example those hosted on other battle-group CCCS compliant surface platforms), should be capable of exchanging data and coordinating their analytical processes. Such analytical coordination and data exchange efforts should be capable of crossing surface platform computational boundaries (such as organic and non-organic coordination between surface platforms within the battlegroup) when necessary. The CS watch stander should have the ability to configure each SABM agent instance by identifying appropriate tasks and goals, configuring customized alerts, and defining behavioral traits and patterns which, when associated with existing battle-space entities, will help to identify potential ship threats. Each SABM agent instance should be capable of autonomously prioritizing ship tactical threats and, when coordinating with other organic and non-organic SABM instances, identifying and prioritizing threats and other battle-space AOR situational and environmental issues tactically relevant to the task group and mission.

The SABM architectural model, software framework, and AI Algorithm set will function within a software environment modeled on the CCCS/DCOP architecture and software framework.

Any architecture, software framework, or AI Algorithm set developed in response to this topic will be modular in nature and utilize open systems-based design principles and standards [Ref. 5], and well-defined and documented software interfaces. Architectural implementation attributes will include scalability and the ability to run within the computing resources available within the AEGIS Combat System BL10 or later hardware-computing environment.

The requisite algorithms, as well as any hosting system requirements, should be architected around modular principles with eventual utilization of the CCCS Ecosystem CS Application environment and DCOP battlespace situational awareness subsystem, and eventual implementation and integration within the AEGIS Combat System (BL10 or later). It should be noted that any potential Phase II and Phase III extensions would potentially require such implementation constraints.

The software implementation of the prototype SABM agent shall be capable of installation and integration within a prototype CCCS Ecosystem with access to a prototype DCOP battle-space situational awareness subsystem (or AEGIS equivalent). The target execution environment will be hosted on a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (that is, no critical dependencies on network-based remotely hosted resources, save for sensor data emulators and network-based connections to other running CCCS instances). The prototype SABM agent implementation will demonstrate the following: First, it must demonstrate the ability to successfully monitor the battlespace DCOP and successfully perform DCOP data/potential threat analyses. Second, it must develop ship and battle-group-prioritized tactical threat lists and identify tactically relevant battle-space issues. Third, it must generate associated watch stander alerts. Lastly, it must demonstrate agent coordination across 2 or more independently executing SABM instances, one of which will be hosted on a separate computing platform hosting an independent (but network accessible) CCCS Ecosystem instance.

Any prototype must demonstrate that it meets the capabilities described above during a functional test to be held at an AEGIS or Future Surface Combatant (FSC) prime integrator supported Land Based Test Site (LBTS) identified by the Government, and capable of simulating an AEGIS BL9 compatible or newer combat system hardware test environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design a concept outlining the architectural model, software framework and AI-based algorithms needed to implement an Autonomous SABM. Establish feasibility through modeling and analysis commensurate with the design requirements outlined in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design, develop, and deliver a prototype software implementation of a SABM agent. Demonstrate the prototype meets the parameters of the Description during a functional test to be held at an AEGIS or Future Surface Combatant (FSC) prime integrator-supported Land Based Test Site (LBTS) provided by the Government, representing an AEGIS BL9 compatible or newer combat system environment.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the SABM agent software to Navy use. Integrate the SABM agent into a prototype combat system implementation, consisting of one or more of the following: AEGIS BL9 or greater; CCCS experimental prototype, implemented on a virtualized hardware environment within an AEGIS hardware compliant land-based testbed.

This capability has potential for dual-use capability within the commercial Air Traffic Control system in the future development of an air traffic “common operational picture” monitor, capable of predicting and preventing collision events in complex traffic control patterns.

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KEYWORDS: Maintain Situational Awareness; Autonomous Situational Awareness Monitoring Capability; Combat-systems Focused AI-based Analytical Algorithms; Autonomously Prioritizing Ship Tactical Threats; Software Framework; AI-based Software Application

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-028

TITLE: Surfzone Optical Imaging

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMS 495, Mine Warfare Systems Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a capability to image through waves and ocean turbulence in shallow coastal waters from small surface ships and/or airborne platforms.

DESCRIPTION: The Navy and Coastal Battlefield and Reconnaissance Analysis (COBRA) program is seeking innovative approaches to perform optical imaging in surf zones, and through the air water interface. Optically-based mine detection sensors face exacting challenges in forming images of sufficient quality for accurate object detection and discrimination through the air-water interface. Current technical approaches are unable to avoid the effects of the surface on target imagery. This R&D solution will mitigate the surface effects prior to and/or in the DSP (Digital Signal Processing) and significantly improve mission effectiveness. Specifically, the presence of non-regular and breaking waves result in caustic bands and significant image distortion due to lensing/defocusing, and scattering and opacity due to white caps and foam. All of these effects are time variant, creating an extra level of complexity. This topic is soliciting hardware and software approaches to addressing these challenges. Software and hardware solutions will be form-fit-function compatible with the COBRA Mine Warfare (MIW) sensor. Successful proposals may address either or both lensing/defocusing and/or scattering, although priority will be given to solutions that address the full problem. Hybrid approaches are expected for the full solution. For example, physical models have been developed and used to correct for caustic bands and lensing/defocusing; however, they do not explicitly address scattering due to surf and foam. A hybrid approach may combine such a physical model with techniques developed for imaging in a scattering medium such as structured illumination or pseudorandom code modulation.

The figure of merit should be image quality; specifically, the approach must maintain a sufficiently high modulation transfer function at relevant spatial resolution for the intended application. The spatial resolution will be equal to or greater than current the COBRA Block I sensor. Detection algorithm development is not part of this opportunity; however, some knowledge of surf zone mine detection algorithms is needed to validate the approach. The through-surf imaging technique will be integrated with existing mine detection algorithms to baseline performance against uncorrected imagery. Relevant depths are approximately a few to 10 m, and image acquisition rate must be the video frame rate of relevant sensors. Size, Weight, and Power (SWaP) shall be compatible with the COBRA sensor.

Successful Phase I and Phase II efforts will produce a capability that is a suitable pre-planned product improvement (P3I) for COBRA as an engineering change proposal as well as a potential upgrade to other existing optical airborne mine detection platforms.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the

United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for surf zone imaging through waves and ocean turbulence in shallow coastal waters from small surface ships and/or airborne platforms. Demonstrate the feasibility of the proposal approach through a combination of analytical modeling and bread boarding activities with the goal of validating the analytical model through breadboard testing. Identify areas of technical risk and a path to retiring each risk. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design, develop, and deliver an advanced prototype for surf zone imaging. Conduct functional testing of the prototype-imaging sensor in a contractor laboratory environment and facilitate subsequent developmental testing in a representative field environment (i.e., in a surf zone). Integrate the data output and/or DSP algorithms into existing automated detection algorithms for performance assessment. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Government in transitioning the surf-imaging tool for Navy use. Dual use opportunities include coastal and surf zone survey and mapping and coastal search and rescue operations.

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KEYWORDS: Surf Zone Imaging; Fluid Lensing; Through Wave Imaging; Mine Detection; Structured Illumination in I's a Scattering Medium; Pseudorandom Code Modulation

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-029 **TITLE:** Affordable Radar Antenna with Electronic Elevation Scan and Multiple Beams

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PEO IWS 2: AN/SPS-49 Radar Tech Refresh Program.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of

sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a new antenna for the AN/SPS-49 radar that incorporates electronic beam steering in elevation, provides for multiple elevation beams, and incorporates the means for shaping of both transmit and receive beams to improve high elevation radar coverage.

DESCRIPTION: The AN/SPS-49 is a venerable radar deployed widely throughout the Fleet. In such legacy systems, life-cycle cost reduction is a constant goal and maintenance cost is the key driver. Being a rotating radar, periodic overhauls of the antenna are required to replace worn or weathered parts, repair physical damage, re-seal, and re-paint. Little can be done to avoid this. However, the SPS-49 antenna incorporates one feature that might be simplified by the introduction of innovative technology.

The SPS-49 antenna is a parabolic reflector fed by a H-plane sectoral horn. The reflector is asymmetric with the wide dimension aligned horizontally and the H plane of the horn aligned vertically with the narrow dimension of the reflector. Elevation scan in the SPS-49 antenna is accomplished through mechanical drives, powered by electrical motors that “rock” the entire antenna assembly to compensate for ship motion (roll and pitch). This mechanical assembly adds weight, is prone to wear, and requires robust electrical controllers located below deck. Furthermore, the antenna rotary joint must pass DC electrical power in addition to the radio frequency (RF) transmit power. Repair and replacement of these components contribute greatly to the overall SPS-49 sustainment cost. If the antenna elevation could be varied through electronic means, electro-mechanical parts would be eliminated, weight could be reduced, and the life-cycle cost of the radar would decrease, even though the antenna would still need to rotate.

The Navy seeks an innovative rotating antenna technology, compatible with the SPS-49 radar that provides simple, non-mechanical elevation scan over a limited range. The “antenna” in this case is considered only that (rotating) portion above the pedestal and rotary joint that forms and transmits the beam. The most mechanically and electrically simple, lightweight, and affordable solution that meets the performance requirements is desired. In addition to meeting the existing SPS-49 elevation requirement, a desired solution would be for the electronic elevation scan technique to also permit implementation of multiple elevation beams. A minimum of two elevation beams are required to allow elevation estimation against low-to-medium altitude targets, and appropriate beam shaping will be needed to achieve the required cosec² coverage.

As a goal, more than two elevation beams are desired if this can be achieved while meeting the requirements for performance, beamforming, size, and weight described below. It is understood that, in meeting these objectives, the addition of duplexers and other beamforming electronics (as part of the antenna) may be necessary. However, if incorporating active elements, the antenna should not introduce harmonics or inter-modulation products in the transmitted signal. Examples of antennas that could enable electronic steering in the elevation plane (and potential implementation of multiple elevation beams) include the use of a vertical array of “row-boards” with individual phase control (by row) and corporate feed, phased array feeds with a main reflector surface, reflective printed-element arrays (“reflect arrays”) with element-level electronic phase shifting illuminated by a primary feed horn, and transmissive printed-element arrays (“transmit arrays” or “array lenses”) with element-level electronic phase shifting illuminated by a primary feed horn. While examples of these antenna types have been demonstrated before, the sheer size and power of the SPS-49 antenna and its requirements for beam shape and elevation scan represent a significant technical challenge, especially in light of the desire for a lightweight, rugged, and yet affordable design.

The current SPS-49 antenna reflector is approximately 24 feet wide and 8 feet tall. The weight of the rotating assembly (reflector, feed, and supporting structure) is approximately 2000 pounds. Due to ship structural considerations, i weight and overall size cannot be exceeded. At a minimum, the desired antenna must transmit across the band 850-950 MHz with a total elevation scan of ± 25 degrees. The peak power supplied to the antenna at the output of the rotary joint is 300 kW maximum (at 4% duty cycle) and the desired aperture efficiency (relative to the power supplied at the rotary joint) is 65% minimum. The transmitted beam should have a 3 dB beam width in

the azimuthal direction of no more than 3.5°. In the elevation plane the combined transmit and receive patterns shall provide cosec² coverage to 30 degrees. The antenna gain shall be at least 28 dB (measured relative to the power supplied by the rotary joint). Azimuthal side lobes shall not exceed -30dB (relative to the peak antenna gain) in the region of 10° on either side of the main beam. Beyond 10° from the main beam, side lobes shall not exceed -15 dBi (relative to isotropic). The interface to the antenna is through a rotary joint, which is not considered part of this effort. Proposed designs should assume a waveguide feed and an available communications path (analog or digital) to control the elevation scan. If the proposed technology will incorporate electronics integrated within the antenna assembly, low voltage power (nominally 24 V maximum) can also be assumed available through the rotary joint. However, active liquid cooling is unavailable.

A prototype antenna is desired and, should a reflect array, transmit array, or similar type antenna be selected, the feed is considered an integral part of the design. However, as a full-size prototype will likely be prohibitively expensive, a partially populated antenna array is acceptable, provided that the full antenna performance can be determined through extrapolation (by analysis, modelling, and simulation) of measured prototype data. Likewise, cost, size, and weight shall be extrapolated from the partially populated prototype. The prototype need not be subjected to environmental testing (which is also prohibitively expensive), but the prototype design shall anticipate the need for environmental enclosures (radomes, gaskets, seals, etc.) and structural strengthening for shipboard operation and rotation at 12 rpm when determining final size, weight, and cost. Estimates of weight shall include a mechanical structure capable of withstanding high winds (90 knots operational and 120 knots without damage) and icing in accordance with MIL E 16400 (and without sustaining damage with ice loading of seven pounds per square foot of antenna surface).

PHASE I: Propose a concept for an affordable and lightweight antenna meeting the objectives and performance parameters described above. Demonstrate feasibility through a combination of analysis, modelling, and simulation. The feasibility analysis shall include predictions of performance parameters, size, weight, and cost described in the Description. The Phase I Option, if exercised, will include development of initial design requirements, performance specifications, and a capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype (or partially populated array prototype) that meets the requirements defined above. Ensure that the prototype should be sufficiently complete (populated) such that measured data is meaningful and can be extrapolated (using analysis, modelling, and simulation) to predict the performance of a full prototype antenna. The size, weight, and cost of a full, qualified (deployable) antenna shall also be extrapolated from the data obtained from the prototype design. At the conclusion of Phase II, the prototype antenna (and supporting data) will be delivered to the Government for additional testing, design analysis, and to facilitate future systems integration.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use. This is expected to entail the finalization of specifications, completion of a final design, production of a drawing package, selection of materials, testing, and support during system and ship integration. The final antenna will be tested according to the SPS-49 system specification and applicable military specifications for shipboard equipment. The final product will therefore be a complete antenna, suitable and qualified for replacement of the existing SPS-49 antenna.

The technology should also find additional applications for other surface shipboard radar systems and possibly land-based military radars. Potential commercial applications include weather and air traffic control systems.

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KEYWORDS: Reflect Arrays; Transmit Arrays; Array Lenses; Phased Array; Electronic Elevation Scan; Electronic Phase Shifting

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-030 TITLE: Automated Configuration Deployment and Auditing

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO-IWS5: Surface ASW Combat System Integration, Surface ASW System Improvement

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an architecture that automates capabilities within Naval Control Systems (NCS) to minimize operator-associated cybersecurity vulnerabilities and streamline rapid fielding of modular capability updates.

DESCRIPTION: Naval Control Systems (NCSs) are comprised of a complex combination of hardware systems, operating systems, and software elements. The installation and configuration of the tactical software, to include operating system, middleware, and applications, is currently a time-consuming, operator-intensive, and error-prone process. Current commercially available solutions do not meet the standards necessary. The Navy needs an innovative process to automate installation, configuration, application deployment, auditing, and reporting of system status within a complex NCS. This process will need to align with the Navy's desire to deploy incremental capability improvements to ships at sea in a manner that maintains secure cyberspace posture and weapons safety. It is envisioned that the solution will include software and an architectural construct.

The current operator-intensive installation process can result in the introduction of cybersecurity vulnerabilities or misconfigurations that affect the performance and effectiveness of the NCS due to inadvertent operator error or the reduction of security controls during the execution of administrative tasks associated with installation. The possibility of operator error also introduces configuration uncertainty. This configuration uncertainty prohibits rapid introduction of modular capability updates.

Industry has demonstrated significant productivity improvements by migrating to automated tools such as Ansible [Ref. 1] to reduce complexity and enable DevOps initiatives. However, industry tools do not account for the rigor associated with weapons safety, with which the Navy must be concerned. Automated tools reduce the cybersecurity vulnerabilities associated with operator-intensive installation processes.

The desired innovation will be able to completely install and configure a tactical capability from a 'bare-metal' state while providing objective quality evidence (OQE) of the installation and periodic auditing of the configuration after installation. The desired innovation will utilize existing Navy-specified system and sub-system components to provide a fully functional operational capability with minimal operator involvement in an automated and repeatable process. The innovation desired should also demonstrate the capability to ingest a modular update to the NCS to allow agile deployment of capability improvements and bug fixes.

The correctness of the automated software deployment and auditing will be measured by objective assessment of proper operating systems configuration, configuration of software applications, and proper allocation of network device operating systems and configurations. By taking an 'infrastructure as code' approach [Refs. 2-5], the desired innovation will ensure the installed configuration is properly version controlled. The automated approach will reduce the need for operator-intensive interaction during installation and configuration, ensuring a repeatable process and reducing the opportunity to introduce cybersecurity vulnerabilities or misconfiguration.

The automated system will produce a logged record of the installation and therefore provide OQE of the installation results and auditing and reporting of current system configuration to permit identification of configuration drift. This will reduce costs associated with maintenance, manning, and operations associated with configuration management and cybersecurity.

The initial Naval Control System transition for this technology will be the AN/SQQ-89 Anti-Submarine Warfare Combat System Element, which fields with different Combat Systems on Cruisers, Destroyers, Frigates, and the Littoral Combat Ships. Testing of the automated system will take place under the cognizance of the Navy at the AN/SQQ-89 Prime Integrator site, currently LM RMS at Manassas, VA.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Define and develop a concept for innovative software and its associated architecture that will enable the automated installation and configuration of all components of an example NCS. Demonstrate the feasibility of the concept in meeting the parameters in the Description by modeling and simulation or analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build the prototype in Phase II.

PHASE II: Develop and deliver a prototype of the software and its architecture for automated installation and configuration of NCS capabilities. Demonstrate the prototype performance through the required range of desired performance attributes given in the Description. Testing and demonstration will occur at a Government-specified facility.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to Navy use. The prototype will provide support for Navy specified NCSs and the associated system engineering activities of the program.

The architecture developed has a high potential for dual use in systems that require a repeatable, automated installation and configuration process to reduce the introduction of potential cybersecurity vulnerabilities and misconfiguration in complex, critical systems, such as municipal infrastructure for power (nuclear, electrical) and connectivity. Automated installation and configuration that creates ‘infrastructure as code’ is of high interest to companies like Amazon and Google.

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KEYWORDS: Cybersecurity; Automated Software Deployment and Auditing; Agile Deployment; Naval Control Systems; Combat Systems; DevOps

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N201-031 TITLE: Digital Mission Planning Tools for Air Cushion Vehicles

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PMS 377, Amphibious Warfare Program Office, Ship-to-Shore Connector.

OBJECTIVE: Develop a mission-planning tool implementing Artificial Intelligence (AI) and machine learning (ML) for afloat mission data collection and analysis.

DESCRIPTION: The Ship-to-Shore Connector (SSC) is an Air Cushion Vehicle (ACV), or “hovercraft”, providing amphibious transportation of equipment and personnel from ship-to-shore and shore-to-shore.

The ACV crews need a Mission Planning System (MPS) to support mission planning and post mission analysis for ACV operations that is integrated and synchronized with a lightweight and easy to use handheld tool for use onboard the craft. The LCAC Mission Assessment Tools (LMAT) along with Mission Planning Software (MPS)/Personal Digital Assistant (PDA) will give the Navy Landing Craft, Air Cushion (LCAC) crews the ability to adapt more quickly to requests by the United States Marine Corps (USMC) and accommodate rapidly changing mission parameters such as fuel burn rate and endurance with ease. The MPS will be able to develop and Integrate Mission Plans, Communication Plans, and selected navigation charts to the craft. The MPS should be able to process and display post mission data extracted from the craft. MPS will be a Windows10-based application that will provide mission planning, briefing, and debriefing support to LCAC operational crews and amphibious planning staffs. MPS will also support mission execution by generating electronic mission data packages for use in interfacing the craft's on-board navigation and communication systems. Mission data packages will include Digital Nautical Charts (DNC), operational, navigational and training overlays, mission navigation plans, engine performance and communication plans.

The capability to develop mission plans will support the gamut of Service Life Extension Program (SLEP) and LCAC 100 Class operations, ranging from single craft proficiency-training missions to complex multi-mission, multi-wave amphibious assault operations. This support will include proper route planning, environment-based predictive performance computations to ensure mission viability and conformance to approved operational envelopes, and post-mission analysis of executed missions through playback of recorded navigation, engineering, and communication data.

The system will provide a means to conduct off-craft mission planning and to perform post mission analysis of craft recorded data. Mission planning for ACVs currently takes over four hours and requires use of multiple volumes of manuals and data for implementation and years of training to do properly. Application of AI and ML to the solution will condense the mission planning to a single application based on a series of inputs, which include environmental conditions, cargo, distance, and crew day (calculated Main Engine start to Main Engine stop), greatly decreasing the amount of time needed to plan a mission and allow for greater flexibility when mission requirements change. There are unique sets of performance data for the SLEP LCAC with deep skirt as well as different power settings and engine performance tables for ETF40B engines which include fuel burn rate and endurance. This performance data will be contained within the software installed on each PDA and Land Based mission planning computer system. The MPS/LMAT will allow removal of the bulk of the performance data from the Safe Engineering and Operations (SEAOPS) Volumes and eliminate the complex iterative hand calculations within the planning process.

The MPS software will replace SLEP LCAC systems that are currently in fleet use and contains the following applications:

- Vehicle weight database
- LCAC Weight Allocation Calculator
- Crew Day Calculator
- Electronic Version of SEAOPS OCP Mission Planning Checklist
- LCAC Performance and Analysis System (LPAS)/MPS Computers

The LMAT will give the Navy LCAC crews the ability to adapt more quickly to requests by the USMC and accommodate rapidly changing mission parameters with ease. This is critical for an ACV, which has a defined balance of fuel and payload versus range.

Software developed must be executable on Government-approved Navy/Marine Corps Intranet (NMCI) compliant computing devices and integrated into standard NMCI software loads or software compatible with NMCI systems. Software must be adaptable by Navy System Subject Matter Experts to meet emerging needs and changes to mission priorities. The handheld tool will allow for greater flexibility by being able to be carried with the crew for on-the-fly mission changes. Prototype software is to be loaded on an ACV or appropriate test platform for human factors and regression testing at Naval Surface Warfare Center Panama City Division (NSWC-PCD).

PHASE I: Develop a concept for an MPS/LMAT for ACVs with an onboard handheld device that meets the requirements of mission planning tools for the unique sets of performance tables/data for the LCAC 100 Class with Advanced skirt, and SLEP LCAC with deep skirt as well as different power settings and engine performance tables for MT7 andETF40B engines. Ensure that the performance data will be contained within the software installed in a

PDA-type device and the land-based desktop system, which will allow removal of the bulk of the performance data from the SEAOPS Volumes and eliminate the complex iterative hand calculations within the planning process. Incorporate latest data from all SEAOPS Volumes into PDA as described above. Demonstrate the feasibility of the concept in meeting Navy needs and demonstrate that the MPS concept can be readily and cost-effectively manufactured through standard industry practices by proof testing and analytical modeling. The Phase I Option, if exercised, should include the initial layout and capabilities to build the prototype in Phase II.

PHASE II: Develop and deliver a prototype MPS/LMAT with an onboard handheld device that meets the intent of the Description. Demonstrate the prototype on an ACV or appropriate test platform for human factors and regression testing at NSWC-PCD and support the testing. Evaluate the prototype to determine its compatibility with current craft layout and ability to perform to requirements. Use evaluation results to refine the prototype into a design that will meet the LCAC SLEP and LCAC 100 class Specifications. Prepare a Phase III development plan and cost analysis to transition the technology to Navy use. Provide detailed drawings, code and specifications in Navy-defined format.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the MPS for use on the Navy ACV program. Refine the design of the MPS, according to the PMS 377 Phase III SOW, for evaluation to determine its effectiveness in an operationally relevant environment.

The SSC MPS will have private sector commercial potential for craft of this scale operating in the near-shore or on-shore environment. Commercial applications include hovercrafts, airplanes, helicopters, ferries, the oil and mineral exploration/retrieval, automotive, and cold climate research and exploration.

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KEYWORDS: Ship-to-Shore Connector; Air Cushion Vehicle; Mission Planning Software; Machine Learning; Hovercraft; Artificial Intelligence; ACV; ML; AI

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N201-032 TITLE: High-Efficiency Wideband Linear Power Amplifier

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: Program Executive Office (PEO) Integrated Warfare Systems (IWS) 6.0; Command & Control (C2) Director

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a high-powered Radio Frequency (RF) linear power amplifier that enables efficient, linear operation with multiple simultaneous signals across a wide instantaneous bandwidth capable of operating in an active antenna array.

DESCRIPTION: Current Navy directional, tactical communication networks operate in a one beam at a time fashion with each message exchange assigned separate time slots. This limits network performance and spectral usage. The next generation of communication networks will use multiple simultaneous beams to leverage the spatial dimension in order to establish multiple communication links simultaneously in different directions. To achieve the major networking advantages of multi-beam operation (discussed below) enabled by digital array communications technology, power amplifiers will need to be developed that do not generate unacceptably high levels of interfering nonlinear effects when multiple communications signals are transmitted through them simultaneously. Current state-of-the-art amplifier designs are challenged to achieve acceptable levels of linearity performance without significant reductions in RF power, bandwidth, and power-added efficiency. Due to the reduced link ranges and allocated bandwidths of commercial communications, there is little investment to meet the metrics required for Navy operation.

Linearity together with power, bandwidth, and efficiency enables multichannel Transmit (Tx) capability. This, in turn, yields increased network throughput and decreased latency. High linearity also enables new, modern waveforms that further improve throughput. Improved throughput is needed to support the increasing network sizes; the growing emphasis on joint, cooperative, and net-centric technologies; as well as the proliferation of Unmanned Aerial Vehicles (UAVs) and other persistent surveillance platforms with their high throughput requirements. The resulting increased throughput will enable the flow of more data and growth in new mission areas such as Ballistic Missile Defense and Electronic Warfare. The decreased latency will enable new and compressed kill chains against advancing threats as well as larger networks. The Navy needs a technology that provides simultaneous, multichannel Tx operation. This will enable the warfighter to expand and refine the battlespace through improved and expanded network functionality.

A solution is needed in the area of high-powered RF linear power amplifier. Advanced techniques such as those described in [Refs. 1-3] will be needed to attain the targeted performance metrics. Current commercially available power amplifiers do not meet the combined power, bandwidth, linearity, and efficiency performance needed for military, multichannel operations.

The prototype amplifier solution must demonstrate the following performance metrics: (1) The amplifier will transmit M-ary Continuous Phase Frequency Shift Keying (CPFSK) and Orthogonal Frequency Division Multiplexing modulations and up to 4 simultaneous signals located in C-band (4 GHz to 8 GHz). The instantaneous bandwidth of these signals will be relatively narrow compared to the operational bandwidth of all C-band. 8 is a stretch goal for the number of simultaneous signals. (2) The peak power output by the power amplifier should be selectable from 36 dBm to 46 dBm in 2 dB steps. (3) The goal for the Error Vector Magnitude (EVM) is 2% or less. (4) The output third order intercept should be more than 55 dBm. (5) The goal for the power-added efficiency is 55% or more. (6) The goal for the power gain is 45 dB. All performance metrics should be met while operating with an output Voltage Standing Wave Ratio (VSWR) between 1:1 and 2:1 in the architecture.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating

Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Define and develop a concept for a high-efficiency wideband linear power amplifier. Demonstrate the concept can feasibly meet the Navy requirements as provided in the Description. Establish feasibility by a combination of initial analysis and modeling and if possible, through demonstration on existing hardware. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II. Develop a Phase II plan that includes prototype testing, evaluation, and demonstration.

PHASE II: Develop and deliver a prototype power amplifier that demonstrates the performance parameters outlined in the Description. Validate the prototype through comparison of model predictions to measured performance.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Further refine the prototype for evaluation to determine its effectiveness and reliability in an operationally relevant environment. Support the Navy in the system integration and qualification testing for the technology through platform integration and test events to transition the technology into PEO IWS 6 applications for simultaneous communications links to improve and expand tactical network functionality.

High-powered RF linear power amplifiers will have direct application to private sector industries that involve directional communications between many small nodes over large areas. These applications include transportation, air traffic control, and communication industries.

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KEYWORDS: Linear Power Amplifier; Power Added Efficiency; High-powered Radio Frequency; RF; Multibeam Operation; Digital Array Communications; Spatial Dimension

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N201-033

TITLE: Real-Time Adaptive Data Model and Dynamically Extensible Markup Language for Distributed Common Operational Picture

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a real-time extensible and evolvable Distributed Common Operational Picture (DCOP) battlespace data model and associated descriptive battlespace data model markup language to improve command and control.

DESCRIPTION: The current AEGIS combat system implementation does not include a comprehensive distributed (i.e., multi-platform) capability for capturing the complete battlespace operational, environmental, and tactical picture in a coherent integrated manner. Currently available commercial systems and software that might be considered for adaptation to Navy needs (e.g., the FAA Air Traffic Control System hardware and software) are dated in their design, and lack the flexibility and track capacity required to adequately address Navy tactical needs. Specifically, currently available commercial technology is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in the DoD environment. A new capability is needed within AEGIS to present a common operational picture (COP) with complete situational awareness to the combat system watch standers. In order to support the development of such a COP subsystem, an innovative design is needed for a real-time adaptive data model of the battlespace, capable of supplying fire-control quality data to combat systems software applications. Development of such a data model will require achievement of dynamic on-the-fly run-time variation capability requirements critically necessary to successfully perform the mission within a rapidly changing combat scenario. The subsystem architecture should have the capability to provide engagement quality real-time track data to any combat systems application, which makes use of the services provided by the subsystem.

Sources of data may include identification data, estimated platform sensor and weapons capabilities, and observationally-derived behavioral data for entities within the battlespace. The subsystem must be modular in nature, and support sharing of the COP across all warfighting platforms within the battlegroup in a manner which insures the data coherence of the COP on every platform to the greatest extent possible.

The DCOP architectural model is needed and must have a common, expandable, and evolvable data model that supports the relevant metric set for any potential battlespace entity. An "evolvable" data model architecture should have the intrinsic capability to support any later addition, extension and/or modification without the requirement of extensively rewriting or scrapping previously developed code. The DCOP data model, including all its constituent software structures and component data elements, should, when taken in total, be capable of quantitatively and qualitatively describing the tactical and operational characteristics of all battlespace entities. This includes friendly, hostile, and neutral (i.e., non-combatants) within the host combatant's Battlespace Area of Responsibility (AOR). It also includes any tactically relevant surface, subsurface, underwater, air and ground sensors, and weapons systems with their associated data and control streams capable of having an impact within the scope of the DCOP Battlespace AOR. The DCOP data model must also be capable of supporting data structure components and associated data fields enabling multi-platform data synchronization, access control, time tagging, and data senescence. Since it will not be possible to completely capture all relevant parameters for newly emerging

combatant entities, sensors, or weapons systems, the data model must be dynamically evolvable and extensible (at run time) to provide for the emergence of previously unknown battlespace entities and their associated operational and tactical parameters. This combination of an overarching battlespace scope, a real-time non-disruptive data model, and structure content adaptability/evolvability, as well as multi-platform data synchronization support, are required for implementation of a DCOP capability within the fleet.

A Distributed Data Model Markup Language (DDML) will be developed to provide a software data structure design tool for DCOP, and a well-defined and concise documentation mechanism for all data structures making up the DCOP data model. The DDML will implement a dynamic, evolvable, and extensible descriptive linguistic construct capable of capturing the contents and structure of all DCOP data model constituent software structures and associated component elements as described above. The DDML must consist of a human-readable / machine-readable text-based (ASCII/Unicode compliant) descriptive language construct supporting linguistic components and structures roughly based on the Extensible Markup Language (XML) 1.0 Open Standard. The intent of developing the DDML is to provide both a software data-structure design tool for DCOP, as well as a well-defined and concise documentation mechanism for all data structures making up the DCOP data model as a whole. The DDML will provide a development tool, which will assist in both initial creation as well as any future maintenance, expansion, and adaptive evolution of the DCOP data model. This will enable the data model to capture operational and tactical characteristics of future battlespace entities not yet encountered or envisioned.

The DCOP architecture should be capable of supporting the ability to allow the successful modification of DCOP data structures within an operating software environment. It is also critical that any data model changes made within an operating software environment can be accomplished without significant negative impact on currently executing software accessing the DCOP data model. Specifically, run-time modification of the DCOP data structures should be possible without: (a) requiring the running software to be paused or cease operation; or (b) requiring the need to restart/reload the system.

Both the DCOP data model and its associated DDML descriptive language architecture shall be well documented and conform to open systems architectural principles and standards. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS combat systems BL10 or later environment.

The DCOP data model should initially include operational and tactical parameters, maneuvering capabilities, sensors, weapons, and off-board tactical and operational data sources (Unmanned vehicles, Satellite links, etc.). Focus will be on commonly encountered battlespace entities (air, surface, and subsurface platforms) and their respective associated parameters (radar, sonar, and EW track data).

The parsing application may be written in either C++ or Java and be capable of running in both 64-bit Windows (Version 10 or later) and Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environments as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources). The prototype DDML parser will demonstrate the following: (i) The ability to generate C++ data structure analogues to DDML linguistic components, and assemble them into overarching or composite data structures, each of which aligns to an associated battlespace entity; and (ii) The ability to non-destructively modify and update currently existing data structures within an operational DCOP environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design, develop, and deliver a concept for a real-time extensible and evolvable DCOP battlespace data model and associated descriptive battlespace data model markup language. Establish the concept through evaluation of the ability of the proposed model. Establish that it can successfully capture all tactical and operational battlespace

parameters as detailed in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype software DDML parsing application capable of generating data structures compatible with the C++ programming language and compliant with the requirements outlined in the Description. Use evaluation and test results to refine the prototype into a revised design that will meet Navy requirements. Develop and propose a Phase III Development Plan to transition the technology to Navy.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Implementation will include the integration of the DCOP data model for evaluation to determine its effectiveness in an operationally relevant environment at an AEGIS test site or test bed.

This technology has potential within the commercial Air Traffic Control system in future development of an air traffic “common operational picture” capable of handling complex traffic control patterns.

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KEYWORDS: Battle-space Data Model Markup Language; Extensible Markup Language; Distributed Common Operational Picture; Battlespace Data Model; Time-tagging and Data Senescence; Dynamically Evolvable and Extensible Data Model

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-034 TITLE: Low-cost, Expendable Surface Ship Threat Countermeasure

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMS 415, Undersea Defensive Warfare Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual

use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and develop a combined, compact, multi-function, lightweight, expendable, low-cost surface ship countermeasure capable of countering ever-increasing adversarial threats.

DESCRIPTION: All key U.S. Navy surface combatants require expendable countermeasure protection from adversarial torpedoes. The current Program of Record (PoR) uses submarine variant countermeasures for surface ship deployment, of which the submarine devices are overdesigned for surface ship requirements (i.e., temperature, shock, hydrostatic pressure). The Navy desires to tap into existing innovative form-factor reconfiguration and/or miniaturization capabilities and develop a lower-cost surface ship countermeasure that meets the surface ship environmental requirements while maintaining the notional acoustic and functional requirements of the current acoustic device countermeasure (ADC) Mk 2 Mod 6. Key surface ship environmental requirements that the device must withstand include, in general, resiliency to temperature shock, shipboard-launched water impact, and hydrostatic pressure up to 250 feet depth. Further testing details are listed below. It is expected this redesign of the existing submarine countermeasure adopted for surface ship use will reduce unit item cost while reducing overall lifecycle costs compared to the existing PoR. As a goal, a 20% to 25% reduction in unit cost, and a similar lifecycle cost reduction, is desired to facilitate installation aboard a wider range of surface platforms. As an added benefit to the warfighter, the devices ultimately resulting from a successful SBIR effort will not only provide the same mission capability and performance, but also have the potential of providing an innovative sailor-friendly form-factor.

In terms of test and evaluation throughout the Phases of this SBIR topic, Phase I is intended to develop a concept for an end-to-end design of a redesigned ADC Mk 2 Mod 6 that meets the operational requirements of the current device, but only meets the environmental requirements for over-the-side shipboard launch. Phase II is intended to evaluate three to five prototype systems and their abilities to acoustically perform both before and after exposure to primary environmental stress screening involving temperature shock (-54°C in air to 2°C in water, and +71°C in air to 15°C in water), shipboard-launched water impact of 80g radial acceleration and 25g axial acceleration, and hydrostatic testing to 250 feet depth. Environmental stress testing, including pre- and post-acoustic testing, will take place at facilities maintained by the Naval Undersea Warfare Center in Newport, Rhode Island. These Phase II tests will be the responsibility of the proposer with assistance and test facilities provided by the Navy. Phase III is intended to evaluate further matured devices against more formal environmental and operational tests, including storage temperature thermal cycling (-54°C to +71°C), lightweight shock testing (MIL-S-901D), vibration testing (MIL-STD-810, Section 528.1), in addition to operational in-water acoustic testing in a demonstration on a Navy instrumented test range. There is potential for some of this extended testing to occur in Phase II if the Phase II prototype design is a mature representation of a potential low-rate initial production design that is expected during Phase III.

Work produced in Phase II will likely become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for an end-to-end design of a redesigned ADC Mk 2 Mod 6 that meets the operational requirements of the current device, but only meets the environmental requirements for over-the-side shipboard launch, of which are noted in the description. Include, in the design, details of the modularized reconfiguration of the existing acoustic projector, electronics, and thermal lithium power supply, which notionally can be provided as Government Furnished Information (GFI). Establish the feasibility of the design through modeling and simulation pitted against known environmental requirements enabling surface ship launch capability. The Phase I Option, if

exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and build three to five prototype devices for testing and evaluation. Further refine the prototype systems that can be transitioned to the Navy. Conduct evaluation and testing of the prototypes based on the environmental requirements for over-the-side shipboard launch, including but not limited to, temperature shock (-54°C in air to 2°C in water, and +71°C in air to 15°C in water), lightweight impact shock testing, and hydrostatic testing to 250 feet depth, as well as the performer's low-level subassembly performance tests. Further details of the testing requirements are noted in the Description. Include acoustic evaluation, which will take place both before and after environmental stress testing at facilities maintained by the Naval Undersea Warfare Center Division Newport. Ensure final delivery of three (3) to five (5) prototypes. Perform initial testing with assistance and test facilities provided by the Navy. Assist the Navy with follow-on testing.

It is probable that the work under this effort will be classified under Phase II (see Description for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use in the form of follow-on Low-rate initial production (LRIP) units using any lessons learned from the Phase II prototyping and testing efforts. Provide engineering support for full environmental testing, which will expand on the testing that was performed within Phase II. The primary applicable NAVSEA program office is PMS 415, which resides within PEO SUBS. Some alternative Naval applications include active sonobuoys, training targets, and alternative acoustic sound sources. . Perform testing that includes long-duration storage temperature thermal cycling between -54°C and +71°C, lightweight shock testing in accordance with MIL-C-901D, vibration testing (shipboard and transportation in accordance with MIL-STD-810, Section 528.1), and all associated acoustic evaluation testing (source level, duration, and frequency content), both before and after environmental stress testing. (Note: There is potential for some of this extended testing to occur in Phase II if the Phase II prototype design is a mature representation of a potential low-rate initial production design.) Launch at least five LRIP units from a U.S. Navy surface ship to assist in the full circle environmental evaluation of the design.

Some commercial applications include marine mammal acoustic diversions and geological exploration.

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KEYWORDS: Surface Ship Torpedo Defense; Acoustic Countermeasure; Soft-kill Torpedo Countermeasure; Anti-submarine Warfare; Lightweight Shock Testing; Environmental Qualification Testing

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N201-035 TITLE: Advanced Compact Shipboard High Temperature Superconducting (HTS) Cable Terminations

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320 Electric Ships Office

OBJECTIVE: Develop an innovative warm-to-cold high temperature superconducting power cable termination suitable for shipboard applications.

DESCRIPTION: The U.S. Navy is progressing toward increased electrification of ship systems and weapons requiring unprecedented levels of power distribution capabilities on ships. Electric propulsion motors are expected to demand 20-80MW per ship supported by multiple 10-40 MW generator sets. Additional high-power loads will include rail guns, lasers, electronic warfare systems, and high-power radar. These systems will be tied together through an integrated power system (IPS) that maximizes the utility and efficiency of installed power generation by routing power to loads on demand. A primary benefit of the IPS approach is an increase in overall power distribution density, electrical efficiency and fuel savings. Moving 10's to 100's of MW of power around a ship favors increased distribution voltages (greater than 450VAC and/or 6-18 KVDC) to minimize added cabling necessary to overcome the ampacity limits of traditional conductors. High Temperature Superconductors (HTS) are candidates for advanced conductor technology that can be used to increase the power distributed through a single lightweight cable without the necessity of going to higher voltage. Implementation of these technologies require HTS power cable termination suitable for shipboard applications. An additional benefit of a HTS cable system is the ability for co-axial or tri-axial cable designs that minimize externally emitted magnetic field thereby having no impact on ship magnetic signature. The compact cable termination will also enable center of gravity favorable power delivery to high elevation loads eliminating the negative weight impact using traditional copper conductors. Additionally, decoupling the cryogenic cooling system from the cable and termination would allow for additionally favorable placement of the heavier cryogenic system components lower in the ship.

HTS power cables have been successfully operated in several land-based demonstrations using liquid nitrogen as the cryogen. The primary benefit of HTS cables for in-grid land applications is the ability to utilize existing cableways, or right-of-way, originally intended for underground or overhead transmission cables to increase power distribution by 10. This is particularly useful in upgrading power distribution in cities with growing load demands where conventional approaches to expanded distribution is not feasible. While the HTS cable generally has an outer jacketing diameter in the range of 1.5 inches to 3 inches, the cable termination is usually several orders of magnitude larger. These terminations generally serve as the entry and exit point of the cryogen requisite to maintain the conductor's superconducting state. Minimizing the physical size and weight of terrestrial HTS cable terminations has not been a focus of the community. Existing terminations are unsuitable for the Navy shipboard environment since they impose a large footprint at each end of the cable.

The Navy has been developing superconducting cable technology using cryogenically cooled helium gas, which eliminates the logistic impact of handling a liquid cryogen and minimizes safety concerns related to the 700-time volumetric expansion of nitrogen from liquid to gas state. This gaseous helium cooling approach has been demonstrated in HTS degaussing cables as well as power cables. The cryogenic systems used in these cables have been optimized to provide gaseous helium at 50 K (-367°F) and up to 20 Bar (290 psi) charge pressure with mass flow rates up to 10 grams/sec.

Novel solutions are required to advance HTS cable technology through the development and testing of a compact

cable termination to serve a wide range of naval power applications including shipboard power distribution and shore power. Proposed solutions should include flexibility to integrate with multiple HTS cable topologies including single and multiple-pole configuration of Conductor on Round Core cable (CORC®) or co-axial cable designs. The termination will enable the transition from the cryogenic superconducting cable to the ambient temperature environment and interface with conventional conductors or buss bar while also providing means for cryogen entry and exit. The termination should be scalable from 1kA-4kA, applicable for 450VAC and above and/or 12kVDC and above, for 2 MW to 100 MW of power while incorporating a McFee-based cryogenic current lead optimization approach. Proposed solutions shall include plans for verifying the design through testing within the Phase II effort. Cable termination concepts that include a compact termination, less than 6-in diameter by 12-in length at one end of the cable, and a requisite larger (24-inch diameter by 36-in) termination at the opposite end are acceptable under this topic. A successful termination product will enable the cost competitive acquisition of an affordable HTS system.

PHASE I: Develop a concept and demonstrate the economic, technical and manufacturing feasibility of a compact superconducting power cable termination design that meets the needs of the Navy as defined in the Description. Demonstrate the design and manufacturing concepts through modeling, analysis, and bench top experimentation where appropriate. Document the identification of the size, weight, and cryogenic thermal load vs current, along with ability and impact of scaling voltage and current ratings. Include, in the Phase I final report at a minimum, the technical and economic feasibility and the ability to complete more than one prototype termination iterations with the Phase II funding. The Phase I Option, if exercised, should include an initial detailed design and specifications to build a prototype with the Phase II effort.

PHASE II: Develop, fabricate, and test prototypes of compact HTS cable terminations of a quantity to fit within the scope of work and accomplish tasking. Perform testing activities that include demonstration and characterization of key parameters and objectives at the proposer's facility or other suitable testing facility identified by the offeror. Design the compact cable terminations for rated voltage and current, integrated with a HTS cable, and test them using a gaseous helium cryogen. Test the terminations to demonstrate the ability to meet the design characteristics. Deliver the Phase II prototypes consisting of HTS cables and terminations to the Navy for further testing. Submit the design and drawings of the tested superconducting compact cable termination prototypes to the Navy. In addition, submit to the Navy any updated designs, design changes, and related drawings that result from lessons learned discovered during prototype testing. Ensure that the final submitted design will pass Navy qualification testing (MIL-S-901D, MIL-STD-167-1, and others) once manufactured.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Perform market research, analysis, and identification of teaming opportunities with industry partners to establish production-level manufacturing capabilities and facilities that will produce and fully qualify a HTS cable and compact termination. Transition the compact superconducting cable termination to the Electric Ships Office for incorporation into shipboard power systems. Develop manufacturing plans to facilitate a smooth transition to the Navy.

This technology has potential high-value application in the commercial electric power industry, including the electric power transmission and distribution; and high-power-use industries (e.g., Data storage and Supercomputing centers). It is expected this technology will enable compact superconducting cables to serve high power loads without the traditional termination footprint requirement.

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KEYWORDS: High Temperature Superconducting Cable Termination; High Temperature Superconducting; Advanced Conductor; Power Distribution; Cryogenic Helium System; Cryocooler

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N201-036 TITLE: Dynamic Loadable Module Architecture and Applications Program Interface for a Distributed Common Operational Picture Subsystem

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a real-time extensible and evolvable architectural model, software framework, and Applications Program Interface (API) for a modular software execution environment capable of supporting dynamic run-time installation and control of new capabilities via the use of dynamically installable and reconfigurable software modules.

DESCRIPTION: The Navy has a requirement to expand its sea-based advantage through increased capability. This need can be addressed by providing technology that has the potential to improve ship combat effectiveness and efficiency by significantly improving battlespace situational awareness, thus reducing the management complexity of the overall battlespace. This may allow for a reduction in the number of platforms needed in a specific tactical arena to provide an equivalent track engagement capability, and for reduced staffing or increased duty time. By reducing the potential stress and fatigue levels experienced by the operator while monitoring tracks in a sensor- or communications-compromised or denied environment, the Navy can potentially reduce shipboard manning requirements, and subsequently improve affordability.

The current AEGIS combat system implementation does not include a comprehensive distributed (i.e., multi-platform) capability for capturing the complete battlespace operational, environmental, and tactical picture in a coherent, integrated manner. Currently available commercial systems and software, which might be considered for adaptation to our needs (e.g., the FAA Air Traffic Control System hardware and software), are dated in their designs, and lack the flexibility and track capacity required to adequately address Navy tactical needs. Specifically, currently available commercial technology is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in the DoD environment. The Navy needs a modular software execution environment and API intended for integration into a Distributed Common Operational Picture (DCOP) software subsystem. This modular execution environment will provide the DCOP software subsystem with the ability to dynamically (on-the-fly) install, remove, or modify DCOP capabilities without disrupting the ongoing real-time performance of the DCOP subsystem, other currently executing combat systems applications, or the host combat systems performance as a whole. The capability is needed within AEGIS to present a common operational picture (COP) to the combat systems watch stander. The subsystem must be modular in nature, and support the sharing of COP data across all participating platforms within the battlegroup in a manner, which ensures the real-time multi-platform coherence and synchronization of COP data on every platform to the greatest extent possible.

The DCOP architectural model, software framework, and API should be considered in context with an appropriate DCOP data model (DM), DM markup language, and multi-platform data coherency and synchronization algorithm set. These components, when considered as a whole, should be capable of supporting the functional capabilities and requirements needed to provide a comprehensive real-time battlespace DCOP to each Navy or allied warfighting platform capable of hosting a DCOP subsystem.

The DCOP architectural model and software framework must be capable of providing both combat systems operators and combat systems software applications with real-time access to a distributed (i.e., multi-platform) COP. This COP represents a complete tactical view of the battlespace as well as all tactical and non-combatant entities present within the ship's Area of Responsibility (AOR) and is characterized by a set of quantized parameters associated with each "entity" resident within the battlespace. The actual parameters for each entity will be defined by a DCOP real-time extensible and evolvable battlespace data model (and its associated markup language) which will constitute an associated modular component of the overall DCOP subsystem.

The DCOP architectural model and software framework must be capable of supporting "on-the-fly" addition and/or deletion of DCOP capabilities, with each capability implemented via a loadable software module. The installation, removal, activation, and deactivation of software modules within an executing DCOP implementation should have no adverse effect on the real-time performance of the DCOP system and/or the services it provides to the host platform and operator at the time those changes are implemented. An exemplar of this type of low/no impact behavior during runtime installation and removal of capabilities within an executing system can be observed in the kernel module control facilities of the Linux operating system (kernel 4.4 and above), such as the insmod, rmmod, depmod, lsmod, modinfo and modprobe commands [Refs. 2, 3]. The process of installing, removing, or otherwise controlling DCOP services and capabilities within an executing DCOP installation should be easily executed by combat systems watch personnel without the need to stand down, halt, or reload the currently running combat systems software instance and without the attention of specially trained software maintenance personnel.

The DCOP subsystem architecture and software framework must be capable of supporting battlespace common operational picture data access control and multi-platform DCOP data coherency and synchronization mechanisms as a modular replaceable or upgradable component of the overall DCOP architecture. To this end, the DCOP subsystem architecture will utilize a modular multi-platform high-reliability communications services capability provided by the host combat system, in conjunction with its own resident modular multi-platform data coherency/synchronization algorithm. This will ensure that the DCOP battlespace data model reflects the current real-time state of the battlespace, notwithstanding data update related multi-platform communications issues due to enemy electronic countermeasure action and problematic atmospheric radio frequency environment issues.

The DCOP API should provide a DCOP data access and subsystem control interface capable of supporting two major categories of DCOP-related software applications or modules. First, it must support the DCOP subsystem capabilities implementation modules, which add, remove, or control organic capabilities and services within the DCOP subsystem itself, with the purpose of enhancing the overall suite of capabilities and services, which DCOP

provides to the platform's combat system. Second, it must support the COP data access to combat systems hosted and console operator-initiated client applications or other software entities (e.g., software agents) resident within the combat systems suite, which require DCOP API-based real-time access to common operational picture data. The API architecture and software framework will provide an accessible data abstraction layer between any combat systems client software application and the actual DCOP data structure implementation maintaining common operational picture data, insuring that any combat systems applications remain independent of any implementation-specific changes, enhancements, etc. made to the DCOP data model and supporting data structures.

Both the DCOP architectural model and its API shall be well documented and conform to open systems architectural principals and standards [Ref. 4]. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS combat systems BL9 or later environment.

The software implementation of the DCOP prototype subsystem should be compatible with the C++ programming language and capable of running in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources, save for sensor data emulators). The prototype DCOP subsystem implementation will demonstrate the following: (i) the ability to install, remove, and control various DCOP capability software modules in an executing system with minimal/no impact on system performance; (ii) the ability to support third party sourced C++ and Java applications requiring real-time access through the DCOP API to common operational picture data resident within the DCOP data model; and (iii) the ability to demonstrate real-time multi-platform sensor data updates, synchronization, and data coherency across multiple executing instances of the DCOP subsystem.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design, develop, and deliver a concept for an architectural model and software framework of a DCOP modular software execution environment and API capable of meeting the subsystem and API requirements and capabilities outlined in the Description. Establish the feasibility of the concept through evaluation of the ability of the proposed model to successfully capture all tactical and operational battlespace parameters as detailed in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Ensure that the software implementation of the DCOP prototype subsystem is compatible with the C++ programming language and capable of running in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources, save for sensor data emulators). Ensure that the prototype DCOP subsystem implementation will demonstrate the following: (i) the ability to install, remove, and control various DCOP capability software modules in an executing system with minimal/no impact on system performance; (ii) the ability to support third party sourced C++ and Java applications requiring real-time access through the DCOP API to common operational picture data resident within the DCOP data model; and (iii) the ability to demonstrate real-time multi-platform sensor data updates, synchronization, and data coherency across multiple executing instances of the DCOP subsystem.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the DCOP subsystem software for Navy use. Support implementation that will include the integration of the DCOP subsystem software into a prototype combat system implementation, consisting of one or more of the following: AEGIS BL9 or greater or Common Core Combat System (CCCS) experimental prototype and implemented on a virtualized hardware environment within an AEGIS compliant land-based testbed. This capability has potential for use within the

commercial Air Traffic Control system in future development of an air traffic common operational picture, which would be capable of handling complex traffic control patterns.

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KEYWORDS: Real-time Extensible and Evolvable Battlespace Data Model; Resident Modular Multi-platform Data Coherency/Synchronization Algorithms; Current Real-time State of the Battlespace; Loadable Software Module; Run-time Installation and Removal of Capabilities; Common Operational Picture Data

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N201-037 TITLE: Multi-platform Real-time Synchronization and Coherency Algorithms and Architecture for a Distributed Common Operational Picture Subsystem

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a set of real-time multi-platform data synchronization and coherency (DCS) algorithms to support an extensible and evolvable Distributed (i.e., multi-platform) Common Operational Picture (DCOP)

subsystem.

DESCRIPTION: A Navy requirement exists to expand its sea-based advantage through increased capability. This need can be addressed by providing technology that has the potential to improve ship combat effectiveness and efficiency by significantly improving cross-platform data transfer and subsequent improvements in multi-platform situational awareness data coherence, thus reducing the management complexity of the overall battlespace. This reduction in battlespace management complexity may allow for a commensurate reduction in the number of platforms needed in a specific tactical arena, improved affordability, and an improvement in the overall tactical efficiency of the battle-group as a whole (i.e., the whole is greater than the sum of its parts). Such improvements to both ship and battle-group tactical efficiency may prove exceedingly cost-effective and lead directly to the “creation of a more lethal force by improving command, control and effectively delivering lethal force within a joint environment” (see 2018 National Defense Strategy [Ref. 1]).

The current AEGIS combat system implementation does not include a comprehensive distributed capability for capturing the complete battlespace operational, environmental, and tactical picture in a coherent integrated manner. Currently available commercial systems and software, which might be considered for adaptation to our needs (e.g., the FAA Air Traffic Control System hardware & software), are dated in their designs, and lack the flexibility and track capacity required to adequately address Navy tactical needs. Specifically, currently available commercial technology is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in the DoD environment.

Work has been done on distributed database system design over the years [Ref. 2]; however, the real-time performance parameters and constraints imposed by Navy tactical requirements on a viable common operational picture (COP) battlespace monitoring and data information subsystem contain a unique set of constraints (i.e., to provide consistent and synchronized fire control quality targeting data) mandating substantial innovation be applied in order to develop a workable solution. The DCOP DCS algorithm set and its associated architecture must be capable of supporting real-time battlespace COP data access control (to eliminate data access race conditions) and multi-platform DCOP data coherency and synchronization mechanisms as a modular part of the overall DCOP architecture. A new capability needs to be developed within AEGIS (as well as any future proposed combat system architecture) in order to present a COP to the combat systems watch stander, which provides that watch stander with complete situational awareness. The Navy needs an innovative method of ensuring real-time data synchronization and coherency across multiple ship- and shore-based platforms implementing a DCOP software subsystem. The focus of this topic is the development of a set of algorithms, and an associated software framework, capable of providing and maintaining real-time fire-control quality data for any and all combat systems applications utilizing the DCOP. Any subsystem which provides such a capability should include detailed engagement-quality track data, identification data from various sources, estimated platform sensor and weapons capabilities derived from organic and non-organic databases, and observationally derived behavioral data for each tactically relevant entity or non-combatant entity within the battlespace. The subsystem must be modular in nature and support the sharing of the COP across all participating platforms within the battlegroup in a manner that ensures the real-time data coherence of the COP on every platform.

The DCOP multi-platform data synchronization and coherency algorithm set should be considered in context with an appropriate DCOP software architectural model, data model (DM), and DM markup language. These components, when considered as a whole, should be capable of supporting the functional capabilities and requirements needed to provide a comprehensive real-time battlespace DCOP to each Navy or allied warfighting platform capable of hosting a DCOP subsystem.

The DCOP data synchronization and coherency algorithm set system model contains the following major components. First, it must contain the DCOP architectural model, software framework, and Applications Program Interface (API), which provides a mechanism for dynamically loading and managing software modules implementing DCOP capabilities and a DCOP API. This API provides various combat systems applications with a real-time mechanism for accessing battlespace COP data in a manner which is independent of the method by which such data is stored and maintained within the DCOP subsystem. Second, the DCOP Data Model, which defines the architecture of the actual DCOP software data structures, must be designed to reflect a parametric model of the actual battle-space and the various entities (friendly, hostile, or neutral platforms and their sensors, weapons, etc.) populating it. Lastly, the DCOP multi-platform data synchronization and coherency algorithm set and its requisite

architecture, which has the responsibility of ensuring that each of the various executing DCOP instances and their associated data models residing on the participating DCOP platforms, must maintain a common synchronized and coherent picture of the overall battle-space. The technology sought focuses specifically on the development of this component, but it is important to recognize that the product of this topic is intended for integration with the other DCOP components described.

The DCS algorithms should be capable of monitoring the overall battlespace picture and the various elements and entities within that picture. The algorithms should also be capable of coordinating the real-time synchronization of the data model instances on each participating DCOP platform to ensure COP coherency across the entire DCOP network. In the event that real-time data coherency becomes compromised due to communications issues (e.g., adversary jamming, weather issues), the DCS algorithms must be capable of tagging the impacted non-organic (i.e., off-board) sensor-sourced data structure elements with appropriate coherence-focused “senescence and reliability” metrics. Metrics include, but are not limited to, data update delay in milliseconds, average delay jitters, and multi-source correlation. The algorithms must also be capable of synthesizing an overall Quality-of-Service (QOS) and reliability metric intended to give the operator and/or any combat systems applications an indicator as to the staleness or reliability of the data for any particular battle-space entity.

The DCS algorithms will also be capable of prioritizing and tagging battlespace entities with respect to a set of overarching operator- and Artificial Intelligence-based application-specified threat identification parameters. The algorithms must also be capable of utilizing that data to determine requisite cross-platform and sensor data update rates for each entity within the battlespace, with the intent of minimizing cross-platform data update bandwidth requirements by reducing update rates for non-threatening and slowly changing or moving battlespace entities.

Both the DCOP algorithms and their associated architectural models shall be well documented, and conform to open systems architectural principles and standards [Ref. 3]. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS combat systems BL9 or later environment. The algorithms, as well as any hosting system requirements, should be designed using modular principles with these goals: (i) eventual utilization of the DCOP Application Program Interface (API) for abstracted data structure access; and (ii) the eventual implementation via a dynamically installable software module within the DCOP dynamic loadable module software system architectural model.

Any developed software should be compatible with the C++ programming language and capable of installation within a prototype DCOP subsystem via the use of DCOP modular runtime loading mechanism. The DCOP host subsystem execution environment will be hosted on a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources, save for sensor data emulators or network-based connections to other running DCOP instances). The prototype DCOP multi-platform data synchronization and coherency algorithm suite implementation will demonstrate the following abilities. First, it must demonstrate the ability to successfully coordinate battlespace COP real-time data synchronization and maintain coherency across 10 or more executing DCOP instances hosted on separate computing platforms. Second, it must demonstrate the ability to successfully tag appropriate data elements within the DCOP data environment with QOS reliability metrics reflecting a loss of QOS when a DCOP communications channel between two or more DCOP instances is compromised or disabled. Third, it must demonstrate the ability to dynamically set DCOP data element update parameters based on operator specified threat identification parameters. Lastly, it must demonstrate the ability to successfully update the DCOP algorithm set software module within an executing DCOP subsystem implementation without impact to the performance of that executing instance.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design, develop, and deliver a concept outlining the algorithms needed to implement a DCOP multi-platform data synchronization and coherency capability meeting the requirements and capabilities as outlined in the Description. Establish feasibility of the concept through modeling and analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Produce a prototype DCOP multi-platform data synchronization and coherency algorithm suite. Implement the prototype and demonstrate the following abilities. First, it must demonstrate the ability to successfully coordinate battlespace COP real-time data synchronization and maintain coherency across 10 or more executing DCOP instances hosted on separate computing platforms. Second, it must demonstrate the ability to successfully tag appropriate data elements within the DCOP data environment with QOS reliability metrics reflecting a loss of QOS when a DCOP communications channel between two or more DCOP instances is compromised or disabled. Third, it must demonstrate the ability to dynamically set DCOP data element update parameters based on operator specified threat identification parameters. Lastly, it must demonstrate the ability to successfully update the DCOP algorithm set software module within an executing DCOP subsystem implementation without impact to the performance of that executing instance.

Demonstrate the prototype capabilities outlined above during a functional test to be held at an AEGIS and/or Future Surface Combatant (FSC) prime integrator supported Land Based Test Site (LBTS) provided by the Government, representing an AEGIS BL9 or newer combat system environment.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the DCOP multi-platform data synchronization and coherence algorithm set prototype for Navy use. Integrate the algorithm set and DCOP subsystem software into a prototype combat system, consisting of one or more of the following: AEGIS BL9 (or greater) or Common Core Combat System (CCCS) experimental prototype implemented on a virtualized hardware environment within an AEGIS compliant land-based testbed.

This technology has potential for dual-use capability within the commercial Air Traffic Control system in future development of an air traffic “common operational picture” capable of handling complex traffic control patterns.

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KEYWORDS: Data Synchronization and Coherency Algorithm Set; Synchronized and Coherent Picture of the Overall Battlespace; Operational Picture Data Access Control; Real-time; DCOP; COP Synchronization of the Data; Resilient Multi-platform Distributed Common Operational Picture; Common Synchronized and Coherent Picture; COP; DCOP

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-038 TITLE: Multi-aperture Active Metrological Sensor for Submarines

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: NAVSEA 073, Advanced Submarine Systems Development

OBJECTIVE: Design an advanced Multi-aperture Differential Image Motion Analysis (MaDIMA) and monitoring system for marine wave boundary turbulence and atmosphere characterization in submarines.

DESCRIPTION: Design an advance metrological sensor based on multi beam and Multi-aperture Differential Image Motion Analysis (MaDIMA) system for the purpose of atmospheric turbulence by using MaDIMA and analysis and monitoring, marine wave boundary layer temperature, pressure, and atmospheric particle contents. The proposed technology shall be based on high-energy multiband short pulse (pico-second) laser, Light Detection and Ranging (LIDAR) technology in time domain, and focal plane array (FPA) for image and intensity mapping from a back-scattered laser. One of the key aspects of this system is that it is mono-static, meaning both laser and MaDIMA are collocated. The metrological system shall survive in a marine environment including temperatures from -40 °C to 60 °C, thermal shock (hot air at +66 °C to warm water at +20 °C and cold air at -54 °C to cold water at 0 °C), severe icing, and UV sunlight. The ultimate objective under the proposed concept shall incorporate pixel-by-pixel mapping of local optical turbulence parameter (C_n^2), temperature, pressure, and evaporation fluctuation from periscope-to-target at far field. The MaDIMA system shall consist of short pulse lasers, known as transmitter and detector Focal plane arrays to detect image pulse, and is the receiver in the metrological system in the topic.

Current technology is based on single aperture differential image motion monitor (DIMM) technology. The disadvantage of the system is it requires distance source and it provides only the average marine turbulence parameter only.

This SBIR topic will increase mission capability, increase performance, and/or reduce lifecycle costs by providing advance awareness of Marine Wave boundary atmosphere by optimizing the sensor software and hardware.

PHASE I: Develop a concept to characterize marine wave boundary atmosphere based on MaDIMA and multiband pico second high-energy laser. Demonstrate the feasibility of the concept of multi-aperture differential image motion monitoring and analysis/characterization. Ensure that the proposed concept is able to measure 3-D temperature, pressure, humidity, evaporation, marine particle size (based on the mie scattering or Rayleigh scattering), etc., using active multiband Pico-second lasers integrated with FPA. Co-locate both the laser transmitter and receiver of the metrological system so any optical path of the scatter signal from the atmosphere or reflected signal from the target shall be detected. Ensure that the system operates in multiple mode, such as LIDAR and particle size. Describe and demonstrate the concepts and design of the proposed architecture of the system. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design and develop single lab prototype MaDIMA systems for testing and evaluation. Use this lab prototype to collect data and calibrate system performance. Use the prototype system to characterize marine wave boundary layer atmospheric parameters to show the technology has the potential to meet the performance as metrological instruments under all modes of operation. In the period of performance for the Phase II Option II, if exercised, the Navy shall provide the 3 band Pico-second Laser as Government Furnished Equipment (GFE) to build the integrated MaDIMA system and deliver the field prototype MaDIMA system to the Navy for further evaluation at a Navy Lab. Develop a Phase III transition plan.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Identify the final product and describe how the Navy expects to support transition to Phase III. (Note: The Government will

identify the platform or program where the technology has the potential to be used and describe how the technology will meet critical Navy needs.) Assist the Navy with evaluation of the prototype product performance with a standard off-the-shelf instrument to calibrate the product; and with validation, testing, qualification, and certification for Navy use as a metrological tool.

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KEYWORDS: Marine wave boundary layer (MWBL); Focal Plane Array (FPA); Differential image motion monitor (DIMM); Multi aperture differential image motion analysis(MaDIMA); Picosecond LIDAR

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N201-039 TITLE: Power Dense Single Core Three-Phase Transformer

TECHNOLOGY AREA(S): Electronics

ACQUISITION PROGRAM: PMS 400D, DDG 51 New Construction Program

OBJECTIVE: Reduce the size and weight of single-core three-phase transformers for use on Navy Shipboard power distribution systems.

DESCRIPTION: Isolation transformers are used on U.S. naval ships to provide galvanic and ground fault isolation between electrical components of the ship service electrical distribution system. This functionality is critical to the

survivability of the ship's power distribution system, as transformers both prevent certain casualties from affecting other aspects of the system and suppress electrical interference and noise between devices.

The U.S. Navy is keenly interested in achieving space and weight savings within the DDG 51 design wherever possible. The three-phase isolation transformers currently in use are large and heavy. These transformers are widely used in many spaces throughout the ship. Space, maintenance, acquisition, and weight savings can all be achieved through new and innovative product development.

DDG 51 class ships currently utilize banks of three dry-type, single-phase 60 Hz transformers, rated at 37.5 kVA per transformer, to provide input isolation within vital loads of the ship service electrical power distribution system. Electrical power of this system is Type 1 60 Hz power, rated at 440 Vrms, three-phase, ungrounded, and is in accordance with the power requirements of MIL-STD-1399-300B Department of Defense Interface Standard: (Section 300b) Electric Power, Alternating Current. A single core three-phase transformer would need to replicate the electrical properties and tolerances, and meet the physical construction requirements of the current single-phase transformer bank design per phase. The transformer can be configured to be bulkhead or deck mounted, and able to be mounted horizontally or vertically. The Not To Exceed (NTE) dimensions and weight of the transformer shall be 95 in.x 71 in x 63 in and 1100lbs respectively. The combined power rating for the three-phase transformer design would be 194.85 kVA, to meet the power handling requirements of the existing transformer banks. The new transformer design would also be required to meet all Navy test and qualification standards including shock, vibration, airborne noise levels, and enclosure design.

Qualification shall be in accordance with Grade B shock of MIL-STD-901D Shock tests High Impact, Shipboard Machinery Equipment, MIL-STD-1310D Shipboard Bonding, Grounding, and other Techniques for Electromagnetic Compatibility and Safety, drip proof in accordance with IP 22, and in accordance with MIL-E-917E Electric Power Equipment Basic Requirements.

Single core three-phase transformers have been used in electric power distribution grids and to power larger electric motors. The commercial units used do not meet Military Standards and U.S. Navy shipboard requirements. Smaller units have been used onboard naval vessels but are not Navy-qualified and only used on non-vital loads. The development goal of this SBIR topic is to miniaturize and militarize this technology for implementation in a naval context. The design should incorporate innovative design aspects, such as novel material selection, to maximize the weight and space savings achieved by this project.

PHASE I: Develop a conceptual design for an affordable, compact, and durable single core three-phase transformer for application to naval ships. Present the salient features of the performance as well as the physical and functional characteristics of the proposed system(s). Using best practices, develop electrical models to predict system performance and provide justification for the model assumptions. Using the results from the modeling, assess the feasibility of the proposed solution to meet the performance goals and metrics. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop, fabricate, demonstrate, and deliver a prototype scaled to fit within the projected scope of the transformer as identified in the Description. Demonstrate that the same technology can support full-scale operation for shipboard power distribution. In a laboratory environment, demonstrate through test and validation that the prototype successfully powers a load and galvanic isolation of the source from the load. Ensure that Operational Testing of the prototype mimics shipboard operation. Perform Standard Environmental Qualification Testing of the prototype. Perform all analyses and efforts required to refine the prototype into a useful technology for the Navy. Provide detailed drawings and specifications. Document the final product in a drawing package. Develop a Phase III installation plan.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the single core three-phase transformer to Navy use. Develop installation and maintenance manuals for the transformers to support the transition to the Fleet.

Isolation transformers within electrical distribution systems are used on Navy and civilian naval vessels and in

commercial applications. Thus, the same potential demand exists in commercial shipping and cruise liners.

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KEYWORDS: Input Transformer; Electrical Power Distribution; Three-Phase Power; Isolation transformer; Galvanic Isolation; Miniaturization; Single Core

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

~~N201-040~~ [Navy has removed topic N201-040 from the 20.1 SBIR BAA]

N201-041 TITLE: Bridge-to-Bridge Radio for Unmanned Surface Vehicles

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 406, Unmanned Maritime Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Create a system that converts VHF Bridge-to-Bridge radio transmissions from voice to text to meaning and integrates them into a COLREGS reasoning engine; and generates an intelligent reply to a proposed maneuver.

DESCRIPTION: The nautical rules of the road (COLREGS) provide clear guidance for encounters between two vessels, but they do not directly specify what should happen when three or more vessels come in close proximity to each other at nearly the same time. Mariners commonly deal with such situations by communicating via VHF Bridge-to-Bridge radio. Current Unmanned Surface Vehicles (USVs) have COLREGS reasoning engines, but they cannot incorporate information from Bridge-to-Bridge conversations, nor can they reply to simple maneuver proposals. Component technologies exist to convert voice signals to text, to convert text to meaning, and to maneuver unmanned vessels to avoid collisions while following COLREGS. The Navy seeks an integrated solution that will enable a USV to act much like a human mariner; in particular, the USV should be able to understand secure Bridge-to-Bridge radio transmissions, incorporate their meaning into its world model, develop appropriate maneuvering plans, and respond via voice on the Bridge-to-Bridge radio. Partial solutions to the problem may be acceptable, though preference will be given to approaches that are comprehensive and achievable.

PHASE I: Provide a concept to solve part of or the entire USV Bridge-to-Bridge radio problem stated in the Description. Demonstrate the feasibility of that concept. Ensure that, at a minimum, the proposed end product includes recognizing common call-ups such as “Sea Hunter, this is Sun Princess; propose a port-to-port passage.” Produce English language transmissions from native speakers. Integration with an actual VHF radio is not required in Phase I, but Phase I should include a plan to extend the product in Phase II and beyond, analysis showing viability of that plan, and a proposed approach to Phase II testing.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II that incorporates an actual VHF radio, extends functionality to mariners who speak English as a second language, and generates English replies to proposed maneuvers.

PHASE II: Build a prototype system for testing and evaluation. Incorporate into the prototype, at a minimum, an actual VHF radio, extend functionality to recognize English spoken by non-native speakers, and generate English replies to proposed maneuvers. Explore additional functionalities if feasible, such as integration with a COLREGS reasoning engine and world model. Ensure that the prototype is delivered at least three months prior to the end of Phase II to facilitate ashore testing followed by at-sea testing. (Note: Phase II testing may be accomplished on a manned surrogate vessel with a stand-alone autonomy system running on a laptop or other computer but not actually controlling the vessel’s movements. Phase II testing may also be accomplished on a USV that is temporarily manned for evaluation and safety reasons.) Ensure that the prototype complies with the Unmanned Maritime Autonomy Architecture (UMAA). The Navy will provide UMAA documentation at the beginning of Phase II.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Produce a final end-to-end system that enables a USV to perform like a human mariner, particularly in its use of the VHF Bridge-to-Bridge radio for negotiating maneuvers in situations involving three or more vessels. The Navy will provide a candidate COLREGS reasoning engine for integration along with an Interface Control Document (ICD) at the beginning of Phase III if needed by the proposer. The Navy expects proposers to support transition to Phase III by integrating into the ICD, supporting additional laboratory and at-sea testing, and developing any required intermediate hardware. This technology will be used in the Medium Unmanned Surface Vehicle (MUSV) program, the Large Unmanned Surface Vehicle (LUSV) program, and possibly other USV programs. This technology will meet critical Navy needs by helping to ensure safe USV navigation in compliance with COLREGS. The product will be validated and tested through extensive laboratory trials followed by more limited at-sea trials.

The civilian market for unmanned vessels appears poised for take-off, and such vessels will need to be able to function even when satellite links to remote oversight facilities ashore are inoperative. Additionally, this technology can be used on minimally manned vessels and pleasure craft as an aid to a human operator.

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KEYWORDS: Speech Recognition Software; Voice to Text; Text to Meaning; COLREGS; VHF Bridge-to-Bridge Radio; USV COLREGS Compliance; Natural Language Processing

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-042 TITLE: Rolling Shutter and Fast Panning Effects Mitigation

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: Integrated Submarine Imaging System, PMS 435, Submarine Sensor Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a system to restore image degradation caused by a rolling shutter and correct for motion blur during fast periscope panning.

DESCRIPTION: Future submarine periscopes or future submarine off-board systems will employ Complementary Metal-oxide Semiconductor (CMOS)-based imaging systems operating at high resolution of 8 megapixel pixel density or greater, which pan across and image the scene. Some of these imaging systems will use rolling shutter-based imaging chips. Artifacts in rolling shutter imagery present challenges for many Navy maritime image-processing algorithms and severely affect Navy photogrammetry algorithms, which require highly accurate, geometrically correct measurements. In rolling shutter sensors, each row in the image is collected at a slightly different time, which results in scene distortion due to moving objects, platform motion, and panning. This makes

single-frame image processing and multi-frame image registration difficult due to blur and pixel location errors. Approaches for mitigating rolling shutter effects include both video-processing algorithms and inertial measurement unit (IMU) data-processing algorithms. For image processing-based approaches to rolling shutter mitigation, the maritime environment presents a challenge due to the lack of consistent scene texture, as opposed to terrestrial imaging. For IMU-based approaches, raw IMU data may not be available, may have low fidelity, or may have time synchronization errors, which decrease the ability to accurately determine the camera's attitude during image collection. The Navy seeks to address these challenges and improve intelligence, surveillance, and reconnaissance (ISR) capabilities to detect, track, 3D model, and geo-locate targets using on-board or off-board low-cost sensors in maritime environment. The approach will reduce motion blur and correct pixel geolocation.

To modernize key capabilities for advance naval operations from the perspective of sensing and navigation, the Navy must manage the operational environment and develop advance capabilities that exploit novel principles to bring new affordable capabilities to the warfighter. The technology identified in this SBIR topic will enable faster situational awareness; enhance enemy, friendly, and neutral ship detection and classification; and improve safety of ship navigation.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for an algorithm to reduce motion blur and correct pixel geolocation in imaging data collected from a rolling shutter Complementary Metal-oxide Semiconductor (CMOS) camera systems as discussed in the Description. Demonstrate the feasibility of the concept via analysis or data collected with cameras provided by the vendor. The Phase I option, if exercised, will include the initial capability description to build a prototype for Phase II. Develop a Phase II plan.

PHASE II: Develop and deliver a prototype algorithm for testing and evaluation. Ensure that the algorithm runs in real time and demonstrates motion blur reduction by showing improvements in edge sharpness, edge spread function, or other quantitative metrics. Test the algorithm with data provided by the Government at the developer's facility and/or a government facility. Prepare a Phase II development plan to transition the technology for Navy and potential commercial use.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the algorithm for Navy use through the Technology-Insertion / Advanced Processing Build (TI/APB) process into the submarine combat system (across multiple classes of submarines). Support the TI/APB process, which includes several steps of testing, both laboratory and at-sea, using Government-provided data sets.

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KEYWORDS: Maritime Imaging; Periscope Imaging; Rolling Shutter; Image Enhancement; Complementary metal-oxide semiconductor; CMOS; Advanced Processing Build; Motion Blur

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N201-043 TITLE: Holistic Integration of Air Anti-Submarine Warfare Capability for Effective Theater Undersea Warfare

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS5: Undersea Systems Program Office, AN/UYQ-100 Undersea Warfare - Decision Support System (US

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a toolset to integrate aviation assets into Theater Undersea Warfare (USW) operations through data and information exchange and sharing between air platforms, ground support Command and Control (C2) nodes, and shore-based Theater USW C2 systems.

DESCRIPTION: Theater USW watch floor C2 planning currently contains limited information regarding Anti-submarine Warfare (ASW) mission planning and execution performance for Maritime Patrol and Reconnaissance Aircraft (MPRA), which conduct Air ASW, such as the P-3 [Ref. 1] and P-8 [Ref. 2] naval aircraft. The data available is often limited to the Area of Interest (AOI). The MPRA unit's mission is to search for planned locations for buoy fields.

The TacMobile Program provides expeditionary ground support for MPRA assets, but there are no data exchange requirements between TacMobile and Theater USW C2 systems. Therefore, in-situ information sharing is currently limited to chat, voice, and tracks passed via Link-16.

The Navy seeks innovative data sharing and information exchange technologies to achieve holistic integration of MPRA assets into Theater USW C2 decision making and execution tracking to support future Theater USW C2 operations. This decision making and execution tracking is performed using the AN/UYQ-100 USW Decision Support System (USW-DSS) [Ref. 3]. This integration will become increasingly critical as unmanned air vehicles (UAVs) performing ASW sensing missions [Refs. 4, 5] augment operated MPRA assets. While some commercial tracking capability exists, no available capabilities encompass the scope and breadth of data sharing and information exchange sought by this SBIR topic.

For this integration to be effective, all aspects of MPRA mission planning, communication of in-situ observation,

and reporting, as well as post-mission replay and assessment, are necessary. Naval Air tactical operations centers (TOCs (shore based) and MTOCs (mobile)) will need to produce mission planning products that layer all sensor predictions, and then feed those models to the Theater USW operations center via USW-DSS.

Data to be exchanged or shared include the following:

- 1) Sensor performance predictions for all sensors. Example sensors include passive and active sonobuoys (SSQ-53, SSQ-62, SSQ-101, SSQ-125), radars, magnetic anomaly detection (MAD), electro-optical and infrared (EO/IR), and electronic support measures (ESM).
- 2) Mission planning data. Data to be shared include routes, search areas, and predicted cumulative detection probabilities (CDPs) for sensors employed during a planned search over time.
- 3) Mission execution data. Data to be shared include calculated CDPs during mission execution based on in-situ environmental measurements and actual execution parameters.
- 4) Contact and track data. This data includes information such as lines of bearing, positional information, and tracks passed via Link-16.
- 5) Mission readiness data. This includes information regarding aircraft sensors available for use, availability of flight crews, fuel stores, available weapons, and remaining stores of expendables (e.g., sonobuoys).
- 6) Common tactical picture (CTP) data. This would include area search performance for individual air assets and fused information across multiple sorties.
- 7) Environmental measurements. This would include measurements of atmospheric conditions, bathymetric measurements to infer sound speed profiles, and ambient noise measurements.
- 8) Intelligence data. This includes acoustic intelligence (ACINT) and signal intelligence (SIGINT).
- 9) Geographic plot and air tasking order (ATO) or flying program (FLYPRO) data. These data include search areas, routes, Weapon System Manager (WSM) acknowledgements, and geographic overlays.

Integration of MPRA data into USW-DSS will produce a fully informed USW common tactical picture to enable effective decision making when planning and executing employment of MPRA and ASW UAVs in a Theater or Operational Level of War environment. This addition to a more fully informed USW tactical picture will reduce acquisition costs to develop similar technologies with a lower level of confidence. Unit and individual sortie-level data across all applicable sorties will be needed to build a comprehensive MPRA picture to integrate with tactical pictures produced by surface combatants, submarines, surveillance systems, and unmanned assets when confronting a peer adversary. The result of this integration effort will reduce the level of effort required for coordination between Theater USW watch floors and TOC/MTOC sites.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a module for the holistic integration of MPRA planning, execution, and state data with the USW-DSS system. Use modeling and simulation to demonstrate the feasibility of the concept to convey all the categories of data listed in the Description. The Phase I Option, if exercised, will include the initial system specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype of the Air ASW module. Demonstrate prototype performance through the required range of parameters given in the Description. If needed, coordinate with the Government to conduct testing at a Government- or company-provided facility to validate the prototype capability.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to an integrated element of USW-DSS. Demonstrate and report on performance during laboratory testing or at-sea trials.

Commercial use could be in industries involving vehicle tracking and status. Tracking vehicles on a site-specific map, level of readiness for deployment, and the preventative maintenance each vehicle may need would provide situational awareness to reduce costs and provide safe vehicles for the customer (e.g., rental cars, school bus systems).

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KEYWORDS: Anti-submarine Warfare; Air ASW; Theater USW Command and Control; Maritime Patrol and Reconnaissance Aircraft (MPRA); MPRA Mission Planning; Post-mission Replay and Assessment

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N201-044 TITLE: 2 micron Wavelength Kilowatt Class High Energy Laser/Amplifier

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: NAVSEA 073, Advanced Submarine Systems Development

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of

sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a high-energy laser operating at 2 μm (micron) wavelength, kilowatt (kW) class amplifier design for Next Generation Submarine Warfare and Battle Space supremacy using non kinetic energy.

DESCRIPTION: The Navy is evaluating how it uses the Electro-magnetic (EM) Spectrum with an objective of gaining military advantages and achieving freedom of action across all Navy missions in support of nearwater warfare. This effort is driven by both new threats and available and emerging technologies. These technologies have the potential to vastly improve the agility and flexibility of the Navy systems by utilizing high-energy lasers for Battle Space Supremacy and Water Space Management as envisioned by the Chief of Naval Operations (CNO). The current technology for High Energy Laser (HEL) at this wavelength for kW class amplifiers is in early development. A major challenge exists for this technology to be viable for development of doped fiber for the 2 μm kW class amplifier systems. The Navy seeks to address the manufacturability, electrical-to-optical (EO) efficiency and technology risk assessment and reduction of this class of laser amplifier design.

The major advantage of this spectrum for HEL class amplifier should lead to an increase in engagement range at marine atmospheric conditions, such as scattering, thermal blooming etc., when compared to the scenario where the same power at 1 μm wavelength is used. Another advantage of this wavelength spectrum is providing operation in the eye-safe spectrum from the optical scattering from the marine wave boundary layer (MWBL) when compared to the 1 μm wavelength laser, which has higher scattering properties from MWBL. The third consideration of 2 μm laser is the less detectability compare to current standard 1 μm HEL system.

A major challenge to develop this technology is the development of thulium based doped double clad optical fiber design for the 2 μm kW class amplifier system. The second challenge is to demonstrate an EO efficient $> 40\%$ with high beam quality ($M^2 < 2$) > 2 kW class laser module prototype system for test and evaluation at Navy lab.

The current state-of-the-art technology in the commercial or DoD arena is based on 1 μm wavelength high-energy, weapon-grade laser. The challenges of current laser technology at marine atmosphere levels are its detectability by adversaries due to its higher scattering property and that it is not an eye-safe operation in a clutter condition where friendly force or bystanders are present. The EO efficiency of the 2 μm kW laser amplifier module shall be greater than 30%. The technology shall be demonstrated through the Spectral Beam Combining (SBC) of the individual module to combine power to achieve 30 kW continuous wave output power with higher beam quality $M^2 < 2$. Both the power specifications and wavelength of operation and EO efficiency will be tested at a NSWC Dahlgren, Navy HEL test facility.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept of 2 μm operating wavelength fiber laser/amplifier products for Navy application. Consider the Size, Weight, and Power-Cooling (SWaP-C) aspect of the amplifier for the design of the kW class amplifier. Ensure that the EO efficiency of the amplifier is greater than 30%. In Phase I company shall provide a feasibility study of the kW class 2 μm amplifier design based on Model Based Engineering. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution based on by modelling and simulation. Develop a Phase II plan.

PHASE II: Develop, demonstrate, and deliver an efficient, high beam quality ($M^2 < 2$) 2kW class prototype laser module system for testing and evaluation. Evaluate the prototype laser kW class module by testing. Provide test results and analysis. Demonstrate the SBC of the individual module to combine power to achieve 30 kW output power with higher beam quality $M^2 < 2$. Deliver the prototype to the NSWC Dahlgren Navy lab to evaluate the performance of the system in terms of power specifications, wavelength, beam quality and EO efficiency for a HEL prototype system that can meet Navy performance goals.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. For this purpose, show the scalability of power to 100kW class and beyond. The laser system will be deployed ultimately in a submarine or other Navy platform to advance the future Navy warfighting capability. Both the power specifications and wavelength of operation and electrical to optical (EO) efficiency will be tested at a NSWC Dahlgren, Navy High energy laser (HEL) test facility.

There is a potential for dual use of this system for cutting/welding, optical communication and use in space or airborne platforms. One of the most important characteristics of this wavelength is that it will be less affected by the atmospheric operation near marine wave boundary layer (MWBL) and its eye-safe operation from scattered light.

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KEYWORDS: HEL; High Energy Laser; Optical Amplifier; Optical Efficiency; Spectral Beam Combining; SBC; Electro Magnetic Spectrum; Marine Wave Boundary Layer; MWBL

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N201-045

TITLE: Development of a Debris Prediction Method for Hardened Structures

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: Naval Ordnance Safety and Security Activity (NOSSA)

OBJECTIVE: Develop a fast running model (FRM) for hardened structure debris prediction by using reliability analysis and adopting a stochastic procedure that can provide practical fundamentals for site planning of the hardened structures such as the magazine.

DESCRIPTION: Analysis of reinforced concrete and other forms of structural component cementations affected by weapons effects have been performed using a variety of deterministic analysis tools/methods, such as finite element methods, FRMs, pressure-impulse (PI) curves, and single-degree-of-freedom models. Such analyses have a critical limitation related to the manner in which such tools handle the inherent stochastic nature of the weapons effects problem. The modeling and simulation (M&S) technology is not standardized, thus no reliable procedure for evaluation has been developed. Currently the required time and effort for the evaluation is a measurement taking weeks or months for just one specific case. A new FRM will provide reliable and accurate predictions in the scale of minutes for all the magazine and related hardened structures.

The present approach to weapons effects analysis should be revised to improve its consideration of the actual uncertainties presented by targeting problems and weapons effects responses. The methodology was developed in 1943 and since then it has not been changed or improved seriously. The only advantage of the methodology is that it is a simple hand calculation process, and because of this advantage, it is traceable to check validity. The analysis method far beyond finite element method is being used as a proven technology. However, the non-traceable nature, huge Computer Processing Unit (CPU) time and technical complicacy prevents the use of advanced methods such as mesh-free analysis, even though it is the most reliable method. The proposed R&D pursuing the development of FRM can solve three problems to keep the reliability and accuracy: no need to be traced for validation because it is already validated by this proposed R&D; week-level CPU time can be reduced to minute level thanks to FRM nature; and easy access by user-friendly Graphical User Interface (GUI).

More reliable prediction of the structural damage due to fragment and secondary debris in case of detonation shall specify required resistance of the structural components of a specific area to enhance the structural soundness evaluation, and eventually to reduce cost and efforts for the maintenance of the magazine structures. Generally, maintenance of the structure is conducted by three levels: visual inspection; non-destructive test (NDT); and computer simulation or test for validation by acquired inspection data and NDT data. More reliable prediction of the structural damage due to fragment and secondary debris in case of detonation can specify required resistance of the structural components of specific area. It can enhance the efficiency of the structural health monitoring and eventually can reduce cost and efforts for the maintenance of the magazine structures.

Functional change of the ammunition structures requires stopping all the operations related to the designated structure. The development shall pursue accurate and reliable prediction of the structural response to expedite the evaluation process, which drives the minimization of the operational discontinuity. Functional change of the ammunition structures requires stopping all the operations related to the designated structure. Accurate and reliable prediction of the structural response can expedite the evaluation process, which drives the minimization of the operational discontinuity.

The statistical characteristics of the debris or fragmentation prediction cause two major difficulties in the application of deterministic analysis procedures for analysis: the high statistical variance of the loading and the variance in response that it engenders. For example, mesh size is not sufficiently considered in performing an analysis concerning the influence of smaller particle fragments on the results. The influence of the small size fragment (e.g., one smaller than the mesh size) cannot be adequately predicted by a conventional finite element or mesh-free analysis method. Cracks and break-up simulation requires the mesh to be as small as possible. Even tenth of an inch is not sufficiently small enough to simulate discontinuity. Normally, analysis should accept the error from the

mesh size, which cannot be ignored.

Since the physical reduction of mesh size in the model is limited based on the response information computed during the analysis, less physical analysis techniques or indirect analysis methods, such as FRM or database concepts, should be incorporated in the analysis procedure. For example, multi-layer analysis schemes could be applied to get the behaviors caused by smaller size fragments into standard size meshes. Non-structural analysis techniques are needed to capture these multi-scale stochastic features of weapons effects analyses. A combination of structural, non-structural, and intermediate approaches is needed to capture such characteristics of the fragment loading, and similar features would be needed for other aspects of such response predictions. For example, response to contact and embedded munitions, where the standard analysis methodologies cannot effectively operate even by high-fidelity physics-based (HFPB) analyses methodologies. This research would result in a new form of analysis method, such as a hybrid method combining HFPB modeling with reliability modeling. This combination will address problems where refinement alone is inadequate for considering the intense environment generated by many forms of weapons effects and the corresponding extreme distortions introduced in the structural component struck.

PHASE I: Provide a concept for new forms of analytic models that incorporates hybrid HFPB and reliability-based on formulations that are intended for very intense weapons effects analyses. Identify the viable candidates for such a hybrid approach and the feasibility of their development. Highlight the limitations of conventional weapon effects analyses using HFPB models to identify the problems to be addressed and how the proposer recommends mitigating these problems.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop, and validate theoretically, analysis methods for both structural and weapons effects characterizations. Ensure that one or more of these analysis methods is realized sufficiently to perform some weapons effects analysis for validation against test data. The test results from the Navy ESKIMO series are available to use for the validation. Produce a final report of findings of all the issues described above and a prototype form of FRM software that has the capability to analyze a structure developed to display the technology. For example, the software should comprehensively incorporate the physics-based and stochastic-based modeling of the weapons effects and, in particular, modeling the casing fragment characterization and structural response induced by fragment impacts/perforation. Normally FRM is composed by scientific computing software such as MATLAB or Python for standalone program or linked to the integration software. Scope of this development is to setup theoretical approaches and compose standalone program for current use and future integration, if it is required.

Ensure that the developed FRM shall have functions of magazine structure debris prediction under the given conditions such as construction materials, design facts, or surrounding structures.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the FRM for Navy use in improving design regulations and standard designs for hardened structures. In the new design or when the modification or new design is required, predict the response for the safety estimation of the surrounding structures. Support the approval procedure conducted with interagency cooperation including Naval Ordnance Safety and Security Activity (NOSSA) and the Department of Defense Explosive Safety Board (DDESB). Validate the results of this effort by full scale tests whether simplified or full scale to be used as a part of the approval procedure.

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KEYWORDS: Debris and Fragmentation; Hardened Structure; Magazine Structure; Meshfree Method; Stochastic Analysis; Fast Running Model

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N201-046 TITLE: Through-Hull Underwater Submarine Communications

TECHNOLOGY AREA(S): Electronics

ACQUISITION PROGRAM: PMS391, Submarine Escape and Survivability

OBJECTIVE: Develop external means to provide real-time externally mounted communications through the hull of a distressed submarine (DISSUB) to provide digital communications and/or external measurement of internal DISSUB conditions.

DESCRIPTION: To successfully rescue a DISSUB, and minimize risks to rescue forces, it is necessary to quickly and efficiently determine the status of the DISSUB survivors. Current procedures utilize available onboard communications, such as underwater telephones and globally recognized tap codes, to assist rescue forces in determining status and risk. However, in the event the DISSUB is unresponsive, no method exists to determine the status of the survivors in real time. U.S. Navy rescue protocols dictate that in this instance, rescue will not be attempted because of the unknown risks to rescue forces.

While an unresponsive DISSUB may be because there are no survivors, there are other reasons why the DISSUB survivors may not be able to effectively communicate with rescue forces: loss of underwater telephone capability, location of survivors within the DISSUB, and atmospheric conditions that limit and/or prevent consciousness – such as high internal pressures or higher than normal atmospheric contaminants. In these instances, it is necessary for rescue forces to be capable of externally determining the status of survivors in real time to effectively determine the risks associated with a rescue attempt prior to the rescue vehicle mating with the DISSUB. Current technology using external communications equipment requires the transmission to be recorded and then the equipment to be removed

for future download. Due to the necessity for rapid assimilation of all available information to support rescue of a submarine, the ability to receive and transmit DISSUB information in situ is paramount.

To provide all necessary information to rescue forces to be able to accurately determine risks associated with a rescue attempt, the Program Office desires communications that are capable of providing digital transmission and receipt, determining the internal pressure of the submarine compartments, and determining the levels of atmospheric contaminants within the compartments. These communications should not rely on DISSUB survivor inputs, should not require permanent onboard installation of equipment, and should minimize power requirements as much as practical. The proposed solutions should be capable of the following: (1) Externally mountable to a submarine hull via Remotely Operated Vehicle (ROV) or Unmanned Undersea Vehicle (UUV); (2) Implosion- and explosion-proof to a minimum of 3000 feet of sea water (fsw); (3) Transmit and receipt of digital data to the surface via relay station onboard an ROV or UUV; (External measurement of internal submarine pressure up to 6 atmospheres absolute (ATA) [Note that the use of available thru-hull penetrators is acceptable, but establishing new penetrators is not desired]); and (4) External measurement of internal atmospheric contaminant levels up to 8 ATA. It is well known that the accuracy of currently available technology to assess atmospheric contaminants under pressure is widely disparate. The solution proposed should take this into account and either provide a scalable correlation or a means of determining tolerances of data provided. At a minimum the solution should be capable of measuring the following contaminants: Carbon Dioxide (CO₂) up to 5 parts per million (ppm), Oxygen (O₂) 13 to 30 %, Carbon Monoxide (CO) up to 50 ppm, Hydrogen Cyanide (HCN) up to 50 ppm, Ammonia (NH₃) up to 300 ppm, Chlorine (Cl₂) up to 10 ppm, Hydrogen Chloride (HCl) up to 50 ppm, and Sulfur Dioxide (SO₂) up to 100 ppm. In terms of technology development effort priority, the proposed solution threshold is the development of digital communications and the objective is the ability to measure atmospheric contaminants.

In addition to being a safety and duty of care issue, continued advancement and modernization of the USN Submarine Escape and Rescue Program is considered an Assistant Secretary of the Navy core field in support of the larger Undersea Warfare effort and directly aligns to both the National Defense Strategy and the Submarine Commander's Intent by defending the homeland, enabling interagency counterparts to advance U.S. influence and national security interests, ensuring USN submarine warfighting readiness and survivability, strengthening alliances, and attracting new partners. The latter was highlighted in the geopolitical outcome following the USN Submarine Escape and Rescue response to the ARA SAN JUAN incident in November 2017.

PHASE I: Develop a conceptual solution that defines the methods and identify the major components required to meet the Navy needs. Determine feasibility by using modeling and simulation to demonstrate the proposed solution. The Phase I Option, if exercised, will include refinement of the proposed solution to support Phase II breadboard and prototype development.

PHASE II: Develop a breadboard design based upon the conceptual solution, including the major components identified, to provide a representative simulation of the proposed solution. Following breadboard testing, refine, as necessary, the design to build and deliver a reduced scale prototype for testing. Depending on schedule and asset availability, test the reduced scale prototype at sea on a submarine platform, but at a minimum via bench-testing in a simulated environment comparable to the anticipated operational environment at NSWC Philadelphia and/or NUWC Rhode Island. Include, in testing, verification of the ability to meet implodability and explodability in accordance with SS800-AG-MAN-010/P-9290 Revision A. Develop the concept of operations for utilizing ROV and/or UUV to support delivery and attachment of the equipment. Develop a Phase III plan.

PHASE III DUAL USE APPLICATIONS: Assist the Government in transitioning the technology for Navy use. Develop, build, and deliver a full-scale through-hull communications system based on the proposed design for use in the support of the USN submarine rescue mission. Test the system(s) at sea in a representative operating environment before transition to a program of record and procurement to support submarine rescue mission needs. Support the development of any required training manuals, technology refresh considerations, and other applicable lifecycle sustainment requirements.

The ability to provide real-time digital communications through various obstructions and monitor and/or externally measure atmospheric conditions of confined spaces is a technology requirement that extends beyond the submarine rescue mission, both in other military and commercial applications. Confined space rescue and the ability to assess

the risks associated with that rescue are also mission needs within organizations such as the National Aeronautics and Space Administration (NASA), Mine Safety and Health Administration (MSHA), and National Institute for Occupational Health and Safety. While the program office's intent is to develop technology that addresses the unique needs associated with a submarine rescue event, potential exists to leverage that technology to address similar needs across these other organizations.

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KEYWORDS: Underwater Communications; Atmosphere Control; Atmosphere Monitoring; Submarine Rescue; Digital Communications; Disabled Submarine Assessment; DISSUB

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N201-047 TITLE: Modular Architecture Framework Model and Application Program Interface for
Common Core Combat System

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Common Core Combat System (CCCS) modular architecture framework and software component Application Program Interface (API) capable of serving as (i) a core combat system architectural upgrade within the current AEGIS system and (ii) the basis for a new platform-agnostic combat system core implementation for Future Surface Combatant (FSC) platforms.

DESCRIPTION: The Navy needs to expand its sea-based advantage through increased capability. This need can be addressed by providing technology that has the potential to improve ship combat effectiveness and efficiency by providing an updated 21st century combat system implementation capable of handling the increased complexity of today's battlespace environment. Such a combat system will provide increased task automation utilizing Artificial Intelligence (AI) technology and Autonomous software concepts, thus reducing the management complexity of the overall battlespace as presented to the combat systems operator. This may allow for potential reduced shipboard manning requirements, increased duty time productivity by reducing the potential stress and fatigue levels experienced by the combat systems operator while performing his duties, and improved affordability.

The current implementation of the AEGIS Combat System has fundamental architectural limitations deriving from its initial hardware and software design constraints. These architectural limitations have forced the use of inefficient "bolt-on" style modernization modifications and enhancements to meet evolving 21st century threats. Currently available commercial systems and software, which might be considered for adaptation to partially address the Navy's ever-growing needs for advanced situational awareness (e.g., the FAA Air Traffic Control System hardware and software), are dated in their designs. They lack the flexibility and track capacity required to adequately address tactical requirements. Specifically, the currently available commercial technology mentioned above is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in a combat environment. Additionally, such commercial systems have no intrinsic ability to provide the other critical weapon and sensor coordination services provided by an effective combat system implementation. Since no viable commercial alternatives exist or can be adapted, it becomes necessary for the Navy to pursue a different avenue of exploration.

A fundamental redesign of the core architecture of the current AEGIS combat systems is needed to enable the efficient, rapid, and cost-effective addition of new capabilities, such as multi-platform sensor and weapons coordination, off-board and organic on-the-fly sensor and weapons integration, built-in cyber resilience, and real-time fault recovery. The Navy needs a software execution framework and API capable of supporting the real-time addition, removal, and control of the major software components constituting a CCCS implementation. The framework and API must also be capable of the real-time dynamic installation, removal, and control of any software modules supporting multiple on-board and off-board sensor and weapons capabilities, as well as any requisite multi-platform integration packages, all without disrupting the real-time performance of the currently executing combat system. Due to the severe tactical real-time constraints placed on the performance of combat-system related software, such as the need for real-time fire-control quality engagement tracking data, target de-confliction data, and identify, friend, or foe (IFF) verification data all synchronized across multiple platforms, the development of a suitable software framework and API capable of meeting the requirements outlined above will demand the application of innovative software architectural design techniques and concepts. To address this critical need, a new CCCS architecture is currently in the planning stage with the intent of providing a modular set of platform-agnostic common combat system services. This CCCS implementation, when supplemented by platform-specific sets of weapon, sensor, and communications capabilities modules, will constitute a new, modular, and dynamically adaptable CCCS design that can evolve to meet future emerging threats in a rapid and cost-effective manner. The innovative technology sought will improve the reliability and efficiency of the re-designed AEGIS Combat System, improving multi-platform tactical coordination, as well as significantly improving battlespace situational awareness, thus reducing the management complexity of the overall battlespace. This allows for a reduction in the number of platforms needed in a specific tactical arena by improving the overall tactical efficiency of the battle group as a whole.

Development of a CCCS combat system modular architectural framework and software component API is critical to the future needs of the Navy. The architectural framework and software component API will be combined with: (i) an appropriate CCCS Ecosystem software execution model and software application/component API; (ii) an appropriate CCCS multi-platform coordination architecture and inter-platform data exchange algorithm set; and (iii) an appropriate multi-platform coordinated/synchronized Distributed Common Operational Picture (DCOP) subsystem to provide a comprehensive architectural model for a complete, versatile platform-agnostic "core"

combat system implementation. The term “core” means this system implementation will provide combat system services and capabilities that are considered necessary to satisfy common tactical warfighting requirements, which span various and diverse surface combatants. This core combat system implementation, when configured with the appropriate surface warfighting platform-specific sensor and weapons capability software modules, will be capable of fulfilling the functional warfighting capabilities and requirements needed to support current U.S. Navy surface platforms well into the future.

The CCCS core architectural model and software framework must first and foremost be capable of supporting underlying CCCS functions (i.e., those combat systems capabilities and functions that are common across the vast majority of major surface combatant platforms, such as track management and weapons engagement planning). The required capabilities and functionality are currently outlined in the PEO IWS1 Combat Systems Top Level Requirements (TLR) documentation suite (currently in draft form). This documentation will be made available on request from NAVSEA PEO IWS 1SP for any Phase II efforts. The intent of this SBIR topic is on the design and prototype of an overarching software architectural framework for a CCCS capable of supporting “on-the-fly” addition, deletion, or upgrade of the modular software capabilities within any arbitrary CCCS implementation (hereafter referred to as an “instance”). The solution will allow for the retention of the real-time response capabilities needed to support modern weapons and sensors control and data linkages in a modular manner and within a modular software architecture with native run-time “on-the-fly” no impact combat systems new capability installation.

Commonly used combat systems services will be implemented within the CCCS via the use of software capability modules. The intent is to support all combat systems capabilities, which would benefit from frequent or periodic updates or upgrades (in order to address our rapidly changing threat environment) through the use of such software capability modules. Those modules, which provide common capabilities across multiple platforms (such as Anti-Aircraft Warfare (AAW), Anti-submarine Warfare (ASW), Anti-Surface Warfare (ASuW), and Ballistic Missile Defense (BMD) track management, weapons assignment, scheduling and control.), as well as modules providing platform-specific weapons and sensor capabilities, will be dynamically upgradable at run-time. This allows for rapid capability upgrade via a capability software module run-time installation or removal management facilities supported by the CCCS. Design of an overarching CCCS architecture and software framework capable of supporting “on-the-fly” addition, deletion, upgrade, and control of such capabilities within any arbitrary CCCS instance, with each capability implemented through the dynamic (i.e., run-time) installation of a loadable software “capability” module is the focus. Installation, removal, activation, and deactivation of such software modules within an executing CCCS implementation should have no adverse effect on the real-time performance of the CCCS system or the services it provides to the host platform and operator at the time those changes are implemented. An exemplar of this type of no-impact behavior during runtime installation and removal of capabilities within an executing system can be observed in the Linux operating system kernel module control facilities (kernel 4.4 and above), such as the insmod, rmmod, depmod, lsmod, modinfo, and modprobe commands [Ref. 2&3]. The process of installing, removing, or otherwise controlling CCCS services and capabilities within an executing CCCS installation should be easily executed by combat systems watch personnel without the need for specially trained software maintenance personnel.

The CCCS system architecture shall incorporate a native suite of inter-module and inter-combat-system (CS)-application data exchange and communications services (IM/ICS service suite). The IM/ICS service suite is intended to support real-time data exchange between capability modules internal to a specific CCCS instance (such as a ship CCCS instance), as well as across multiple CCCS instances (like CCCS instances hosted on multiple warfighting platforms). Access to this suite of data exchange services shall be using a well-defined and documented IM/ICS API, which provides a level of software abstraction between the client capability module software and the CCCS service provision layer and associated software capability modules. This allows the potential future upgrade of core CCCS services without affecting existing compiled CCCS capability modules. When supporting data exchange and communications services between ship and non-organic (such as off-board) CCCS instances, the IM/ICS API shall internally utilize a set of services provided by a modular multi-platform coordination and data exchange (MPC/DEX) services capability subsystem intended to provide such services within a CCCS instance.

One example of a potential software capability module for use within the CCCS is a Multi-platform DCOP support module, which would provide real-time access to a battlespace-wide distributed (multi-platform) common operational picture. Access to such a battlespace common operational picture (COP) will supply critically needed

situational awareness (SA) to the combat systems watch stander. The CCCS would support the dynamic run-time installation of such a DCOP capability via the use of a CCCS dynamically loadable DCOP subsystem module. This DCOP capability module will make use of the IM/ICS API and service suite provided by CCCS to achieve COP coherency across multiple warfighting platforms.

Both the CCCS architectural model and its associated APIs shall be well documented and conform to open systems architectural principles and standards [Ref. 4]. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS Combat Systems BL9 or hardware later environment.

Any delivered software prototypes will be compatible with the C++ programming language and capable of running in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) software execution environment as a standalone application (that is, no critical dependencies on network-based remotely hosted resources, save for sensor data emulators). The prototype CCCS implementation will demonstrate the following abilities: (i) the ability to install, remove, and control (i.e., start and stop) various CCCS capability software modules in an executing system with no impact on system performance; (ii) the ability to demonstrate real-time performance when executing various data exchange operations between organic capability software modules; and (iii) the ability to demonstrate real-time performance when executing various data exchange operations between organic and non-organic CCCS-hosted capability software modules.

The Government will furnish AEGIS BL9 or later combat systems design or architecture documentation, draft Common Core Combat Systems TLR documentation, and any other appropriate material needed to assist in the development of the design effort.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design, develop, and deliver an initial concept design for a CCCS architectural model and software framework capable of meeting the subsystem and API requirements and capabilities outlined in the Description. Establish feasibility to accomplish the requirements through modeling and analysis. Develop a Phase II plan. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Produce a software prototype that is compatible with the C++ programming language and capable of running in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) software execution environment as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources, save for sensor data emulators). Demonstrate that the prototype CCCS implementation has the following abilities: (i) the ability to install, remove, and control (i.e., start and stop) various CCCS capability software modules in an executing system with no impact on system performance; (ii) the ability to demonstrate real-time performance when executing various data exchange operations between organic capability software modules; and (iii) the ability to demonstrate real-time performance when executing various data exchange operations between organic and non-organic CCCS-hosted capability software modules. Ensure that the prototype meets the capabilities outlined in the Description during a functional test to be held at an AEGIS or Future Surface Combatant (FSC) prime integrator-supported Land Based Test Site (LBTS) provided by the Government, representing an AEGIS BL9 or newer combat system hardware environment.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the CCCS system software for Navy use. Integrate the CCCS system software along with other CCCS compliant capability software modules into a prototype combat system implementation on a virtualized hardware environment within an AEGIS-compliant land-based testbed.

This capability has potential for dual-use capability within the commercial Air Traffic Control system in future development of an air traffic control system capable of rapid upgrade to handle increasingly complex traffic control patterns.

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KEYWORDS: Software Execution Environment; Platform-agnostic Combat System Core Implementation; Application Data Exchange and Communications Services; Tactical Warfighting Requirements which Span Various and Diverse Surface Combatants; Platform-specific Sensor and Weapons Capability Software Modules; Software Module Run-time Installation or Removal Management Facilities

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-048 TITLE: MK 48 Torpedo Composite Fuel Tank

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: PMS 404, Undersea Weapons Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type

of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a composite fuel tank that meets the MK 48 torpedo system requirements and increases torpedo in-water performance.

DESCRIPTION: The current MK 48 torpedo fuel tank is manufactured primarily from aluminum. Due to the material properties of aluminum and the resulting product, the current fuel tank has a number of limitations: higher than ideal weight, internal reinforcing structures required for strength reducing internal volume that could otherwise be used for fuel, and a high susceptibility to corrosion.

Due to numerous weapon system requirements, no current commercial off-the-shelf (COTS) solution is available for immediate use by the MK 48 torpedo. Any COTS approach would need to be adapted for MK 48 use and be designed to survive at the maximum operating depth of the torpedo (>1200') and significant torsional loads when putting a composite structure in the middle of a metal torpedo. Additionally, there are high load stresses due to the rapid depth changes, high speed and high turn rates inherent to a torpedo dynamic that other COTS ocean products would not experience.

The Navy is interested in improving the MK 48 torpedoes' performance through an objective of a 20% increase in range and better utilization of more of the Otto fuel in the tank by decreasing or eliminating seawater/Otto fuel mixing during high-speed maneuvers. A secondary goal is to decrease the opportunity for corrosion in the tank, and reducing maintenance and life cycle costs of the fuel storage solution for the weapon. This upgrade for the MK 48 torpedo is important in furthering the Strategic Approach to 'Build A More Lethal Force'. Additionally, topics for improvement include:

Decreased weight: The total weight of the MK 48 torpedo has an effect on the buoyancy of the weapon that affects the torpedo's performance. By utilizing materials with high strength to weight ratios, the weight of the fuel tank can be decreased. The goal for weight reduction is 10% for the fuel tank section. This allows additional fuel or hardware to be installed inside the MK 48 torpedo without affecting the torpedo's performance.

Increased fuel tank internal volume: The current fuel tank has internal ribs and separators that allow the fuel tank to survive the pressure requirements of the torpedo (NAVSEA Drawing 5893767) as well as decreasing the current designs Otto Fuel/Seawater mixing during high-speed maneuvers. By utilizing stronger materials, these ribs can be removed, which would allow for additional fuel storage. Other innovative methods and solutions for creating additional internal volume inside the fuel tank without impacting system requirements are of interest as well. The goal is to increase the usable fuel by 15% or more, which would yield a tactical significant improvement to the weapon.

Better separation of Otto fuel and seawater: Otto Fuel II is the propellant used in the MK 48 torpedo. It has a density greater than water and is immiscible with water, which allows the fuel delivery system to displace consumed fuel with seawater during operation. This reduces the sidewall differential pressure requirement that would be significantly higher if required to operate at the full operational depth of the weapon. However, the seawater displacement system creates the opportunity for mixing during high-speed maneuvers and the ingestion of seawater into the torpedo power plant during operation, which results in shutdowns before fuel exhaustion. The current fuel tank has internal structures to mitigate this potential. However, fuel and seawater separation can be improved by designing improved separation or a better fuel management scheme. This would allow additional fuel to be consumed prior to seawater ingestion. The goal is to increase fuel utilization by 10% by increased Otto fuel/seawater separation.

Reduced fuel tank corrosion: The current fuel tank and internal components are inherently subject to corrosive materials (reactants and seawater), which can cause extensive corrosion damage to high replacement cost items. By increasing the utilization of corrosion-inert materials and decreasing areas that are hard to flush or clean, corrosion damage can be reduced or eliminated along with associated hardware repair and replacement cost. The goal is to reduce fuel tank maintenance between runs and the maintenance required between storage turns by 30%. It is also a

goal to reduce the need for replacement of the fuel tanks by 15% over the normal 20-year or greater life of the weapon.

The awardee will have to apply research in the field of composites to design and manufacture a composite pressure vessel that meets all of the MK 48 fuel tank requirements. Additionally, the awardee will have to determine a method to ensure adequate bonding at the interfaces between a composite fuel tank and existing MK 48 torpedo metal components. Fuel tank requirements include pressure loads; axial and radial force loading; temperature, vibration, shock, impact, and corrosion resistance; atmospheric control requirements; and hazards to electromagnetic radiation on ordnance requirements. The awardee will need to demonstrate that the design approach will withstand the maximum differential pressure that the fuel tank is expected to experience, which is the design test depth of the submarine plus the launch from a torpedo tube. The exact numbers are classified but it is >1200 feet of Seawater. Once these requirements are satisfactorily met, the application of composite pressure vessels can be applied to other cases where pressure vessels are required by the Navy or industry in Undersea Unmanned Vehicles, Naval Mines, and potentially manned submersibles. Fuel separation systems improvements will also require research and development and can be applicable to other fuel handling systems that are seawater compensated.

In order to qualify the design for Navy use, qualification testing will occur during Phase II. The Government will furnish test services for all testing required specific to qualification of the design for the Torpedo (i.e., hydrostatic, land-based propulsion testing with the fuel tank, in-water testing, shock, vibration, thermal). Contractor testing may include bond testing of the composite to metal interface and coupon testing. Government testing will take place primarily at Naval Undersea Warfare Center Division Newport (NAVUNSEAWARCENDIVNPT), Naval Undersea Warfare Center Division Keyport (NAVUNSEAWARCENDIVKPT), or other sites where the Government has unique test capability.

Full Rate Production of the existing aluminum fuel tank begins in FY21 and is projected to go through FY30. Once this new composite fuel tank design is qualified and determined to have cost benefits and/or performance improvement, the Navy anticipates the new tank will be phased into production for replacing the aluminum fuel tank. Replacement of the current inventory of aluminum fuel tanks will also be considered as the MK 48 torpedo is expected to remain in service for at least 30 more years. 700 new fuel tank procurements are planned for the MK 48 Production program and for insertion into a large number active inventories of the U.S. Navy, and/or to be sold through foreign military sales.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Determine the technical concept and feasibility of manufacturing and fielding composite fuel tanks that meet the current requirements including deployment life. Work with the Government to ensure applicable requirements are understood, so that the awardee can develop a design proposal that will address all requirements. Address areas of weight reduction; improved fuel separation/management; technology improvements; and risk reduction of the metal to composite interfaces. Perform analysis on the concept to determine the ability of the concept to meet requirements, including exposure to environments from the stockpile to the target sequence and long-term exposure to Otto fuel. Assess the durability of the composite material to the shipboard handling and storage environment, and damage inspection techniques. Investigate manufacturing processes required to manufacture a prototype fuel tank. Perform a cost analysis to estimate the procurement costs and maintenance cost per 5-year period. Assess the improvements of the MK 48 torpedo's tactical use. The Phase I Option, if exercised, will include the initial design concepts and plan to build a prototype in Phase II.

PHASE II: Design prototype fuel tanks with a minimum of one prototype manufactured to evaluate the proposed design approach. Evaluate the prototypes to determine if the design approach will accomplish the goals of this

project concerning cost reduction, increased performance and decreased maintenance as well as the final design's ability to meet the weapon's environmental requirements. Conduct testing with the Navy to evaluate the increased fuel volume and fuel separation. When Navy specific assets are required for testing, the Navy will provide the assets or conduct the test for the performer. Refine the prototype until it can successfully transition to the Navy. Upon successful validation of a prototype, deliver the prototype(s) to the Government for the completion of MK 48 torpedo integration testing and in-water testing.

It is probable that the work under this effort will be classified (see Description section for details). If the Phase II Option is exercised, the performer will produce production representative prototypes (minimum of 6) that will be used to validate the design requirements against the MK48 torpedo's design.

PHASE III DUAL USE APPLICATIONS: Phase III will finalize the design and manufacturing processes into final products and production drawings. The production of fuel tanks or license the technology to produce operational fuel tanks for the Navy will also be awarded in this Phase. The Phase III awardee will provide production drawings to the Government for configuration management and maintenance of the fuel tanks. The Phase III awardee will document and provide the Government assembly and disassembly procedures, inspection procedures, maintenance procedures, and repair procedures that will be used to support composite fuel tanks for the duration of their service life.

Technology and manufacturing methods developed on this SBIR topic could be transitioned to other military and commercial submersibles and industry for manned or unmanned applications. Commercial application include oil and gas exploration; deep-sea salvage and recovery operations; and deep-sea exploration, as examples.

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KEYWORDS: Composite Fuel Tank; Composite Pressure Vessel; High Strength Material Use in Fuel Tanks; Seawater Ingestion; Displacement of Fuel with Seawater; Corrosion in Fuel Systems

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-049

TITLE: Towed Array Position Estimation System

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 5, PMS 401: Submarine Acoustic Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a system for determining the position of the headline of the towed array relative to some fixed point on the towing platform for incorporation into future towed arrays.

DESCRIPTION: The Navy uses towed acoustic sensor arrays and hull-mounted acoustic sensors to detect submerged and surface vessels. Each type of sensor provides unique capabilities [Ref. 1]. In order to take advantage of capability overlap, it is critical to know key parameters about both systems, including physical location of towed acoustic sensors relative to each other. However, the ability to combine these capabilities is limited because state-of-the-art technology cannot accurately locate the towed array relative to the hull array.

Co-processing sensors provides two main benefits: increasing gain by increasing the number of channels and aperture at the design frequency; and allowing for target ranging and localization (triangulating). The required accuracy is a function of the design frequency of the array. Two (2) wavelengths are sufficient accuracy for position measurement for co-processing purposes [Ref. 2].

The Navy seeks an innovative solution to determine the relative positions of the towed and hull arrays to support coherent processing of the combined arrays. This capability will assist the Navy in maintaining or increasing its tactical advantage in the undersea warfare (USW) domain. While the Navy currently has many capable hull-mounted and towed sensors, there is currently no means to process the towed and hull sensors coherently with each other in order to provide increased awareness of the battlespace and overall performance improvement. The solution sought will provide, in three dimensions, accurate (relative to the wavelength correlating to the design frequency of the array in question), near real-time (less than one sample delay relative to the array sample rate) position data of the towed array headline relative to some fixed point on the towing platform. The array headline position is the most important position, but fully locating the entire array would be of additional interest to the Navy. The desired capability must also permit the desirable capabilities in currently fielded technologies (such as the capability some multi-line towed array systems use to report relative positions of each of several towed lines to each other) [Ref. 3].

The proposed solution must be suitable for packaging within towed arrays (no more than 5.1" long, 0.75" in diameter) and must not cause elevated signatures (e.g., acoustic or electro-magnetic) in a manner that makes the towing platform more detectable. Specifically, the system shall not generate any detectable signals above ambient conditions at a range of 100 yards. While modeling solutions may be part of the solution, it is anticipated that sensor-based elements will be required to achieve sufficient accuracy to attain the desired coherent processing.

Sensor elements associated with the proposed solution must survive extreme environments (as described below) during deployment and must maintain their accuracy within 10% of nominal (inclusive of drift) over the requirements described below. The sensor element(s) must suffer no degradation over a fifteen-year span from time of first use while operating at pressures up to 1200 psi, temperatures over a range of -28°C to 50°C, and accelerations up to 100 Hz over a range of 0.0 g to 25.0 g. The reliability of the sensor element(s) will need to support a Mean Time between Failure (MTBF) of at least 7,000 hours. Testing to validate the technology meets

these requirements will be performed at the Naval Undersea Warfare Center in Newport, RI, or at the contractor's facility if deemed sufficient by the Government.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for determining the position of the headline of the towed array relative to a fixed point on the towing platform. Demonstrate that the concept can feasibly meet all requirements in the Description. Establish feasibility through modeling and analysis. The Phase I Option, if exercised, will include the initial system specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype system for testing. (Note: The Government will provide support for packaging the system within the towed array.) Validate the prototype through testing. Demonstrate that the position of the headline of the towed array does not negatively affect the detectability of the towing platform. Perform testing and validation at a Government-provided facility.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Assist the Government in transitioning the technology for Navy use. Conduct experimentation and refinement to qualify the technology for use on towed arrays within the Advanced Processing Build process. (Note: The Government will provide the performer access to a Navy ship where the final system validation and performance verification will be conducted.) Support installation and removal from an at-sea test platform and assist in data recovery and processing. Use the resulting data to verify the measurements and accuracy of the system.

This technology would prove useful for oceanographic research, oil and gas exploration, congested area traffic monitoring, and other applications where data from multiple disparate sensors are fused to provide a more holistic awareness of the volume being monitored by sensors, especially where sensors are not in fixed locations.

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KEYWORDS: Towed Array; Sensor Fusion; Position Measurement; Acoustic Detectability; Measurement Certainty

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N201-050 TITLE: Real-time Insights for Combat System Integration and Testing

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 5.0: Undersea Systems, Surface ASW Combat System Integration, Surface ASW System Improvement

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative, rapid, iterative capability to monitor, visualize, and assess combat system interface traffic in real-time during integration and testing of combat systems.

DESCRIPTION: Surface ship combat systems represent complex systems of systems, such as the SSQ-89 Anti-Submarine Warfare (ASW) combat system element [Ref. 1], that must adapt to rapidly evolving threats. Integration, testing, and certification of the SQQ-89 are required prior to fielding production systems. These activities are time consuming and costly, throttling the rate of improvement to warfighting capability. Migration to automated testing [Ref. 2] alone for external interfaces has been insufficient to eliminate this throttling effect. The Navy desires to adopt rapid, iterative approaches to capability development and reduce costs, technological obsolescence, and acquisition risk.

A key challenge to the time and cost associated with integration is the testing time spent by engineers and coders during integration and test events trying to gain insight into the cause of errors related to internal interfaces between systems or modules of systems. An ability to monitor, visualize and assess combat system interface traffic in real time during integration and test events would allow real-time root cause analysis and reaction in place of the current time lag, duplicative, and labor-intensive processes.

Development, integration, and element testing is performed at the AN/SQQ-89 prime integrator site. Combat system integration testing of the AN/SQQ-89 with associated combat system elements is performed in conjunction with the appropriate Combat System Engineering Development Site (CSEDS), such as the AEGIS CSEDS at Moorestown, NJ. Real-time insight during integration and testing of combat system elements - both stand-alone and when connected via Ethernet and legacy Naval Tactical Data Systems (NTDS) - facilitates Navy migration to a DEVOPS approach to modular capability fielding. To serve as this enabler for DEVOPS, the real-time analysis must be able to support automated development and test environments with rigorous datagram packet inspection for root cause analysis [Refs. 3, 4].

This capability will have utility for a range of complex interconnected systems that are safety critical, such as military systems, utility systems, and information technology systems.

A real-time integration analysis tool must be developed to test the specific combat system applications and their interactions through the interface. It must conduct deep packet datagram inspection to assess the specific data fields for the application messages sent between the systems. The system must compare the data to government-furnished information (GFI) interface design specifications in order to determine if the message is in error. It must assess

specific data fields within the datagram to find these potential problems; and must assess if the data is out of bounds; and must determine if an older incorrect weapon specification is being used. Testing of the technology sought will take place either at Navy facilities (e.g., Naval Undersea Warfare Center, Newport, RI) or at Navy Prime Integrator sites (e.g., LM RMS at Manassas, VA or LM RMS at Moorestown, NJ).

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a software tool that provides the test team the ability to conduct real-time monitoring, visualization, and assessment of combat system interface traffic. Demonstrate the concept can feasibly support interface traffic in development, integration, and test environments, including automated testing described in the Description. Establish feasibility through modeling and analysis of the tool.

The Phase I Option, if exercised, will involve initial system specification of the performer's solution with associated capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype of the software tool that will focus on supporting SSQ-89 development, integration, and testing. Validate the prototype through testing to demonstrate it achieves the metrics defined in the Description. (Note: The Government will provide access to the facility at LMCO, Manassas, for testing using the prototype software and run-time environment on the interface between the SQQ-89 and the AEGIS VTWIN. The A Government representative will witness a system performance test to verify that it satisfactorily meets the requirements. The test will utilize the Automated Combat System of System Integration Test for Certification tool to run automated operator kill chain actions to fully vet the IDSs.)

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use through the prototype's successful ability to produce a real-time monitoring and assessment capability to support system of systems development, integration, and testing for modular capability improvements using DEVOPS in the SQQ-89 Advanced Capability Build development process.

Commercial applications are possible for software developers, where complex code integration and testing can currently only be assessed after testing or which requires duplicative re-testing to validate fixes could benefit from an approach to achieve real-time insights into integration and testing of information technology infrastructure.

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KEYWORDS: AN/SSQ-89; Errors Related to Internal Interfaces; Assess Combat System Interface Traffic in Real-time; DEVOPS Approach to Modular Capability Fielding; Integration and Test Events; Rigorous Datagram Packet Inspection for Root Cause Analysis

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

~~N201-051~~ [Navy has removed topic N201-051 from the 20.1 SBIR BAA]

N201-052 TITLE: Wide Band Large Aperture Beam Director Head Window

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: NAVSEA 073, Advanced Submarine Systems Development

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a new, environment-friendly, wide spectral band (from visible to mid wave infrared (IR)), high optical transmission (> 99.9% near IR) band, and high strength hydrophobic, greater than 12-inch diameter) submarine beam director head window materials.

DESCRIPTION: The Navy requires an innovative material solution for new large aperture (greater than 12 inch in diameter) and wide spectral band (broadband) optical development for High Energy Laser (HEL) beam director head window with anti-reflection coating (ARC) and water shedding or hydrophobicity ability. At present, there is no large aperture broad spectral band commercially available for a high strength, extreme low loss head window is available. The head window shall be broadband (0.5 to 5 μm) and high strength with a greater than 99.9% transmission at near IR wavelength. The bandwidth of the material shall be within greater than 80% - both in visible and MWIR band. The head window shall also have near broadband (visible to MWIR) ARC, water-shedding (hydrophobicity), non-fouling and service life performance of the HEL beam director head windows (or imaging

windows).

Residual water (seawater, rain) on a small craft operation near the marine wave boundary layer head window will lead to the delivery of the HEL optical power at greater than 100 kW with less than 0.1 percent total loss at HEL pass band. The proposed head window shall withstand static pressure equal or greater than the current fused silica window (thickness 3 inch), the head window material used in submarine imaging system window. Removing or shedding water fully and completely is critical to the successful operation of the beam director system. In addition, HEL beam director head windows are affected by micro fouling, which is currently one of the prime causes of reduced water shedding performance or hydrophobicity of the head window material.

The Navy needs an innovative approach to develop broadband large aperture window materials. The proposed window shall have broadband anti reflection (AR) coating and hydrophobicity, with a contact angle greater than 130°, with a goal of greater than 150°. The optical transmission of the window at near IR wavelength shall be greater than 99.9 percent, at visible and at 0.5- μm wavelength with 90% transmission, including any absorption and scattering from the optical surface. The window random anti reflection (RAR) coating shall be able to withstand HEL power greater than 100kW. The proposed HEL window material shall have superior hydrophobicity and micro fouling or performance against salt sedimentation, which are major causes of any degradation, by no more than 10 percent during 15-year life of the head window. In addition, the window materials should be capable of being cleaned using normal maintenance and cleaning procedures without causing damage to the hydrophobicity of the surface or AR coating. The window materials shall survive in an environment including temperatures from -40°C to 60°C, thermal shock (hot air at +80°C to warm water at +50°C and cold air at -54°C to cold water at 10°C), severe icing, and ultra violet (UV) sunlight. The broadband large aperture beam director head should have RAR and IR coating and hydrophobicity technology that meets the above requirements and can, in addition, be applied to other types of HEL beam director head window materials such as sapphire, spinel, and aluminum oxynitride (referred to as ALON).

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for new and innovative materials for wide spectral band large aperture beam director head windows. Conduct a feasibility study to demonstrate the viability of the proposed broadband high transmission materials with RAR coating through modeling and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop the window material, ensuring that the materials will support RAR, hydrophobic, non-fouling technology. Develop large aperture window materials for HEL application. Document the results and demonstrate the feasibility of the manufacturing concepts. Identify suitable candidate materials (e.g., sapphire, spinel, and ALON), low transmission loss (less than 0.1%) processes at 1 μm , and transmission higher than 90% (both in 0.5 and 5 μm spectral band). Ensure that the concept highlights process techniques to improve HEL beam director head window hydrophobicity and RAR. Propose the selection of a final material for window materials and AR coating and hydrophobicity technology candidate(s). Develop and deliver a large aperture (12 inches diameter) low transmission loss (at 1 μm , > 99.9%), hydrophobicity and AR coating window material test coupon to the Navy lab to carry laser power (less than 100kW), environmental and stress test. Characterize the head window service life and determine service life protocols (e.g., service life, in-service maintenance) for the developed AR coating on actual head window materials. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for operational use. Manufacture the successful materials, hydrophobicity, and coating based on the mechanical and environmental constraints of the HEL beam director.

This technology can be used in commercial airlines and satellite imaging systems.

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KEYWORDS: Electro-Optics; Hydrophobic; Hydrophobicity; Non-Fouling; Non-Hazardous; Marine Wave Boundary Layer; MWBL; High-energy Laser Beam Director; HEL

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-053 TITLE: Development of New Generation Earth Covered Magazine (ECM) Structure Design using Composite Materials

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: Naval Ordnance Safety and Security Activity (NOSSA)

OBJECTIVE: Develop lightweight materials and associated structural components to produce a more efficient means to construct Earth Covered Magazines (ECMs) while keeping the same or higher level of protection capability, making it easier to maintain and upgrade them, and enabling the military to fabricate the munition

structure under field conditions.

DESCRIPTION: The defense technology based on the weapons effect phenomenology can increase the functions of weapon storage structures by adopting new generation structural members with improved energy absorption. The design of ECM storage facilities has been standardized by developing several typical models. The primary components of the ECM structure are concrete walls, concrete roof, basement, blast door, and earth cover. Design details very typical of hardened structure design before 1945 are employed. Few changes to this design concept have been made, and the standard design is still being used, even though there have been important technical developments in blast resistant structure design concepts.

The Navy seeks innovative, advanced materials specifically found advantageous for enhancing blast resistance, which will be considered to replace the standardized heavy concrete structures of the past and will afford for deployment of much more lightweight and easily constructed ECMs. This new approach to the design of ECMs is to employ modular components fabricated from composite structural components, which has many advantages for various types of munitions storage facilities both at a base and in the field. The material or structural members will be developed to maximize blast effect resistance and then, three types of structures will be designed to show the applicability, efficiency and feasibility of the developed material/component to ECM design and construction. Various ECM standard designs are currently being used. The general dimension of the ECM in rough measure is in the range of 30 ft. X 30 ft. X 30 ft. to 100 ft. X 100 ft. X 30 ft., with normal concrete thickness of more than three ft. Tunnel and standalone ECM module type have totally different measurements. Cost and function shall be evaluated by comparison with Navy standard design of concrete structures to show efficiency.

The development is planned in three steps – composite material development, module development, and module application to the ECM. Based on selected or developed composite material, a structural module will be developed. A Lego-type module integration, which will be assembled to the ECM, will be designed by computer simulation and validated by full-scale testing. Full-scale structural testing, assembled by developed modules, can hardly be conducted in this project due to limited cost. Instead, the construction procedure can be precisely reviewed by using building modeling information (BMI) techniques to acquire preliminary information about construction procedure and detail cost.

PHASE I: Identify the blast resistant capacity through energy absorption mechanism of the various materials followed by a study of the participation of the identified foams in composite members. The developments in Phase I shall include:

- Efficient blast resistant composite components based on high-fidelity physics-based (HFPB) analytic simulations shall be generated.
- Lab tests for dynamic material characteristics of the materials for energy absorption function shall be conducted.
- Materials shall be identified by using test results to show the contribution of each material in composite action.
- HFPB analysis shall be conducted to show efficiency of the identified material model against the frequency and magnitude range of the blast load. The results of Phase I research shall give solid insight about the practical applicability of the members when it is applied to the magazine or related hardened structures in extensive and comprehensive research in Phase II.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to design a prototype solution in Phase II.

PHASE II: Based on the results of the Phase I, with sufficient and convincing insight of the application of composite materials to the magazine and related hardened structures, practical design and validation through integrated member testing. Develop a comprehensive new generation design of ECMs. Ensure that the components and modules can be deployed for the construction of different ECM structures requiring hardened capacity or a high level of blast resistance. Include:

- Development of a module design suitable for fabrication from the results of HFPB analysis for materials and structural components.
- Development of structural designs in accordance with the design guidelines specified by UFC (Unified Facility Criteria) and DDESB (Department of Defense Explosives Safety Board) technical notes.
- Testing of optimal designs of the composite material with three different levels of blast resistant capability

according to the applied blast loadings in reference to the ECM design guideline.

- Consideration of a modular concept of the ECM structures to control the local damage and make the maintenance effective and efficient.
- Full scale detonation testing of integrated modules with the boundary conditions and connection conditions for validation of the development, which is the basic module to the structural assembly.
- Production of standard drawings of the three structures with the modular concepts in the same format as the conventional design. Provide the construction and fabrication simulation with BMI technology.

PHASE III DUAL USE APPLICATIONS: The developed design of the practical structures will be extended to more standard designs those were established before 1980's. Also, the developed and validated structural members and integrated modules will be assembled by modeling and simulation (M&S) and BMI to check any remaining practical problems to be solved.

The developed design of the practical structures can be extended to more standard designs those were established before 1980's. Also, the developed and validated structural members and integrated modules will be assembled by modeling and simulation (M&S) and BMI to check any remaining practical problems to be solved. It can be applied not only the new construction of the new generation magazine structures but for the pure protection of the commercial structures. According to the protection level adjustment, enhancement of the magazine storage capacity can be pursued by the developed design.

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KEYWORDS: Magazine Structure; Blast Loading; Energy Absorption; Composite Material; ECM Modular Design; ECM Modeling and Simulation; Full Scale Detonation test; Earth Covered Magazine; ECM

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-054

TITLE: Coordinated, Layered Defense Capabilities of Multiple Torpedo Countermeasures

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMS 415, Undersea Defensive Warfare Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a capability for acoustic torpedo countermeasures to coordinate focused layered defense strategies against incoming advanced threat torpedoes.

DESCRIPTION: All submarines are currently protected by 6-inch and 3-inch diameter expendable torpedo countermeasures that, upon launch, act autonomously and independently to thwart adversarial weapons. Adversarial weapons are becoming more and more sophisticated requiring the Fleet to develop smarter and more capable countermeasure devices. It is the intention of this effort to develop additional capabilities that can be incorporated into current and future torpedo countermeasures to provide increased platform protection. As such, the innovation sought by the execution of this effort is to develop the ability for multiple acoustic countermeasures to coordinate a layered defense against adversarial torpedoes. The countermeasures, which are based either on the existing three-inch diameter Acoustic Device Countermeasure (ADC) Mk 2 Mod 7 and/or the existing six-inch diameter ADC Mk 3 Mod 1, would have the ability to identify the incoming direction of a threat torpedo through an onboard receiver(s) or other devices/platforms in the engagement. Additionally, the solution will use its relative positions to provide spatial, temporal, and spectral defensive protection for the host platform. The ability to detect the threat, identify threat localization, and implement appropriate threat acoustic responses amongst a potentially highly cluttered acoustic environment will be evaluated. The specific acoustic response would be based on the existing acoustic modes of the current ADC, depending upon the chosen form factor for the design. The innovation challenges involved in this topic execution are twofold: first, coordination of the communication capabilities amongst multiple torpedo countermeasures and with the host submarine platform need to be robust in what is anticipated to be an acoustically cluttered environment; second, technology advancements are needed to provide this coordinated capability (on-board receiver and identify friend or foe (IFF) and communication logic) without driving significant increase (less than 25%) in unit cost and not significantly changing the form factor of the baseline device (either 6-inch diameter, 100-inch long, 120 pounds or 3-inch diameter, 39.5-inch long, 10 pounds). By providing these additional features, these advanced countermeasures will possess the ability to reduce the number of devices needed to thwart adversarial threats with a reduced number of devices, thus offsetting the anticipated increased unit cost per device. The Technical Point of Contact will provide Testing and evaluation criteria on an as needed basis.

Environmental stress testing will take place at facilities maintained by the Naval Undersea Warfare Center in Newport, Rhode Island. Initial baseline testing (acoustic and coordinated capabilities) will be the responsibility of the executing company, while any follow-on testing will be the responsibility of the Navy, with the company's anticipated assistance. .

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop an end-to-end design and implementation concept for a coordinated countermeasure using acoustic or non-acoustic technologies, including (1) receiver technologies and (2) on-board electronics that are powered by the same power supplies currently in use by the legacy devices: either thermal lithium like the ADC MK 2 MOD 7, or silver chloride seawater activated battery like the ADC MK 3 MOD 1, to provide the capability to identify incoming threat torpedoes and send the appropriate signals to the existing acoustic projector to thwart the threat. Consider a device solution that is based on the existing legacy devices: ADC MK 2 MOD 7, and/or ADC MK 3 MOD 1. Establish feasibility of the proposed concept. Evaluate the operational ability of the device design will be evaluated per the requirements in the Description. The Phase I Option, if exercised, will include the initial system specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and build three to five prototype systems for testing and evaluation. Conduct evaluation and testing of the prototypes based on the anticipated inter-countermeasure and countermeasure from/to host platform communication links, which are expected to be simplistic, yet robust, and have the ability to avoid host-platform "beaconing." Ensure that the specific acoustic response would be based on the existing acoustic modes of the current ADC Mk 2 Mod 7 and/or ADC Mk 3 Mod 1, depending upon the chosen form factor for the design. Evaluate the robustness of the communications technology. Subject the prototype devices to limited environmental testing and design risk reduction evaluations. Focus testing primarily on the evaluation of the communications implementation, with environmental stress testing, as noted in the Description, folded in to mitigate operational design risks. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Deliver five to six follow-on prototypes (incorporating any lessons learned from the Phase II prototyping and testing efforts) and engineering support for full environmental testing. Conduct the following testing: storage temperature thermal cycling (-54°C to +71°C) testing; shock testing (MIL-S-901D), hydrostatic testing to submarine operational depths, internal countermeasure launcher acceleration testing (via the Naval Undersea Warfare Center Division Newport's internal countermeasure launcher facility), and any additional evaluation testing for the newly developed communications technology, including, in-water acoustic testing in a demonstration on an instrumented Navy test range. (Note: Some of this testing may occur in Phase II if the Phase II prototype design is a mature representation of a potential low-rate initial production design.) Depending on platform availability, it is anticipated that some, or all, of the prototypes will be evaluated through real-world range operations with active torpedoes or with a host submarine. Ultimately, the primary focus within a Phase III effort will be on evaluating the ability of the devices to coordinate collectively for effective host platform protection, while showing resiliency against applicable environmental stressors.

Alternative naval applications include sonobuoys (launched on the surface whereas the intended innovation product is launched from submarines), training targets, and alternative acoustic devices launched from various platforms. Some commercial applications include marine mammal acoustic diversions and geological exploration.

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KEYWORDS: Torpedo Defense; Acoustic countermeasure; External Countermeasure Launcher; Internal Countermeasure Launcher; Anti-submarine Warfare; Detection and Tracking

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N201-055 **TITLE:** Coaxial Insulated Bus Pipe for High Energy Application

TECHNOLOGY AREA(S): Electronics

ACQUISITION PROGRAM: PMS 407, Surface Ship Modernization; Robust Combat Power Control FNC

OBJECTIVE: Develop a Medium Voltage Direct Current (MVDC) coaxial Insulated Bus Pipe (IBP) conductor and associated components for integration onto U.S. Navy ships.

DESCRIPTION: A MVDC coaxial IBP conductor with the associated connectors, bulkhead penetrations, and shock excursion mounts for transmission of MVDC with voltages in the range of 6 kV to 12 kV and ampacity from 2000 to 4000 amperes is required to mitigate the challenges associated with cabling of available IBP technologies. Existing cables are limited in ampacity to approximately 400-700 amps per conductor, which requires multiple paralleled cables and terminations. Multiple paralleled copper cable conductors are difficult to install, heavy, and require more of the ship's internal volume to meet the needs of future surface combatants. As such, higher conductor capacities are desired to support higher power distribution without the need to install and maintain multiple parallel cables and the associated terminations.

The Navy, as well as shipyards, are seeking an innovative MVDC IBP conductor to improve power transmission and modular ship construction. Prior developments resulted in single phase IBP design appropriate only for Medium Voltage Alternating Current (MVAC) Navy distribution systems. Magnetic fields in MVDC IBP must be limited so as not to disrupt other systems nor increase the ship's magnetic signature. To mitigate the magnetic fields of high power parallel MVDC conductors, a coaxial IBP configuration with the associated connectors, bulkhead penetrations, and shock excursion mounts are required.

This effort will require finding innovative solutions to enable bus pipe technology to meet Naval traditional operating environment requirements. These requirements are in accordance to the Navy's MIL-STD-1399. The proposed design must be able to support a range of voltages from 6kVDC to 12kVDC and currents from 2000 to 4000Amperes. 3000Amperes at 12kVDC provides 36MW, which will allow a single coaxial MVDC IBP to support most loads. The design must also address shock excursions of bulkhead penetrations and mounts.

Cost impacts will be evaluated for both the replacement of conventional cabling with IBP and tradecraft manpower reductions due to the configuration changes to preformed modular sections rather than pulling multiple long lengths

of heavy cable throughout the ship during construction.

In modular Navy ship construction, connection tubes and terminations must be maintenance free to reduce the risk of loose-connections and associated arc-faults. IBP must also meet US Naval application specification and standards to include Shock Tests (MIL-S-901); Cables, Electric, Low Smoke Halogen-Free (MIL-DTL-24643); Electromagnetic Interference Characteristics Requirements for Equipment (MIL-STD-461); Electromagnetic Environmental Effects Requirements (MIL-STD-464); 1399-MVDC interface specification; and IEEE 1580.1. A MVDC bus pipe specification does not currently exist; however, the MVDC IBP system is expected to comply with applicable Military standards and specifications, such as shock, fire and Electromagnetic Interference (EMI). Electric and magnetic fields must be managed and comply with Navy EMI requirements.

PHASE I: Develop a concept for MVDC coaxial IBP conductor and associated connectors, bulkhead penetrations, and shock excursion mounts for transmission of 6 kVDC to 12 kVDC to support high power loads in Navy high power systems.

Demonstrate the feasibility of a MVDC coaxial Insulated Bus Pipe design concept that meets the needs of the Navy as defined in the Description. Identify the technical feasibility of the proposed concept, and demonstrate the concept through modeling, analysis, and/or bench top experimentation where appropriate. Capture the technical feasibility and estimated production costs for the proposed concept in the Phase I Final Report. During a Phase I Option, if exercised, awardees will provide for initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design and build prototype IBP sections in straight and complex configurations. Design and manufacture connectors necessary for testing. Provide viable design of bulkhead penetrations and mounts allowing for shock excursions.

Develop a test plan to validate IBP to proposed Navy IBP standards. Test IBP prototypes to U.S. naval application specifications and standards to include: MIL-S-901, MIL-DTL-24643, MIL-STD-461, MIL-STD-464, 1399-MVDC interface specification, and IEEE 1580.1.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. The use of Insulated Bus Pipe in Navy construction will allow for modular installation and enable optimized workflow of high-power distribution systems installation in ship construction.

Power distribution systems in all commercial Medium Voltage high current applications will benefit with reductions in size, weight and cost of cabling. Current commercial applications are in cruise ship design and urban underground power distribution in constrained environments.

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KEYWORDS: Insulated Bus Pipe; IBP; Solid Conductor; Coaxial DC Power; Modular Ship Construction; Bulkhead Penetration; MVDC Distribution; Medium Voltage Direct Current

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N201-056 TITLE: Data Exchange Subsystem Architectural Framework, Algorithm Set and Applications Program Interface for Common Core Combat System

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an architectural framework, algorithm set, and Applications Program Interface for a Common Core Combat System (CCCS) Modular Multi-platform integration and coordination Data Exchange (MPDEX) subsystem capable of providing data synchronization and common operational picture coherency across multiple coordinating warfighting platforms.

DESCRIPTION: The current implementation of the AEGIS Combat System has fundamental architectural limitations deriving from its initial hardware and software design constraints. These architectural limitations have forced the use of inefficient "bolt-on" style modernization modifications and enhancements to meet evolving 21st century threats. Currently available commercial systems and software that might be considered for adaptation to partially address the Navy's ever-growing needs for advanced situational awareness (SA) (e.g., the FAA Air Traffic Control System hardware and software) are dated in their design. They lack the flexibility and track capacity required to adequately address tactical requirements. Specifically, the currently available commercial technology mentioned above is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in a combat environment. Additionally, such commercial systems have no intrinsic abilities to provide the other critical weapon and sensor coordination services provided by an effective combat system implementation. Since no viable commercial alternatives exist or can be adapted, it becomes necessary for the Navy to pursue a different avenue of exploration.

A fundamental architectural redesign of the combat system's core is needed to enable efficient, rapid, and cost-effective addition of new capabilities, such as multi-platform sensor and weapons coordination, off-board or organic on-the-fly sensor and weapons integration, built-in cyber resilience, and real-time fault recovery. To address these critical needs, a new CCCS architecture is currently in the planning stage, with the intent of providing a modular set of platform-agnostic common combat system services.

This CCCS implementation, when supplemented by platform-specific sets of weapon, sensor, and communications capabilities modules, will constitute a new modular and dynamically adaptable combat system design that can evolve to meet future emerging threats in a rapid and cost-effective manner. An innovative virtual communications channel, a data exchange architectural model, and a software framework that utilizes all available physical data communications pathways in an opportunistic manner are needed to insure real-time communications responses.

Each virtual channel supported by this subsystem shall be fully characterized, and that characterization must be maintained dynamically throughout the effective lifetime that the channel is needed. The virtual channel subsystem developed will be utilized within the CCCS architecture currently under development in PEO IWS 1 to provide redundant, resilient, and radio frequency (RF) environment-adaptive real-time tactical data communications across multiple warfighting platforms within a battlegroup.

The innovative technology will improve the reliability and bandwidth of cross-platform combat systems data exchange services, thus improving multi-platform tactical coordination. In addition, this technology will significantly improve battlespace SA, thus reducing the management complexity of the overall battlespace. This allows for a reduction in the number of platforms needed in a specific tactical arena by improving the overall tactical efficiency of the battlegroup as a whole.

Development of an MPDEX architectural framework, algorithm set and Applications Program Interface (API) for use within the CCCS architecture, or as a modernization enhancement for future AEGIS baselines, is needed. MPDEX should, when taken in conjunction with (i) an appropriate CCCS core combat system modular architectural framework and software component API, (ii) an appropriate CCCS Ecosystem software execution model and software application or component API, and (iii) an appropriate multi-platform coordinated and synchronized Distributed Common Operational Picture (DCOP) subsystem, provide a comprehensive “core” architectural model for a complete, versatile platform-agnostic combat system implementation. “Core” means this system implementation will provide combat system services and capabilities satisfying common tactical warfighting requirements that span various and diverse surface combatants. This core combat system implementation, when configured with the appropriate surface warfighting platform-specific sensor and weapons capability software modules, should be capable of fulfilling the functional warfighting capabilities and requirements needed to support current U.S. Navy surface platforms well into the future.

The CCCS MPDEX will provide a CCCS modular cross-platform data exchange mechanism and synchronization capability through utilization of current shipboard communications services. MPDEX will make maximum use of currently available hardware-based communications facilities or other high-level communications capabilities in a manner intended to satisfy the following design criteria. First, it will need to increase the overall reliable/guaranteed bandwidth. Second, it will need to improve connection reliability and anti-jam resistance. Lastly, it will need to provide automatic hardware-connection “fail-over” capability in the event of loss of a hardware-based connection pathway. One method to achieve this goal is by utilizing the concept of “dynamic hardware channel bonding and aggregation”, in which a set of “virtual communications channels” are created and managed by the MPDEX algorithms and architecture resident within combat system host platform implementations operating at both communications endpoints. Each virtual communications channel will be associated with a “virtual” communications transceiver (or “node”) instance, capable of supporting the combat system’s network application layer. From the point of view of the combat system and its underlying network application layer, a “virtual” communications channel will appear and function as a “generic” physical communication interface and matching transceiver, supporting the same capabilities as other physical shipboard wireless transceiver suites. Software modules (and other client applications within the combat system) requesting the creation and/or assignment of a MPDEX virtual channel will be able to specify a set of minimum performance parameters for that channel, including minimum acceptable data up/down transfer bandwidth, data senescence/delay, maximum acceptable jitter, etc. during channel creation. Virtual channel Quality of Service (QOS) performance parameters (based on the metrics provided by the client application during channel creation and instantiation) will also be maintained in real time for each executing virtual channel instance and be made available to the client application by the MPDEX API. Client applications could qualify their requests for communications services through the MPDEX API by specifying minimum QOS parameters (e.g., data senescence, jitter, maximum and minimum bandwidth) needed for the task at hand. The potential parametric ranges for the requirements above will be wholly dependent on the requirements of any potential combat system client applications, but any prospective MPDEX implementation should be able to satisfy parametric requirements that range from single-digit millisecond to minutes (for data delay and jitter), and from kilobytes/sec to gigabits/sec (for bandwidth). It is important to note that there may also be other design approaches that achieve the capabilities described; however, any successful technological implementation must be capable of meeting the three design criteria outlined above.

MPDEX will provide a well-defined and documented API, which will allow combat systems software modules (and other client applications) to access MPDEX services. These services will include the ability to request the creation,

deletion, reassignment and release of a virtual channel, the ability to specify or modify the minimum performance parameters for that channel, the ability to monitor the performance of that channel, and the ability to support a multi-platform channel endpoint discovery service.

The MPDEX subsystem and its associated API shall be well-documented and conform to open systems architectural principles and standards [Ref. 4]. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS Combat systems BL10. It will run in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) environment. The MPDEX technology will demonstrate the following: first, the ability to create, manage, and destroy virtual communications channels based on the aggregation of a number of available physical communications channels, effectively bonding the data streams from those multiple physical channels into a single virtual data stream of higher reliability and bandwidth; second, the ability to dynamically reallocate physical channels at run-time across a virtual channel suite with minimal or no degradation in current system performance in order to maintain specified performance parameters for each virtual channel; and, lastly, the ability to monitor and report on the real-time performance of each virtual channel.

The development of the technology proposed in this topic will significantly improve the reliability and bandwidth of cross-platform Combat Systems data exchange services, thus improving multi-platform tactical coordination and having the potential to significantly improve battlespace SA, thus reducing the management complexity of the overall battlespace, which may allow for a reduction in the number of platforms needed in a specific tactical arena by improving the overall tactical efficiency of the battlegroup as a whole, with an associated overall improvement in affordability.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop an initial concept design for an MPDEX architectural model and algorithm set capable of meeting the subsystem and API requirements and capabilities outlined in the Description. (Note: The Government will furnish AEGIS BL9 or later combat systems design/architecture documentation, draft Common Core Combat Systems TLR documentation, and other appropriate material needed to assist in the development of the Phase I design effort.) Determine the feasibility of the concept by modeling and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop a prototype MPDEX architectural model and algorithm set that meets the parameters detailed in the Description. Evaluate the prototype to ensure it meets an MPDEX design commensurate with the requirements outlined in the Description. Ensure that the prototype demonstrates the capabilities outlined in the Description during a functional test that will be held at an AEGIS and/or Future Surface Combatant (FSC) prime integrator supported Land Based Test Site (LBTS) capable of providing simulated physical communications hardware supporting multiple modalities and representing an AEGIS BL9 or newer combat system hardware environment. Provide a Phase III plan to transition the technology to Navy use.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the MPDEX subsystem software to Navy use. Integrate the MPDEX subsystem software along with other CCCS compliant capability software modules into a prototype combat system implementation, consisting of a CCCS experimental prototype, implemented on a virtualized hardware environment within an AEGIS compliant land-based testbed. (Please note that the CCCS concept is currently being developed by PEO IWS 1SP as a potential AEGIS Combat System future replacement, as well as an initial combat system implementation for the planned FSC program currently envisioned by OPNAV

N96.)

This capability has potential for dual-use capability within the commercial Air Traffic Control system in future development of an air traffic control system capable of rapid upgrade to handle increasingly complex traffic control patterns.

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KEYWORDS: Virtual Communications Channel; Coordination Data Exchange Subsystem; Real-time Communications; Multi-platform Sensor and Weapons Coordination; Sensor and Weapons Capability Software Modules; Virtual Channel Performance Parameters

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N201-057 TITLE: Software Ecosystem Architectural Model and Application Program Interface for Common Core Combat System

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Combat System Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on

this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Common Core Combat System (CCCS) software application execution and cross-application coordination environment (ecosystem) and associated Application Program Interface (API) capable of supporting various DoD- or 3rd-party-sourced dynamically loadable real-time tactical combat systems client applications.

DESCRIPTION: The Navy requires expansion of its sea-based advantage through increased capability. This need is addressed by providing technology that has the potential to improve Combat Systems client applications real-time performance (and the overall tactical performance and effectiveness of the host surface platform), as well as enabling multi-platform software re-utilization and commonality. This may allow for a reduction in the number of platforms needed in a specific tactical arena by improving the overall tactical efficiency of the battlegroup as a whole, resulting in a subsequent improvement in overall affordability.

The current implementation of the AEGIS Combat System has fundamental architectural limitations deriving from its initial hardware and software design constraints. These architectural limitations have forced the use of inefficient “bolt-on” style modernization modifications and enhancements to meet evolving 21st century threats. Currently available commercial systems and software that might be considered for adaptation to partially address the Navy’s combat systems requirement for advanced situational awareness (SA) (e.g., the FAA Air Traffic Control System hardware and software) are dated in their designs. They lack the software flexibility and track monitoring capacity required to adequately address tactical requirements. Specifically, the currently available commercial technology mentioned above is limited in that it lacks the capability to track, identify, and manage complex air, surface and subsurface entities and threats present in a combat environment. Additionally, such commercial systems have no intrinsic ability to provide a real-time-response-capable software execution environment for DoD- or 3rd-party-sourced combat systems client applications. Since no viable commercial alternatives exist or thus cannot be adapted to address these needs, it becomes necessary for the Navy to pursue a different avenue of exploration.

The Navy needs a combat systems application software execution environment (i.e., software “ecosystem”) for use within a host CCCS (or AEGIS) environment. This software ecosystem will support various DoD- or 3rd-party-sourced dynamically loadable real-time tactical combat systems client applications, all potentially executing simultaneously within the software ecosystem. Here “dynamically loadable” means that a client application can be loaded and started at operator discretion within a currently executing combat system instance, without the need to reload, restart, or otherwise interfere with the current running status of the combat system. The software ecosystem must also provide these client applications with a common API enabling access to combat systems weapon, sensor, and Common Operational Picture data in a real-time manner. The innovative challenge in this design task derives from providing these services without jeopardizing or degrading the overall real-time performance of the other simultaneously executing client applications or the host combat system itself. A fundamental architectural redesign of the combat systems core is needed to enable the efficient, rapid, and cost-effective addition of new capabilities, such as multi-platform sensor and weapons coordination, off-board/organic on-the-fly sensor and weapons integration, built-in cyber resilience, and real-time fault recovery. To address this critical need, a new CCCS architecture is currently in the planning stage, with the intent of providing a modular set of platform-agnostic common combat system services. This CCCS implementation, when supplemented by platform-specific sets of weapon, sensor, and communications capabilities modules, will constitute a new, modular, dynamically adaptable combat system design that can evolve to meet future emerging threats in a rapid and cost-effective manner.

Development of a CCCS software application execution and cross-application coordination environment (ecosystem) and associated API is critical to the future needs of the Navy. Such a capability will allow for the rapid integration of new tactical capabilities within a currently installed and running combat system instance. This software ecosystem is intended to serve as: (i) a core combat system architectural enhancement within the current AEGIS system; or (ii) a primary modular component within the newly proposed CCCS platform-agnostic combat system, intended for implementation on Future Surface Combatant (FSC) and other appropriate Navy platforms.

The CCCS modular ecosystem architectural framework and software component API should provide a comprehensive architectural model for a complete, versatile platform-agnostic “core” combat system, when taken in conjunction with: (i) an appropriate CCCS core combat system modular architectural framework and software

component API; (ii) an appropriate CCCS multi-platform coordination architecture and inter-platform data exchange algorithm set; and (iii) an appropriate multi-platform coordinated/synchronized Distributed Common Operational Picture (DCOP) subsystem implementation. The term, “core” implies that this system architecture and implementation will provide those combat system services and capabilities that are considered necessary to satisfy common tactical warfighting requirements spanning various and diverse surface combatants. This core combat system implementation, when configured with the appropriate surface warfighting platform-specific sensor and weapons capability software modules, should be capable of fulfilling the functional warfighting capabilities and requirements needed to support the vast majority of U.S. Navy surface platforms well into the future. The CCCS modular applications program execution and cross-applications data exchange and coordination environment (hereafter referred to as the “ecosystem”) will provide a software execution environment supporting multiple dynamically loadable (i.e., run-time loadable) combat systems operator controlled and/or autonomous applications. The ecosystem will support application performance monitoring and control services as well as inter-application (ship and cross-platform or battlegroup) coordination and data exchange services, all provided via a well-defined and documented ecosystem API. The architecture of the API will provide a layer of software abstraction hiding any implementation-specific details of CCCS provided lower-level software communications and control services.

The CCCS ecosystem architectural model and software framework will support a software execution environment and API capable of supporting a scalable number of independently executing combat systems applications and autonomous AI-based software agents or entities, such as tactical and engagement planning tools, multi-platform weapons control and assignment tools, and AI-based situational awareness autonomous agents. Within the ecosystem, each application or entity will be capable (when granted the appropriate access permissions) of accessing: (i) ship- or battlegroup-hosted weapons and sensor system control elements system status and sensor data; (ii) DCOP data; (iii) inter-application cross-platform data exchange and messaging services; and (iv) host combat system (i.e., CCCS) ecosystem software management performance monitoring metrics and applications execution controls.

With respect to ship-based ecosystem applications accessing organic-hosted (such as ship) capabilities, all four of the access categories listed above should support real-time access and control. With respect to ship-based ecosystem applications accessing non-organic-hosted (such as battlegroup) capabilities, near real-time performance should be the goal. The ecosystem architecture and its API will support a Quality-of-Service (QOS) application and local and remote capabilities performance monitoring subsystem. This subsystem should be capable of providing QOS metrics for each off-board capability to any application granted access to that capability. The QOS metrics for any capability should be based on appropriate weapons communications control-loop delay and sensor data delay measurements derived from periodic automated communications-loop access senescence and jitter testing of off-board capabilities.

The ecosystem subsystem software architecture and API framework should be modular in nature. The installation, removal, activation, and deactivation of the ecosystem modular software within an executing CCCS implementation (or other host combat system) should have no adverse effect on the real-time performance of the CCCS system or the services it provides to the host platform and operator at the time those changes are implemented. An exemplar of this type of no impact behavior during runtime installation and removal of capabilities within an executing system can be observed in the Linux operating system kernel module control facilities (kernel 4.4 and above), e.g., the `insmod`, `rmmmod`, `depmod`, `lsmod`, `modinfo`, and `modprobe` commands [Refs. 2, 3]. The process of installing, removing, upgrading, or otherwise controlling the ecosystem software implementation module within an executing CCCS installation should be easily executed by combat systems watch personnel, without the need for specially trained software maintenance personnel.

The CCCS ecosystem API architecture and software framework will provide a native suite of Ecosystem cross-application and cross-platform data exchange and message services. The API will provide a level of software abstraction, masking the underlying implementation details of the communications services framework of the CCCS (or host combat systems) that it utilizes. The ecosystem API will also provide ecosystem resident software applications and entities with an access-controlled combat system weapons and sensor-system data real-time- or near real-time-capable interface. This API will be architected to provide a platform-agnostic abstracted weapons and sensor access mechanism capable of providing access to both organic and non-organic weapons and sensors utilizing common well-defined and documented data and control software structures, and access to the QOS metric subsystem described previously to quantify performance when accessing near real-time non-organic capabilities. The ecosystem API architecture will also implement a software applications access control subsystem, which will

utilize a hierarchically structured set of privilege levels to control access to both organic and non-organic weapons and sensor systems data and interfaces.

Both the CCCS ecosystem architectural model and its associated APIs will be well-documented and conform to open systems architectural principles and standards [Ref. 4]. Implementation attributes should include scalability and the ability to run within the computing resources available within the AEGIS combat systems BL9 or later hardware environment.

The technology will be compatible with the C++ programming language and capable of running in a Linux (Redhat RHEL 7.5/Fedora 29/Ubuntu 18.4.1 or later) processing environment as a standalone application (i.e., no critical dependencies on network-based remotely hosted resources, save for sensor data emulators). The prototype CCCS implementation will demonstrate the following: first, the ability to start, stop, and control multiple operator-driven or autonomous combat systems applications or software agent entities; second, the ability of real-time performance when executing various data exchange operations between ecosystems-hosted applications and entities; and lastly, the ability of real-time performance when executing various data exchange operations between organic and non-organic ecosystem-hosted software applications and entities, and real-time or near real-time access and control of organic and non-organic sensor and weapons system emulators.

Any prototype produced during Phase II shall demonstrate that it meets the capabilities described above during a functional test to be held at an AEGIS or FSC prime integrator supported Land Based Test Site (LBTS) identified by the Government and capable of simulating an AEGIS BL9 compatible or newer combat system hardware test environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design a concept for a CCCS software application execution and cross-application coordination environment (ecosystem) and associated API. Establish feasibility through modeling and analysis to show the concept will meet the required parameters in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design, develop, and deliver a prototype software implementation of the CCCS ecosystem. Demonstrate that the prototype meets the capabilities detailed in the Description during a functional test that will be held at an AEGIS or FSC prime integrator-supported LBTS provided by the Government, representing an AEGIS BL9 or newer combat system hardware environment.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Integrate the CCCS ecosystem software along with other CCCS compliant core capability and platform-specific capability software modules into a prototype combat system implementation, consisting of a Common CCCS experimental prototype, implemented on a virtualized hardware environment within an AEGIS compliant land-based testbed.

This capability has potential for dual-use capability within the commercial Air Traffic Control system in future development of an air traffic control system capable of rapid upgrade to handle increasingly complex traffic control patterns.

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KEYWORDS: Common Core Combat System; Modular Applications Program Execution and Cross-applications Data exchange and Coordination Environment; Rapid and Cost-effective Addition of New Capabilities; Cross-applications Data Exchange and Coordination Environment; Communications Services Framework; Dynamically Loadable Real-time Tactical Combat Systems Client Applications

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-058 TITLE: Affordable and Efficient High-Power Long Wavelength Infrared Quantum Cascade Lasers

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PEO IWS 2: Surface Electronic Warfare Improvement Program (SEWIP) Block 4

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an affordable, high-power, highly efficient, quantum cascade laser technology for operation in the long wavelength infrared spectrum.

DESCRIPTION: Solid-state laser systems have a wealth of military applications, including target designators, illuminators, secure communications, countermeasures, and directed energy weapons. Providing effectiveness in

diverse environments and flexibility in the face of rapidly changing operational demands, and addressing the range of enemy threats require lasers operating across wide parts of the electro-optic/infrared (EO/IR) spectra. As with all military systems, issues of efficiency, size, weight, and power (SWaP) and especially cost, are paramount concerns. No single laser system can address all operational requirements, and no single laser technology can operate equally well across the wide span of the visible and infrared bands.

To date, a great deal of effort has been invested in developing compact, affordable, and efficient laser diode technology in the visible, short-wave infrared (SWIR), and mid-wave infrared (MWIR) bands, especially in the area of quantum cascade lasers (QCLs) for the MWIR. QCL-based laser modules have been demonstrated in these bands. They are compact (approximately a few hundred cubic centimeters), lightweight (less than a kilogram), and flexible in application. Alternate laser technologies of comparable performance would necessitate at least an order of magnitude increase in size and weight. The long-wave infrared (LWIR) band, especially the atmospheric transmission window of 8-10.5 microns (μm), has received less attention. This is not to suggest that the LWIR band is less important. Indeed, the LWIR band possesses characteristics that make it particularly attractive for many application – but progress in the area is slowed by the difficulty of fabricating suitable device structures.

Recent QCL research in the 9-11 μm wavelength band has demonstrated single device continuous wave (CW) output powers of 2-3 W with corresponding “wall plug” efficiencies (WPE) of around 12% (WPE is defined as the ratio of total optical output power to the input electrical power). Commercially available devices (what few exist) produce far less power (typically less than 1 W), exhibit efficiencies (WPE) around 5%, and cost in excess of \$5000 in small quantities. Granted, wide scale application of LWIR QCLs in Navy systems would create the demand necessary to somewhat reduce device cost. However, before this can happen, a viable technical path must be shown toward achieving both the required performance and reliable, repeatable manufacture. A per-device cost reduction of at least one order of magnitude is needed.

The Navy needs a high-power, high-efficiency, and affordable LWIR QCL technology. Specifically, a QCL technology that operates over the wavelengths 8-10.5 μm is required. For a single device (a single QCL emitter, not an optically combined array of emitters), the goals for optical output power and WPE are 4 W and 16%, respectively, at room temperature. These power and efficiency goals are understood to apply over the entire 8-10.5 μm band. That is, a single QCL technology is desired such that the entire band of interest can be covered by the same basic device design through parametric design changes (e.g., emitter length, optical waveguide width). Approaches that use different device structures to cover separate parts of the band are not of interest. Prototype devices produced under this effort need not cover the entire band of interest (or even substantial portions of it). However, prototype devices should be demonstrated at representative wavelengths sufficient to show applicability of the technology across the full band of interest. As the combining of output from multiple devices is envisioned for some applications, the output beam should be CW and nearly diffraction limited with M2 of 2.0 or less.

Fundamental to this effort is development of a path toward affordable manufacture of the proposed QCL technology. Therefore, this effort should not only deliver prototype devices, but should also establish and mature the essential fabrication process such that (upon validation of the process) the devices can be reliably manufactured with high batch-to-batch repeatability and yield. Full validation of a semiconductor fabrication process is beyond the scope of Phase I and II of this effort and is left to Phase III. As device design and process development typically require an iterative and incremental approach, it is expected that multiple prototype devices will be fabricated and tested during this effort. Therefore, at least two individual devices shall be tested and delivered to the Naval Research Laboratory.

PHASE I: Propose a concept for an affordable, efficient, and high-power QCL technology as described above. Demonstrate the feasibility of the proposed approach and predict the ability of the concept to achieve the required parameters in the Description. Demonstrate feasibility by some combination of analysis, modelling, and simulation. Address affordability initially by identification of the key manufacturing steps and processes anticipated for manufacture of the device in Phase II, their maturity and availability in the industry, and their projected cost. The Phase I Option, if exercised, will include a device specification, initial process description, and test plan in preparation for device prototype development and demonstration in Phase II.

PHASE II: Develop and demonstrate a prototype QCL technology as detailed in the Description. Demonstrate that the technology (including the nascent manufacturing process) meets the requirements in the Description.

Demonstrate the technology in two progressive parts: a demonstration that a prototype QCL meets the power and WPE requirements in the Description; and a demonstration that multiple (at least four) prototype (packaged and ready to use) CW QCLs meet the performance requirements of the Description such that manufacturing repeatability and the ability of the devices to operate at more than one wavelength within the LWIR band is shown. After electrical performance testing, deliver the prototype devices to the Naval Research Laboratory. Make available the prototype manufacturing process, as documented by initial process control specifications, process definitions, calibration instructions, in-process quality protocols, etc., for review by Naval Research Laboratory personnel or their authorized representatives. Deliver an analysis of production cost based on the resulting manufacturing process and an assessment of the MRL achieved at the end of the effort.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use and Low Rate Initial Production (LRIP). Assist in applying the design to (and maturing the process for) specific QCL devices (specific wavelength devices, packaging, etc.) since the prototype devices and initial manufacturing process resulting from Phase II are a generic demonstration of the technology. Mature and validate the prototype manufacturing process developed in Phase II for production at qualified foundries.

The technology resulting from this effort will have application in the fields of laser spectroscopy and communications.

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KEYWORDS: Solid-State Laser; Quantum Cascade Laser; QCL; Long Wave Infrared; LWIR; Semiconductor Fabrication; Laser Diode; Laser Systems

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-059

TITLE: Automated Management of Maritime Navigation Safety

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 406, Unmanned Maritime Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop software or a combination of software and hardware that enable an Unmanned Surface Vehicle (USV) to tailor its navigation safety active emissions and passive signatures to the current situation based on broad guidance given days earlier by a distant controlling station.

DESCRIPTION: Unmanned Vessels should be able to present an appearance that is appropriate to the current local situation. For example, a USV transiting through pirate-infested waters may seek to minimize its signatures to avoid attracting unwanted attention and a potential boarding. At the other extreme, a USV with a relatively low signature may want to increase its visibility in a high-traffic area to give other vessels more time to react to its presence. The USV may only be in intermittent communications with a distant oversight station, or communications may be completely severed. Therefore, the USV must be able to take the most recent broad guidance received and use it to adapt to the current local situation without real-time human assistance. The signature management may be limited to controlling radiofrequency (RF) emissions, but it may also include installing and operating hardware such as a hoisted radar reflector. Current manned vessels can and do manage their signatures, but the decision-making is done by people on those vessels. Research, development, and innovation are required to enable unmanned vessels to perform this function. The concept can be a novel way to reduce or enhance a particular signature, or it can be software for a USV to manage the signature that it presents, or both. Signature enhancement or reduction could be focused in one direction from the USV, or it could be an overall enhancement/reduction. Companies must include the expected scope of the Phase II effort in their Phase I proposals. Performance and technical requirements will be based on the solution that is proposed.

The Phase II effort will likely require secure access, and NAVSEA will process the DD254 to support the contractor for personnel and facility certification for secure access. The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Provide a concept to solve the stated Navy problem and demonstrate the feasibility of that concept. At the end of Phase I, deliver a technical report including analysis showing how the concept would work and documenting its expected effectiveness. If the concept is for signature enhancement/reduction, its effectiveness should be measured in terms of expected percentage or dB enhancement/reduction as well as radians of coverage (2D case) or steradians of coverage (3D case) for the signature change. If the concept is for signature management software, its effectiveness should be measured in terms of expected probability of matching a desired signature and expected time latency in changing the vessel's signature. If practical and advantageous, conduct limited sub-scale prototyping and testing ashore or on a surrogate vessel.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Produce two prototype systems for testing and evaluation. If the solution is entirely a software product, integrate it with two different USVs using an Interface Control Document (ICD) supplied by Navy at the beginning of Phase II. Finish prototypes within three months prior to the end of Phase II, with the last three months of Phase II devoted to testing and demonstration of the prototypes. If the prototype includes any software, ensure that it complies with the Unmanned Maritime Autonomy Architecture (UMAA), which the Navy will provide at the beginning of Phase II.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Ensure that, at the end, the Medium Unmanned Surface Vehicle (MUSV) and/or the Large Unmanned Surface Vehicle (LUSV) will have better control of its signatures even though the final product will vary based on the proposed solution. Deliver an integrated and tested hardware and software solution. (Note: Navy will provide ICDs in a timely fashion to support software integration.) Validate the product in a series of in-port tests followed by at-sea testing in a variety of conditions, depending on the nature of the solution. For example, if the solution changes the vessel's appearance to an Electro-Optical sensor, then testing would occur in day and night conditions, clear visibility, haze, and fog.

Signature management tools for Navy USVs may be useful for unmanned or minimally manned commercial vessels. Such tools would allow a commercial vessel to make itself easier to detect for safety purposes, or harder to detect to avoid pirates.

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2. Thompson, J., Vaitekunas, D. and Brooking, B. "Signature management-The pursuit of stealth lowering warship signatures: Electromagnetic and infrared." Proceedings of Signature Management-The Pursuit of Stealth Conference, 2000. http://www.wrDavis.com/docs/papers/lowering_warship_signatures.pdf

KEYWORDS: Vessel Signature Management; Vessel Radar Cross-Section; Vessel Infrared Signature; Vessel Radiated Noise; Vessel Electromagnetic Signature; USV Autonomy

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-060 TITLE: Unmanned Passive Navigation without GPS

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMS 406, Unmanned Maritime Systems Program Office.

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a passive device or system that allows an unmanned vehicles/vessels to develop and maintain awareness of its location on the earth's surface without using the Global Positioning System (GPS).

DESCRIPTION: This topic stands at the intersection of three needs: unmanned navigation, passive sensing, and mitigation of GPS vulnerability. First, unmanned surface vehicles/vessels (USVs) are being developed both by global navies and by commercial shipbuilders. While underway, a USV must determine its position on the earth's surface to get to its destination while avoiding shoal waters, charted obstacles, and prohibited areas. Second, military vessels need to have the capability to operate without revealing their locations to potential adversaries. Radio frequency (RF) transmissions, including use of a surface search or navigation radar, can disclose a vessel's location. Commercial vessels may also find that staying silent can aid in avoiding being targeted by warships during hostilities or by pirates. Third, the GPS has become the primary means for navigation for most ocean-going vessels. However, this system is susceptible to interruption or spoofing, especially during times of hostilities between nation-states. Therefore, the U.S. Navy seeks a device that allows an unmanned vessel to develop and maintain awareness of its location on the earth's surface without using GPS or revealing the vessel's location while meeting the accuracy requirements for restricted piloting as well as coastal and open water navigation (As described in CNSP/CNSLINST 3530.4F).

Passive navigation techniques such as celestial navigation with a sextant have been used for centuries, but the navigational fix accuracy is not sufficient for operation of modern Navy systems. Older electronic navigation systems such as Omega and Loran-C have also been retired. Other satellite-based systems such as Russia's GLONASS and the European Union's Galileo have the same disadvantages as GPS. Additionally, there are legislative and policy limitations on use of the Global Navigation Satellite Systems (GNSS) of other nations by the US Navy (Public Law 114-328 and DoD instruction 4650.08). Use of satellite constellations as part of the proposed solution is not prohibited, but cannot be the only means of navigation fixing. This topic seeks a novel system, an improvement over existing methods, and/or a combination of methods to achieve the stated accuracy goals. Solutions only relying on GNSS or using active RF transmission will not be accepted. Use of a fathometer and AIS is discouraged but not prohibited. The final product is a fully integrated system that interfaces with the USV's autonomy by passing a stream of latitude, longitude, time, and confidence fields. The final product should be able to take an input from an onboard inertial navigation system that provides a "dead reckoning" solution to previous fixes and that gives a ship's heading information.

This system will meet critical Navy needs by allowing Medium Unmanned Surface Vehicle (MUSV) and Large Unmanned Surface Vehicle (LUSV) to safely navigate without revealing their location to adversary forces. The product meeting stated goals without operator input or assistance (unmanned or autonomous) will be validated and tested ashore for compliance with the Navy-provided Initial Capabilities Document (ICD). Additionally, the product will be evaluated for ease of integration with the unmanned vehicles/vessels with respect to Hardware (Size, Weight, Power, and Cooling) and Software Integration. Once validated ashore by the Navy, it will be qualified and certified for Navy use through sea trials in at least three different geographical locations (e.g., Atlantic Ocean, Gulf of Mexico, and Pacific Ocean) and in a variety of conditions. These conditions will include near-shore and open ocean conditions, daytime and nighttime, clear visibility and fog. Depending on the technology used, tests will be selected that provide a diversity of conditions having an impact on the solution.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense

Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Provide a concept to solve the Navy's problem as detailed in the Description. Demonstrate feasibility with modeling and or simulation. Provide any preliminary analysis and/or testing supporting the viability of the approach at the end of Phase I.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop two prototype systems for testing and evaluation. Support Government evaluation of the prototype systems at sea in both near-shore and open-ocean conditions to verify navigation accuracy on existing MUSV and LUSV prototypes. Integrate the prototypes into Navy-provided autonomy systems ashore using a Navy-specified Interface Control Document (ICD) that will be provided by the Government after award. After integration, test the prototypes ashore in a laboratory environment to verify that they meet the ICD standards and that they can send navigation messages to the autonomy systems. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the passive navigation technology for Navy use by supplying hardware, software, and technical documentation for installation and repair. Provide assistance, if required, for the first several installations, required on the MUSV and the LUSV.

This technology could be used on manned and unmanned commercial vessels of many different types. In particular, it could be used as a complement to and backup for unmanned navigation systems that rely on GPS, GLONASS, and/or Galileo.

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KEYWORDS: Unmanned Navigation; Non-GPS Navigation; Passive Sensing; Celestial Navigation; Visual Navigation; Magnetic Navigation

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-061

TITLE: Mine Countermeasures Unmanned Surface Vehicle Common Deploy and Retrieve System

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 406, Unmanned Maritime Systems Program Office, MCM USV

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Currently, a common deploy and retrieve system does not exist for towed systems; existing deploy and retrieve systems are specific to the towed body. This SBIR effort aims to develop a common, robust, maintainable, and reliable deploy and retrieve system for Mine Countermeasures Unmanned Surface Vehicle (MCM USV) to deploy, stream, tow, retrieve, and stow similarly sized (diameter 10.29" to 15.5") towed systems that may be towed by connection at the nose of mid-body.

DESCRIPTION: The Mine Countermeasures (MCM) Mission Package (MP) has a requirement to conduct minehunting (MH), which is being executed through a capability to tow either the AN/AQS-20C or AN/AQS-24B sonar system. However, towing of each of the tow-bodies current requires different deploy and retrieve systems, due to the different locations of the tow points. Because of this, the AN/AQS-20C and AN/AQS-24B sonar systems have different tow cables; handling requirements, hydrodynamic requirements, and interfaces. The Navy is seeking innovative approaches to develop a common deploy and retrieve system for a variety of towed sonar systems and platforms, including the AN/AQS-20C and AN/AQS-24B sonar systems. These payloads will be the first two sonar systems to be integrated into a common deploy and retrieve system for the MCM USV.

A common deploy and retrieve system will provide additional flexibility in towed sonar choices and procurement options, and lower life cycle costs to the Navy. The goal is to provide the Fleet with a modular capability to launch and recover towed sensors at a competitive cost. Upon successful demonstration of the deploy, retrieve, and tow capability from an MCM USV, the deploy and retrieve system will be procured as part of the program of record for the MCM USV MH configuration.

PHASE I: Develop a concept for a common deploy and retrieve system that will interface with the nose and the mid body of a towed sonar, per the AN/AQS-20C and AN/AQS-24B Interface Control Document requirements. Demonstrate the feasibility of the concept through modeling, simulation, and analysis.

The Phase I Option, if exercised, will include the development of the initial design specifications and capabilities description for common deploy and retrieve system requirements. The Option will complete with a Preliminary Design Review (PDR) package for delivery to the Navy. Develop a Phase II plan.

PHASE II: Develop a Critical Design Review (CDR) package for the common deploy and retrieve system. Build an operational common deploy and retrieve system prototype to be used to test functionality and validate the physical and logical interfaces. Perform operational testing on the prototype, per AN/AQS-20C and AN/AQS-24B System Requirements Document. Coordinate testing with the Navy to evaluate the system in an at-sea environment. Prepare a Phase III development plan to transition the technology to the Navy and potentially for commercial use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use on the MCM USV program. Further refine the software and hardware to ensure compatibility with existing interfaces and workstations for evaluation to determine their effectiveness in an operationally relevant environment. Support the

Navy for test and validation to certify and qualify the system for Navy use. Similar sized sonars are manually deployed from larger boats and are used for sea exploration and other research and development purposes. This deploy and retrieve assembly would allow for use by smaller boats and would enable unmanned, semi-autonomous, operations.

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KEYWORDS: MCM USV; Detection of Ocean Mines; AN/AQS-20; Moored Mines; AN/AQS-24; Towed Array

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-062 **TITLE:** Hydrophone Incorporating Open Architecture Telemetry

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 5/PMS 401, Submarine Acoustic Systems Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a hydrophone (Acoustic Channel Assembly (ACA)) with embedded electronics that comply with the Open Architecture Telemetry (OAT) standard to support receive arrays with increased numbers of hydrophones and telemetry channels per unit length and reduced ACA cost.

DESCRIPTION: Currently, the acoustic channels in towed arrays deployed from surface ships and submarines consist of an acoustic section (hydrophones) and separate telemetry connected via micro-miniature connectors to exfiltrate acoustic information from the array. There are many Acoustic Channel Assemblies (ACAs) in a typical array [Ref. 1]. Innovation is sought to integrate telemetry electronics with acoustic channel assemblies to permit enhanced coherent processing.

Multiple towed array systems, both surface ship, surveillance, and submarine, could utilize the new ACA's

technology and performance. By integrating hydrophones with telemetry electronics as an acoustic channel assembly, towed array designers can achieve higher sensor density with increased coverage overlaps. This will enable processing enhancements of the towed array data.

Present commercial technology and hydrophones focus on single element hydrophone sensors. The designs are typically for stationary sensing and do not incorporate multiple elements or meet the required form factor.

The cost of the present channel assemblies and the associated electronics (telemetry) account for approximately 20 percent of the overall cost of a towed array. The development of an ACA with incorporated telemetry would allow a 5-10% reduction in the overall system cost by eliminating the separate assemblies and the touch labor associated with the wiring and connectors.

The performance of towed arrays improves when there are more ACAs and telemetry channels per unit length [Ref. 2]. Array performance and processing can significantly increase when single paired hydrophone telemetry channels with separate telemetry are replaced with improved acoustic sensors with embedded electronics to support data exfiltration. Integration of hydrophones with key telemetry electronics will provide for inherent redundancy and graceful degradation in the event of a sensor failure.

The Navy needs an innovative technology that combines the acoustic channel performance with an increased number of ACAs and telemetry channels per unit length. This capability will assist the Navy in maintaining or increasing its tactical advantage in the undersea Anti-Submarine Warfare (ASW) domain. The solution will consist of an acoustic sensing section and the associated electronics to acquire the acoustic information, convert signals to a digital format, and then transmit the data to the second-level telemetry backbone. The entire assembly will be packaged as a single unit. The Navy will provide an Interface Control Document (ICD) that defines the incoming power (estimated 100 milli-watts per ACA), channel performance requirements, and the digital output format, which complies with the Department of Justice Interface Control Document standard [Ref. 3]. The ACA acoustic improvement goal is to measurably improve noise rejection (e.g., improve noise rejection greater than 3 dB) of the turbulent boundary layer noise typical for acoustic sensor towed inside a towed array.

ACAs experience extreme environments; therefore, the system and/or sensors must be capable of functioning without damage or degradation in pressures (depth) up to 1200 psi, temperatures over a range of -28°C to 50°C, and accelerations up to 100 Hz over a range of 0.0 g to 25.0 g. The reliability of the ACA must support a Mean Time Between Failure (MTBF) of at least 7000 hours.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for an improved ACA that integrates the hydrophone with telemetry electronics identified in the Description. Demonstrate feasibility through modeling, development, and analysis. The Phase I Option, if exercised, will include the initial system specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Design, develop, produce, and deliver two dozen of the Improved Acoustic Channel Assembly prototypes. (Note: The Government will provide support for packaging the assemblies within a towed array as well as environmental testing as required.) Demonstrate the prototypes at a Government- or performer-provided facility. Provide technical support to the Government to conduct environmental testing at NUWC DIVNPT, Middleton, RI and performance testing at NSWC Acoustic Research Detachment, Bayview, ID.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Assist the government in transitioning the technology for Navy use. Conduct experimentation and refinement to qualify the system for use on towed arrays. (Note: The Government will provide the performer access to a Navy ship for validation and performance verification of the final system.) Support installation and removal from an at-sea test platform and assist in data recovery and processing using the system for towed arrays.

This system would prove useful for oceanographic research, oil and gas exploration, congested-area traffic monitoring, and other applications where data from multiple disparate sensors are fused to provide a more holistic awareness of the volume being monitored by said sensors, especially where said sensors are not in fixed locations.

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KEYWORDS: Towed Array; Acoustic Channel Assemblies; Turbulent Boundary Layer; Telemetry; Hydrophone; Embedded Electronics in Towed Arrays

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-063 TITLE: SUBSAFE Electrical Hull Penetrator Connectors for Directed Energy (DE) Weapon Systems

TECHNOLOGY AREA(S): Electronics

ACQUISITION PROGRAM: NAVSEA 073, Advanced Submarine Systems Development

OBJECTIVE: Develop submarine SUBSAFE electrical hull penetrators and connectors that can transfer high currents or high voltages in the order of 100's of kW through the submarine's pressure hull.

DESCRIPTION: The Navy seeks technologies for transmitting high electrical power required for operating Directed Energy (DE) weapon systems from inboard the submarine to an outboard DE system, submersible platform, special operation, etc. The technology must address the capability to transfer high electrical power safely from inboard submarine to a DE subsystem or beam director located on an outboard platform through the hull-penetrating path. In the case of all electrical hull penetrators, the solution needs to address high-power electrical cables and appropriate connectors that can carry high electrical power (greater than 500kW of electrical power) over long distances (greater

than 30 ft.) with low ohmic or impedance loss. The electrical cable shall also include additional shielding to minimize EMI. Consideration must be given to the overall system approach and operational aspects of the systems. Ideally, DE systems would require hull penetrations for the high electrical power required for operating a High Energy Laser (HEL) subsystem and low electrical power required for operating a beam director or other auxiliary subsystems within a DE system. The guideline for total electrical power is approximately 300 kW with potential roadmap to greater than 500 kW potential growth.

The solution of the electrical hull penetrator shall be based on current hull penetrator configurations (3 hull penetrators per Universal Modular Mass (UMM)), where one or all three current hull penetrators are used for off board high-power DE systems operation or for other submersible platform and any sensor connection, as required. The electrical hull penetrator shall address affordability because it is a very cost-effective way to get high power outboard from inboard submarine electrical systems. Currently, the Navy needs to tow the generator to support a similar system.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a hull penetrator to transmit kW class of electrical power from the inboard DE system to an outboard HEL subsystem or high energy DE to beam director system. Ensure that the concept includes electrical feed technology in the marine environment that provide realistic energy levels from 300 kW to 600 kW electrical energy required in order to operate an approximately 100 kW to 200kW class outboard high energy HEL system with >30% electrical to optical efficiency. Ensure that the hull penetrator design meets Navy SUBSAFE qualification requirements and uses Model Base Engineering (MBE) approach. Demonstrate feasibility by some combination of analysis, modelling and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities in preparation for prototype development and demonstration in Phase II.

PHASE II: Design and develop a lab prototype that incorporates power-transmitting capability from inboard to outboard Navy systems and can be tested in a representative undersea environment. Include in the design the maintainability and workability of the Hull Penetrator Insert under a marine environment. Conduct a demonstration of the design and a verification test at a Navy facility to verify that key system performance specifications are met. Outline the plan to fabricate an initial field prototype system using model base engineering (MBE) that can be easily integrated and tested on a representative submarine environment. Develop a Phase III plan.

It is probable that the work under this effort will be ITA restricted under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: In Phase III, the company support the Navy or DoD contractor in transitioning the technology for manufacturing of Electrical insert for Hull Penetrator.

As a dual application, this technology can be also be used in commercial industry for oil platform, under water high electrical power to perform number of innovative commercial and academic research. This technology can also be very useful to use safely high electrical power in humid or wet condition for dual use applications.

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KEYWORDS: Submarine Systems; Hull Penetrator; High Energy Laser (HEL); Submarine Safety; SUBSAFE; Universal Modular Mass (UMM); Model Base Engineering (MBE)

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-064 TITLE: Digital Theater-level System Model for Cyber Security Analysis

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: EO-IWS5: Surface ASW Combat System Integration, Surface ASW System Improvement

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a digital model that can assess the communications-related cybersecurity posture of geographically distributed sensors, weapons, and combat systems supporting theater-level mission tasking.

DESCRIPTION: For the Theater Undersea Warfare (USW) mission, the Theater commander's tool is the AN/UYQ-100 Undersea Warfare Decision Support System (USW-DSS) [Ref. 1]. USW-DSS produces plans that optimize USW capability across the entire theater. However, cybersecurity has not traditionally been a part of mission planning at the theater level. The theater-wide system of systems contains distributed networks of disparate systems at varying levels of cyber resiliency, which communicate through physical environments that vary as a function of time, season, commercial and military interference, and other factors [Refs. 2, 3].

Cybersecurity posture of individual systems are monitored in accordance with the Risk Management Framework (RMF) [Ref. 4]. However, RMF is not sufficient to support modeling of the cybersecurity of geographically distributed systems communicating through atmospheric and acoustic environments with variable properties. Commercial infrastructure with similar needs operate on networks specifically designed to be robust, but are not

adequate for military needs. Military combat systems in conflict with a peer competitor cannot count on dedicated intra-system communication network infrastructure and must adapt to transmissions through the available environment (e.g., acoustic transmission, electronic transmission through the atmosphere).

The Navy needs a software architecture and digital system model capable of providing USW planners a comprehensive assessment of the cybersecurity posture of a geographically distributed network of disparate sensors communicating through paths fundamentally dependent on environmental factors. The successful technology will be used as a stand-alone product in support of new system design and will be incorporated into USW-DSS in support of theater ASW operations.

The needed digital system model will provide modeling of actual and planned theater assets and allow designers to assess the cybersecurity implications of distributed and unmanned systems as they communicate and operate in the physical environment. Incorporation of this model into USW-DSS will also allow theater commanders to include cybersecurity in mission planning, mission execution, and post-mission analysis.

The digital system model must be able to represent the cybersecurity posture of each category of USW sensor and platform, including surface combatants, unmanned vehicles, submarines, air vehicles, surveillance assets, and expendables associated with these platforms. The digital system model must also be capable of modeling the communication pathways between these geographically dispersed sensors and platforms, including modeling of environmental factors and their effect on the communication between the sensors and platforms. This technology will reduce engineering efforts to provide Objective Quality Evidence (OQE) for the system cybersecurity resiliency in operational environments.

The digital system model must have a useful instantiation that can run as an element of USW-DSS without increasing processing hardware requirements. USW-DSS is hosted on shipboard computational assets such as the Consolidated Afloat Networks and Enterprise Services (CANES). Mission execution monitoring must be able to support real-time execution. Post-mission analysis must be able to support 4X real-time analysis. The USW-DSS system-operating environment will be defined in greater detail by the Government, but will consist of RedHat Security-Enhanced Linux as the base operating system.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Define and develop a concept for a software architecture that would support assessment of the cybersecurity posture of a geographically distributed network of sensors and platforms. Demonstrate feasibility through analytical modeling and development that address the requirements discussed in the Description. The Phase I Option, if exercised, will include the initial system specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype of the software and its architecture for digitally modeling a theater-wide system of systems to assess cybersecurity posture. Demonstrate performance through the required range of parameters given in the Description, including the ability to conduct robust options analysis in varying locations in support of system design as well as an ability to support real-time assessments by human operators of ongoing operations in the theater. Demonstrate, at a Government- or company-provided facility, utilization of existing Navy-specified system or sub-system components to provide a fully functional operational capability within USW-DSS; and the capability to ingest real-time data representative of operational conditions.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology for Navy use and complete further experimentation and refinement to ensure that the technology provides support for USW-DSS and other Navy specified systems and the associated system engineering activities of the Program.

The technology should have high potential for dual use for industries with geographically distributed systems, such as utilities related to power generation, water distribution, information networks, and border surveillance. This is particularly useful for industries where reliability of the communication networks impacts performance and cybersecurity.

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KEYWORDS: Theater Undersea Warfare; USW; Undersea Warfare Decision Support System; USW-DSS; Cybersecurity Implications of Distributed and Unmanned Systems; Combat Systems; Cybersecurity of Geographically Distributed Systems; Modeling of Environmental Factors

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-065 TITLE: Element-Level Digital Communications Array

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PEO Integrated Warfare Systems (IWS) 6.0 Command & Control (C2) Directorate

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on

this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a digital, C-Band Transmit (Tx) and Receive (Rx) array antenna that transmits and receives multiple spatially and spectrally diverse narrowband signals.

DESCRIPTION: Expanded mission areas and the implementation of additional data routing resulting from future warfighting capabilities place more demand on data distribution services in the form of higher data bandwidths and reduced latencies. These demands require improvements in Radio Frequency (RF) spectrum utilization and advances in antenna technologies. Digital array antenna technology promises to enable these improvements by dramatically increasing operational flexibility. Digital arrays are not off the shelf available; but rather, industry contractors develop digital arrays in response to acquisition efforts. The commercial development of multi-beam 5G networks will focus on small picocells. Lower power levels and reduced linearity challenge leave a significant gap preventing commercial technology from being useful in Navy applications. Defense Advanced Research Projects Agency (DARPA) efforts have made digital arrays a more off the shelf technology. Notable among these is the Arrays at Commercial Time Scales (ACT) and Millimeter-wave Digital Arrays (MIDAS) program. These programs focus on the transceiver and beamforming functionality of the array as opposed to the aperture. However, this technology is still not off the shelf and integration work would be required to meet the digital array needs even using this technology. The Navy must overcome some technology risks with a critical one being the development of digital array technology that can operate at the necessary bandwidths and frequencies while in complex RF environments.

The Navy seeks to expand and refine the battlespace by improving and expanding tactical network functionality. Increased data throughput is needed to enable the flow of more data and support of new mission areas. Decreased latency is needed to enable new and compressed kill chains against advancing threats as well as larger networks. Increased network throughput and decreased latency will be attained by developing 4-channel Transmit (Tx) and Receive (Rx) capability for digital communications arrays. The level of improvement in the fielded system will depend on the topology, size, and operation of the network. For large, half-duplex (i.e., cannot transmit and receive simultaneously) networks of four-beam nodes having all nodes connected along a line, the level of throughput improvement will approach a factor of 2. For large, half-duplex networks of four-beam nodes having topologies where all the nodes are connected to each other, the throughput improvement will approach a factor of 4. For other networks, the improvement will be somewhere in between. Of course, the fielded system may have a different number of beams per node. Four was chosen based on engineering judgement as a compromise between complexity, technical challenge, and capability improvement.

The Navy needs a digital communications array to realize simultaneous, multichannel Tx and Rx capability. The digital communications array is a key enabler for higher data throughputs and reduced latency needed to engage evolving threats and enabling significant improvement in utilization of spectrum. This must be done while pushing the boundaries of signal integrity, dynamic range, isolation of signals and resistance to interference to maximize link performance. No technology currently meets all these requirements.

An innovative digital antenna subarray architecture is sought to attain the previously stated requirements. More specific antenna system goals include a 1 x 4 linear configuration and element level signal generation and digitization. Beam steering in azimuth should be $\pm 60^\circ$. The subarray should transmit and receive 4 simultaneous beams in half duplex mode. The operational bandwidth is C-band (4 GHz to 8 GHz). Compared to the operational bandwidth, the instantaneous bandwidth is relatively narrow. The element level Equivalent Isotropic Radiated Power (EIRP) should be 0 dBW over the scan volume. The output Error Vector Magnitude (EVM) should be less than 3%. The antenna should be able to receive an incident signal with incident power density measured at the free-space-to-antenna interface ranging from -134 dBW to -53 dBW and output a digital signal with 20 dB signal to interference plus noise ratio. The goal for the spur free dynamic range is 80 dB. 32 dBm is the goal for the input third order intercept. The polarization should be selectable, with four options. These options should be horizontal, vertical, right hand circular and left hand circular. The polarization loss factor should be less than 0.25 dB. The antenna will be capable of null steering with a null depth goal of 80 dB relative to the mainlobe.

The subarray must be capable of processing 4 narrowband signals located arbitrarily within a contiguous operational bandwidth within C-band. The design should permit any two 1 x 4 subarrays to be connected in any configuration and beam-steered. A two-dimensional array must be capable of having its beam steered in both dimensions. The

design should permit connecting 1 x 4 or 4 x 1 subarrays into a contiguous rectangular array of arbitrary size. For example, three 1 x 4 subarrays must be able to be configured to form a 1 x 12 and then reconfigured to form a 3 x 4; without re-flashing firmware. Moreover, both configurations must demonstrate vertical, horizontal, right-hand circular, and left-hand circular polarizations while attaining 0.25 dB of polarization loss factor for each of these four polarizations. The design should include built-in testing to indicate failures that occur. The interface to the digital array on the transceiver side will use a standard format to send digits of data, such as Ethernet. Beam steering commands sent to the array will contain azimuth and elevation angles relative to the array face, frequency and Tx or Rx identification.

Testing, evaluation, and demonstration should include configuring and measuring antenna patterns for a 1 x 12 and 3 x 4 array using the same three (3) 1 x 4 subarrays. Moreover, vertical, horizontal, right-hand circular, and left-hand circular polarizations should be demonstrated. Validation of the prototype will be through comparison of model predictions to measured performance. The location for the demonstration may occur at the small business's facility or at a Government-identified location.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Define and develop a concept for a digital C-Band Tx and Rx array antenna. Demonstrate that the concept can feasibly meet the Navy requirements as provided in the Description. Establish feasibility by a combination of initial analysis and modeling. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Develop and deliver a prototype digital C-Band Tx and Rx array antenna that demonstrates the performance parameters outlined in the Description. Conduct prototype testing, evaluation, and demonstration (at the small business's facility or at a Government-identified location). Provide an interface control document guide for developing the signal and control interface for the array. Include configuring and measuring antenna patterns for a 1 x 12 and 3 x 4 array using the same three (3) 1 x 4 subarrays in the demonstration plus vertical, horizontal, right-hand circular, and left-hand circular polarizations. Validate the prototype through comparison of model predictions to measured performance.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use. Further refine the prototype for evaluation to determine its effectiveness and reliability in an operationally relevant environment. Support the Navy in the system integration and qualification testing for the technology through platform integration and test events to transition the technology into PEO IWS 6 applications for simultaneous communications links to improve and expand tactical network functionality.

Digital, high-performance antennas will have direct application to private sector industries that involve directional communications between many small nodes over large areas. These applications include transportation, air traffic control, and communication industries.

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KEYWORDS: Digital Array; Communications Array; Multichannel Tx and Rx; Digital Antenna Subarray Architecture; Narrowband Signals; Digital Antenna Subarray Architecture

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-066 TITLE: Acoustically Transparent Mid-Frequency SONAR Projector

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS-5A: Integrated Warfare Undersea Systems, Advanced Development Program Office

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative acoustically transparent mid-frequency SONAR projector to add active capability to traditionally passive sensor arrays and reduce life-cycle costs.

DESCRIPTION: U.S. Navy nuclear attack submarines (SSNs) have traditionally relied on acoustic receive arrays to sense their environment, including sensing of enemy submarines [Refs. 1-2]. Evolving conditions such as increased shipping traffic have degraded the effectiveness of sensing the underwater regime solely using passive acoustic sensors. Mid-frequency active sonar is used extensively by surface combatants and could meet the environmental sensing needs of submarines; however, current projector technology incorporated into submarine arrays would degrade the passive capability that submarines depend on when covert.

Current Navy and commercial state-of-the-art SONAR projectors are physically large and heavy, and require

specialty-mounting structures. In addition, such projectors must be mounted at a distance from receive sensors and arrays so as not to interfere acoustically. To add mid-frequency active capability to traditionally passive sensor arrays without degrading passive performance, the Navy requires R&D for an acoustically transparent projector that can be located between or in front of receive sensors and/or arrays. Lifecycle costs will be reduced by eliminating specialty structural and mounting requirements and reducing material, manufacturing, and packaging costs.

Advancements in projector technologies involving meta-materials or non-traditional acoustic signal generation, together with lightweight (such as neutrally buoyant) elements make it feasible to envision acoustically transparent mid-frequency SONAR projector arrays that achieve useful acoustic source levels (SLs) with conventional power amplifiers. The projector and projector cable requirement for acoustic transparency is less than 0.1 dB insertion loss and less than 0.5 degrees phase error induced in individual receive array pressure or velocity sensors. The requirement for mounting location is in front of or in-between receive array elements. Current SONAR projector technologies cannot meet these requirements. Finally, the goal for the associated projector power amplifier is to use existing Navy units such as the Modular Power Amplifier (MPA) or High Density Power Amplifier (HDP) or ruggedized commercial-off-the-shelf (COTS) devices such as Class D or Class T power amplifiers. Proposed projector concepts shall address the acoustic transparency and mounting location requirements, and the conventional power amplifier goal. The concept shall then provide derived projector performance including, but not limited to, size, weight, mounting/attachment method, transmit voltage response (TVR), useable bandwidth and source level achievable (SL) with selected power amplifier.

Any specialty equipment required, but not normally associated with a submarine environment, shall be identified. The solution shall also address the environmental requirements associated with submarine use, including but not limited to, temperature (-28°C to 50°C), accelerations (frequencies up to 100 Hz over a range of 0.0 g to 25.0 g), and hydrostatic pressure (depths to 1200 psi). The proposer shall test these parameters at their facilities and may be independently verified at Navy facilities such as the Naval Undersea Warfare Center.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for an innovative acoustically transparent mid-frequency SONAR projector. Demonstrate that the concept can feasibly meet requirements in the Description through modeling and simulation or analysis. The Phase I Option, if exercised, shall include the initial system specifications, models and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver three innovative acoustically transparent mid-frequency SONAR projector prototypes for testing and evaluation. Demonstrate that the technology meets Navy performance goals for source level, frequency and bandwidth as defined in the Description. Conduct testing and evaluation at a company-provided facility and may be independently verified at a Government facility such as the Naval Undersea Warfare Center. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use for submarine arrays in Integrated Warfare Undersea Systems through system integration and qualification testing. (Note: Government personnel will independently verify test results for the prototype projector, pre-production units, and first article inspection at Navy test facilities prior to Navy use in SONARs aboard submarines.)

Commercial applications that currently utilize various forms of active acoustic transmission and reception that could benefit from lightweight and acoustically transparent projectors include oil exploration, seismic survey, rescue and

salvage, and bathymetric survey.

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KEYWORDS: Acoustically Transparent; Mid-frequency SONAR Projector; Eliminate Specialty Mounting Infrastructure; Projector Technology Incorporated into Submarine Arrays; Non-traditional Acoustic Signal Generation; Projector Technologies Involving Meta-materials

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-067 TITLE: Kinematic Contact Tracking Using Hybrid Features

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO-IWS5: Surface ASW Combat System Integration, Surface ASW System Improvement

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop algorithms to use features of acoustic echoes to track and correctly classify multiple targets in noisy, cluttered environments, leveraging extended feature processing and kinematic association to enhance tracking and classification techniques.

DESCRIPTION: Active sonar in anti-submarine warfare (ASW) discriminates between echoes from submarine targets and clutter echoes, which are characterized by signal to noise ratio, echo range, bearing, and Doppler. Traditional tracking methods rely on consistent motion of the high-energy echoes in range, bearing, and Doppler space over multiple active sonar transmissions. While numerous sophisticated algorithms are associated with differentiating submarine targets from surface ships and clutter, these algorithms have traditionally been developed for situations where a single submarine is present.

Future conflicts could involve multi-ship combat operations with a peer competitor that would involve multiple targets in the midst of large amounts of clutter and high ambient noise. In this situation, state-of-the-art trackers, which rely primarily on kinematics, produce large numbers of false tracks, broken tracks, and incorrectly associated tracks. These bad tracks increase false alerts and miss or catastrophically delay true alerts. It is believed that considering features of echoes as well as kinematics can reduce false and broken tracks while retaining or improving correct target identification.

The Navy envisions future multi-ship operations that involve a diversity of sensors on manned and unmanned platforms, increasing the number of potential features that can be considered by a hybrid tracking system.

Tracking algorithms that combine emerging feature-aided detection techniques and kinematic tracking are desired to improve the effectiveness of active sonar against multiple targets in the cluttered, noisy acoustic environment expected during multi-ship ASW conflicts with peer competitors. These improved algorithms will also be crucial to the effectiveness of unmanned platforms utilizing active sonar.

Feature-aided tracking algorithms use measured echo features to inform how the tracker associates' consecutive echoes among the many potential echoes pass the kinematic test. Basic research in this area has been conducted on use of non-kinematic features as it relates to non-acoustic sensors, such as radar [Refs. 1-5]. However, innovation is required to apply emerging feature-aided tracking concepts to active sonar conducting real-time tactical operations in a diverse range of operating environments. The Navy has data sets representing a diverse range of acoustic propagation environments, bathymetric conditions, and operational conditions that can be used to evaluate the benefit of technologies developed under this topic.

For tactical sonar systems such as the AN/SQQ-89 surface ship sonar suite, the performance of the feature-aided tracker is expected to be highly dependent on the transmit waveform, environment, and selection of features to be used. Key tactical propagation environments include direct path, bottom bounce, and convergence zone environments. Anticipated sensor diversity in future multi-ship operations is expected to provide additional target feature data such as measurements of sonar cross-section, physical size, and scattering characteristics. This diversity of expanded feature information can be used with the kinematic information to improve the capabilities of automatic tracking and classification systems, especially in high-clutter, low signal-to-noise ratio and target-dense environments. The solution sought will provide innovative feature-aided tracking algorithms to improve track and classification measures of performance by at least 25% in environments with where acoustic clutter makes target tracking particularly difficult. Key measures of performance include track continuity, false alert reduction, increased true alerts, correct target tracking, and reduced target latency.

By improving these key measures of performance, the technology sought by this SBIR topic will streamline sonar-related tasks to reduce operator workload and enable reduced manning via improved automation. Use of this technology on unmanned platforms is anticipated to improve capability in a manner to enable reduction of acquisition costs.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth

by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for combining new feature-aided tracking tools with kinematic algorithms to track and correctly classify multiple targets in noisy (low signal-to noise ratio) cluttered environments. Demonstrate the concept can feasibly improve tracking performance against multiple targets in noisy, cluttered environments by at least 25% for the active sonar domain. Establish feasibility through analytical modeling and development with simulated or recorded sea data. The Phase I Option, if exercised, will require the initial system specification and capabilities description to build a feature-aided tracking prototype algorithm in Phase II.

PHASE II: Develop and deliver a prototype feature-aided tracking capability and evaluate with tactical active sonar data to show it meets the parameters in the Description. Validate the prototype using diverse data sets to evaluate performance across SQQ-89 transmit waveforms and a representative range of environmental conditions. Develop a Phase III plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Assist the Government in transitioning the technology for Navy use in an operationally relevant environment to allow for further experimentation and refinement. Integrate the software algorithms into an updated PEO-IWS 5 AN/SQQ-89 surface ship ASW combat system program. Validate, test, qualify, and certify the feature-aided tracking algorithms by using the ACB programs current 4-step risk reduction test process for incremental upgrades to the AN/SQQ-89 Program of Record, which will be provided after Phase II.

Commercial applications that currently utilize various forms of active acoustic transmission and reception that could benefit from a feature-aided tracking approach include oil exploration, seismic survey, rescue and salvage, and bathymetric survey.

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KEYWORDS: Active Sonar in Anti-submarine Warfare; Multi-ship Operations that Involve a Diversity of Sensors; Feature-aided Detection Techniques Combined with Kinematic Tracking; AN/SQQ-89 Surface Ship Sonar Suite; Direct Path, Bottom Bounce, and Convergence Zone Environments; Automatic Tracking and Classification Systems

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-068 TITLE: Compact High-energy Efficient System for Removing Carbon Monoxide from Ambient Air on Submarines and Other Closed Manned Environments

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 397, Columbia Class Program Office

OBJECTIVE: Develop a compact high-energy efficient forced-air (100 cfm) system for removing hazardous levels (less than 50 ppm) of carbon monoxide (CO) from ambient air on submarines.

DESCRIPTION: Nuclear submarines in the U.S. fleet use a central catalytic oxidation system to remove carbon monoxide (CO), hydrogen (H₂), and volatile organic compounds (VOC) from air by converting them to carbon dioxide (CO₂) and water vapor. A high ventilation rate is generally used to prevent hazardous gases from accumulating at their sources and is usually sufficient to prevent unsafe concentrations. However, some isolated or poorly ventilated spaces within the submarine would benefit from local removal of CO. Where contamination may accumulate to hazardous levels, if not removed locally, the severity would increase if there was a fire or failure of the central catalytic oxidation system. This SBIR topic seeks to develop an energy efficient, compact, portable, stable, and stand-alone system to prevent the build-up of CO in such isolated and poorly ventilated spaces. The current "CO and H₂ Burner" draws a large volume of air from the Auxiliary Machinery Room (AMR) and catalytically removes CO by conversion to CO₂. The catalyst is only sufficiently active at elevated temperature (500°F) in the presence of humidity. No room temperature or portable systems exist. The proposed portable system would continually monitor its local space and activate when necessary (i.e., greater than 50 ppm CO) to continuously remove the CO until a local concentration of 5 ppm is attained. The airflow through the system must be at least 100 cubic feet per minute (cfm). The catalyst must achieve 95% removal rate over a temperature range of 15°C to 25°C and humidity in the range of 50%-80% relative humidity (RH). The confined spaces do not have access to cooling water but will have access to electrical power for running a fan and operating a CO sensor (115 VAC, 100 Watt maximum). The system must operate for 10,000 hours without requiring maintenance when 115 VAC power is available. Battery backup must be included to allow the system to remove CO for one hour if 115 VAC electrical power is not available. The final target maximum system weight and volume are 50 pounds (lbs.) and 2 cubic feet, respectively. In addition, the final design must pass shock (MIL-S-901) and vibration (MIL-STD-167) testing making it suitable for shipboard application.

References 2 - 4 provide a sufficient overview of the conditions present on submarines and the contaminants found in submarine air. Currently available sorbents are not suitable for this system because they do not have sufficient absorption capacity for low concentrations of CO and would require frequent regeneration or change-out. Platinum- and palladium-based catalysts are not active at room temperature and would require energy to maintain an elevated catalyst temperature. Air-to-air heat exchangers (recuperators) will not eliminate the energy requirement because their efficiency is too low for a lightweight and compact system. Compact high efficiency heat exchangers have a high-pressure drop, which would then require an unacceptably noisy fan or regenerative blower. A room temperature CO oxidation catalyst may be the most feasible option for this system and must be stable in the presence of moisture and other contaminants. Moisture sorbent guard beds that could require maintenance or noisy blowers are not permitted.

Hopcalite is commonly used for short-term room temperature oxidation of CO, but is not suitable for this topic because it rapidly deactivates in the presence of water vapor. Nano-gold has shown extraordinary activity for CO

oxidation at sub-ambient temperatures but is not stable in the long-term submarine environment and has been observed to also deactivate in the presence of water vapor. Catalysts activated by ultra-violet light would be suitable if an overall system requiring less than 100 Watts could be designed.

PHASE I: Develop a concept for a catalytic material formulation that can achieve the CO removal under the conditions of flow, temperature and humidity specified in the requirements above. Demonstrate the feasibility of the concept catalyst material to achieve the required CO removal capacity for 10,000 hours continuous operation. The Phase I Option, if exercised, will include the initial design concepts and plan to build a prototype in Phase II.

PHASE II: Develop a non-dusting engineered prototype form of the material to enable a system design comprising a low-pressure fan as detailed in the Description. Provide a report documenting the results of MIL-S-901D and MIL-STD-167 testing and internal testing showing 90% removal of 50 ppm CO in an air stream at room temperature at 80% RH (relative humidity) for 1000 hours. Conduct shock and vibration testing at a suitable certified laboratory chosen by the proposer and approved by NAVSEA. Provide a sample (engineered form) of the material for Navy testing under the same conditions for 10,000 hours. (Note: Technical requirements will be satisfied if a 90% removal rate is maintained at room temperature for 10,000 hours with no increase in pressure drop.) Ensure that the performance of the engineered form does not decrease if the temperature is increased to 200°C for up to 10 minutes. Develop and submit a Phase III plan for Navy approval.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the system for Navy use. The company may want to offer a non-militarized version for commercial or residential use. One possible use would be in automotive repair garages. The material developed in this SBIR topic will be useful for any system designed to remove CO from commercial or residential buildings.

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KEYWORDS: Room Temperature Oxidation; Carbon Monoxide; Moisture Resistant Catalyst; Poison Resistant Catalyst; Nano-Gold; Indoor Air Quality

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-069 TITLE: Low-cost, High Efficiency, and Non-rigid, Perovskite-based Single-junction or Tandem Solar Cells

TECHNOLOGY AREA(S): Battlespace, Materials/Processes

ACQUISITION PROGRAM: Ground Renewable Expeditionary Energy Network System (GREENS)

OBJECTIVE: Develop and demonstrate, on increasing scales, novel solar cell designs and manufacturing processes relevant to production of robust perovskite-based solar cell modules that outperform crystalline silicon solar cells in terms of cost, efficiency, and energy payback time and have a comparable expected lifetime. Target DoD applications include flexible solar cells mounted on lightweight semi-rigid substrates such as in the current Marine Corps GREENS expeditionary solar power system.

DESCRIPTION: Metal halide perovskites were researched in the 1990's as easy to form semiconductors that formed and crystallize from solution and immediately had promising properties [Ref 1]. However, the poor stability in air (oxygen, moisture) and the presence of lead persisted as major hurdles for further development and commercialization. After a dormant phase, interest was resurrected when the perovskite materials showed excellent performance as absorbers for dye-sensitized solar cells and eventually as the active layer in thin-film solid-state solar cells [Ref 2]. Researchers quickly developed methods to grow films with large grain sizes and fabricate devices with interfacial layers that provided short-term protection from moisture and oxygen to allow facile characterization. Seemingly overnight, hundreds of labs entered this research area and the inherently high-performing semiconductor gave solar cells that increased in power conversion efficiency from below 10% to over 22% within five years [Ref 3], appearing to have the potential to challenge crystalline silicon as a commercial solar cell alternative.

The incredible thrill of research that yielded new record cells every few weeks is satisfyingly in the past (2010–2015). Further records in power conversion efficiency come more slowly and much of the research has moved towards improving inherent stability, removing lead, and developing stable and high-performing device stacks. Inherent stability has been improved by tuning the perovskite composition to tighten the crystal lattice without a large drop in performance. Longer-term research on two-dimensional (2D) lattices currently sacrifices efficiency for stability. Likewise, lead replacement reduces efficiency. Eventually these areas of research may lead to thin film lead-free perovskite devices with reasonable lifetimes and high efficiency that can be applied to flexible substrates with reduced packaging. In the short term, 3-dimensional metal halide perovskites in well crystallized layers, in an appropriately designed device stack, and robustly packaged form-factor promise to compete with silicon on a cost and efficiency basis.

In the perovskite solar cell community, academic institutions and small businesses have demonstrated power conversion efficiencies above 18%, but significantly fewer have investigated each specific layer of the stack for both optimal performance and stability under accelerated aging conditions. Even fewer have begun scaling deposition processes and carried out market analyses to identify device formats that will compete in a crowded, competitive market. This SBIR topic is a manufacturing technology project. The Navy is interested in companies with plans to commercialize perovskite-based solar cells who have progressed to the stage where they have demonstrated a viable device stack of >1 cm² area and >18% power conversion efficiency. The Phase I proposal should describe the company's development of the device stack including how various layers were selected/developed, how they are currently deposited, and plans to scale processing. The proposal should include stability data for unpackaged devices under ambient conditions or other stability characterization. The proposal should include a cost analysis.

PHASE I: The entry point into this SBIR is for the performer to have developed and characterized a high-performing perovskite based solar cell that has achieved >18% power conversion efficiency and to have adequately

described the packaged stack performance and stability in the initial proposal. At the start of Phase I, the performer will pursue certification of this device stack at the 1-cm² level if this has not been done, either with an independent laboratory or with the Navy.

By the end of the 6-month Phase I effort, the performer should develop: (1) a mini-module with >18% power conversion efficiency, 50 cm² or larger, fully packaged device on flexible or rigid substrate, produced by any combination of deposition techniques; (2) a commercial module design; (3) detailed plans on how to develop the manufacturing technology to fabricate larger >18% efficiency modules on flexible substrates over the two-year Phase II including identification of key technical and cost barriers; and (4) an updated business plan/market evaluation with strong cost analysis.

The fabrication and performance of the mini-module should be presented in the final report along with the other deliverables mentioned in the above paragraph. The mini-module performance should be verified by standard techniques and be available for independent evaluation.

PHASE II: Continuously mature device stack, processing, and packaging towards a >18% power conversion efficiency solar cell mini-module (>200 cm²), fully packaged on a flexible substrate with target 10 year lifetime, threshold 5 year lifetime. Include regular submission of packaged small multi-cell modules to an independent party for performance and stability characterization. Provide quarterly metrics and quarterly reporting. Deliverables include the module described above and a final report which details the progress towards a commercially viable product, remaining technical and cost hurdles, and an updated business plan.

PHASE III DUAL USE APPLICATIONS: Scale to cost-effective production level. Work with DoD acquisition programs or current vendors to design and produce application specific solar cell modules for incorporation into products for military applications.

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KEYWORDS: Perovskite; Solar Cells; Stability; Efficiency; Flexible Substrate; Mini-module

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

TECHNOLOGY AREA(S): Ground/Sea Vehicles, Information Systems, Sensors

ACQUISITION PROGRAM: INP: Full Spectrum Undersea Warfare

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate effective sensors and autonomous behaviors that enable unmanned vehicles to conduct missions of relevance to the Navy.

DESCRIPTION: New concepts in the employment of unmanned vehicles in Naval missions will require suitable sensing equipment and the necessary autonomous behaviors to support the desired mission goals. The Navy seeks sensor and autonomy solutions that support timely and effective use of unmanned vehicles in three maritime mission areas. Proposals must address one of these mission areas and suggest the necessary additional vehicle modifications that are expected to be necessary for achieving mission success. The desired vehicle classes and mission areas are:

1) Vehicle Description: Navy Class III Large Unmanned Underwater Vehicle, for example LDUUV "Snakehead". Mission Description: Cable Repair – Locate and survey undersea cables; examine/record exposed cable surface for potential damage; mark precise locations of damaged sections.

2) Vehicle Description: Vertical Takeoff Unmanned Aerial Vehicle, for example Firescout. Mission Description: Anti-Submarine Warfare – Given approximate location data of a submarine, re-locate the enemy and deliver operator-selected effects.

3) Vehicle Description: Tier 2 Unmanned Aerial Vehicle, for example TERN. Mission Description: Anti-Surface Search – Given approximate location data of surface ships, conduct all-weather search, location, and identification and transmit the information to a remote operator.

The specific details of these mission concepts can be classified.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Identify a sensor and autonomy design that can be developed to meet the specifications. Examine the key mission activities that require use of autonomous behaviors. Analyze key design considerations assuming a particular unmanned vehicle and assess the strengths and weaknesses of the proposed approach. Conduct a design review for the proposed concept to be pursued in a proposed Phase II plan, including the impact on the selected unmanned vehicle.

PHASE II: Develop and test a prototype for the proposed approach. Complete preliminary performance testing in a surrogate but possibly classified environment. Where necessary, hardware in the loop simulations can be used for demonstrating autonomous behaviors.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: In Phase III, extensively test the prototype fabricated in Phase II and examine mission performance under nominal operating conditions and well as performance in suboptimal environments and conditions. Potential dual use applications include hydrographic surveys, remote monitoring of harbor traffic, and undersea cable fault identification and repair.

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KEYWORDS: Autonomous Vehicles; Unmanned Vehicles Sensors; ASW; ASuW

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-071 TITLE: Ultra-Fast Metastable Implant Activation System for Selective Area Doping of III-Nitrides

TECHNOLOGY AREA(S): Electronics, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO ships: PMS 320 Electric Ships Office

OBJECTIVE: Develop a commercially relevant tool for activation of implanted dopants for gallium nitride (GaN) and related semiconductor materials and devices at elevated gas pressures with sub-second heating and cooling cycles to achieve dopant activation without decomposition of the GaN surface.

DESCRIPTION: Future Navy ships will require high-power converters for systems such as the rail gun, Air and Missile Defense Radar (AMDR), and propulsion on DDG-51 size ship platforms. High-voltage, high-efficiency power switches are required to achieve the needed power density. Gallium Nitride (GaN) and related III-N alloy materials provide a tunable direct band gap from 0.7 eV to 6.1 eV with high breakdown fields and enable high-power and high-switching frequency devices. In particular, GaN has ~1.5x the breakdown field and ~5x the Baliga Figure-of-Merit compared to SiC, the current state-of-the-art, as well as ~11x and ~850x compared to Si, the current standard. The large Baliga Figure-of-Merit for GaN technology will enable >10kV power switching devices with low on-resistance and high efficiency.

While GaN devices have been commercialized for blue and white LEDs, challenges remain in establishing arbitrary device geometries and doping profiles required for efficient high-voltage and high-frequency devices. Ion implantation is the most versatile approach for the selective area doping required for the efficient high-power devices. However, in GaN materials, high nitrogen decomposition pressure at high temperature (60,000 bar at melt of GaN) causes the surface of the GaN crystal to decompose precluding conventional annealing to activate implanted dopants as employed in silicon and SiC, instead requiring novel annealing methods.

Annealing and activation of the ion implanted p-type magnesium (Mg) dopant in GaN has proven to be more than a 25-year research effort to find an approach that can activate the p-type Mg dopant without decomposition of the GaN surface. Annealing to reduce implant-induced damage requires temperatures near 2/3 the melting point of the crystal or approximately 1,400°C for GaN, whereas the nitrogen begins to leave the GaN surface and decompose the GaN crystal at temperatures less than 900°C at atmospheric pressures. Deposited capping layers allow annealing to 1,100-1,200°C at atmospheric pressures; however, these temperatures are not sufficient to allow activation of implanted p-type Mg dopants in GaN. A combination of ultrafast sub-second heating and cooling cycles and a high nitrogen overpressure is critical to activate implanted p-type Mg dopants in GaN [Refs 1-5].

A novel GaN implant activation approach has been investigated at the Naval Research Laboratory (NRL) [Refs 1-5]. It combines application of moderate nitrogen (N₂) overpressure to prevent the GaN surface from decomposing and applying multiple rapid (seconds) heating and cooling temperature pulses above thermodynamic stability of the GaN crystal to accumulate long enough time at high temperatures for the required implant damage reduction processes by diffusion. The approach includes the steps of: (1) a long time annealing regime at temperatures at which the GaN crystal is still stable; (2) transient annealing in the metastable regime using multiple rapid heating/cooling cycles from a baseline temperature to peak temperatures above the thermodynamic stability of the GaN crystal; and (3) a long time annealing regime at temperatures when the GaN crystal is still stable.

The NRL annealing approach made it possible to demonstrate the first GaN p-i-n diode using Mg implantation; however, the GaN sample size is limited to less than 2 inches. Consistency in activation efficiency and implant damage removal remains problematic in the current implementation.

The shortest heating and cooling cycle duration provided by the RF heating in the NRL system is limited to the scale of seconds and heating/cooling rates of 200 K/s. It is the goal of this SBIR effort to develop a system with ultrafast sub-second heating and cooling rates (>1,000 K/s) that allows shorter temperature pulses and thereby achieves higher maximum peak GaN temperatures without the material decomposing. It is much more difficult to achieve sub-second cooling rates than sub-second heating rates, and thus novel cooling approaches should be investigated to achieve the 1,000 K/s cooling rate. In return, the higher peak temperature at each of the multiple heating pulses provides better conditions for diffusional processes in GaN, and results in better restoration of structure damaged by implantation and better activation of the implanted dopants while preserving the integrity of the GaN surface.

The proposed Ultra-Fast Metastable Implant Activation System for Selective Area doping of III-Nitrides should meet the following thresholds:

Deliverable Design Characteristics Value

- Sample size up to 8” diameter, 0.1 to 5 mm thick
- Stabilizing gas (N₂, Ar, H₂, O₂) pressures up to 100 bar
- Primary heating method providing steady heating regime, and heating and cooling rates no less than 1,000 K/s for anneal (50 Bar pressure, baseline temperature ~1,000°C, peak temperature >1,500°C)
- Optional secondary heating method (possibly by laser heating) to exceed 500 K temperature pulse of heating and cooling in less than 100 millisecond (50 Bar pressure, baseline temperature ~1,000°C, peak temperature >1,500°C, mean heating/cooling rate >10,000 K/s)
- Inclusion of windows and ports that would allow process monitoring and control,
- Uniform heating across entire 8-inch wafer with less than 2 percent nonuniformity
- Achieve steady state temperatures up to 2,200°C for potential dopant activation
- Sub-ppb contamination of moisture or gas mixture (e.g., oxygen in nitrogen) inside the chamber
- Successful demonstration of electrical activation of Mg and Si implanted dopants in GaN
- Successful demonstration of maintaining GaN pristine surface integrity for anneals achieving 3 minutes of cumulative time between 1,300°C and 1,400°C

PHASE I: Determine feasibility and establish a plan for the design and development of a system to activate implanted dopants in GaN. Describe features and issues for the design and development of the ultrafast sub-second dopant activation system that can controllably conduct steady-state and transient uniform heating of 8” GaN wafers at required temperatures, heating pulse frequency, and gas pressures up to 100 bar. Ensure that the system is designed to meet all requirements, providing heat treatment regimes necessary for implant activation. Provide a Final Report that convinces that the proposed system can be properly designed to address the above desired and required features and be achieved if Phase II is awarded. Provide a Phase II development plan addressing technical risk reduction.

PHASE II: Develop a fully functional dopant activation system having all parameter monitoring and control tools and capable of producing p/n type conductive regions in GaN and related materials by activating impurities after ion implantation. Demonstrate that the system provides uniform heating of an 8” wafer as required in the technical specification with heating/cooling rates at gas pressures of 50 bar. Deliver a prototype of the fully operational system with appropriate control software to the Navy for evaluation as required by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Address the commercialization of the product developed as a prototype in Phase II. Work with suitable industrial partners for this transition to military programs and civilian applications by identifying the expected final state of the technology, its use, and the platform it will be used on. The expected final state of this product will match the requirements given in Phase II and will allow for the tool to be installed, certified, and operated within standards of a modern semiconductor fabrication facility. An implant activation system of this design will enable cost-effective, semiconductor-based, high-power devices for solid-state transformers to replace electromagnetic transformers for the electric grid, rail traction, large-vehicle power systems, and wind turbines.

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KEYWORDS: GaN; AlGaN; InGaN; III-nitrides; Power Electronics; Wide Bandgap Semiconductor; Electronic Switching Diode; Power Density

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-072 TITLE: Aligned Nanotube Reinforcement of Polymer-matrix Laminates

TECHNOLOGY AREA(S): Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA265, JPO, Next Generation Air Dominance

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Demonstrate increased performance of polymer-matrix laminated composites using nanoscale additives resulting in a Phase II end product that is a nano-enhanced version of a commercially available fiber/resin system available and capability to produce at relevant scale for DoD programs.

DESCRIPTION: Polymer-matrix composites (PMCs) are used extensively in DoD systems due to their high specific strength and stiffness in-plane. While tensile properties are governed by fiber, many other properties are matrix-limited, including shear, fatigue, compression, impact, conductivity, and maximum service temperature. Polymers intended for high service temperature environments trade off mechanical properties for high Glass Transition Temperature (T_g), increasing the composite's susceptibility to interfacial failures and narrowing their applicability to supplant metallic incumbent structures. For example, AFRPE-4 has a T_g of 371°C (compared with Hexcel 8552 at 200°C), but interlaminar shear with standard modulus fiber is only 73 MPa (vs 128 MPa for Hexcel 8552) [Ref 1].

State-of-the-art structural epoxy-matrix composites are toughened with thermoplastic particles to address interlaminar failure. However, their performance tends to suffer under hot/wet conditions, and epoxy prepreps are limited to T_g < 200 °C, below the range of interest for engine compressor and nozzle applications.

High-temperature polymers like Polybismaleimides (BMIs) and polyimides are in current use in Navy systems. Existing components comprising these materials make design trades to mitigate limitations in mechanical performance, for example interlaminar shear strength. The typical approach to reducing interlaminar stresses in corner radii, such as those that occur at the interface between airfoils and platform features on stator vane twin-packs, and up-turned flanges on fan ducts, is to increase the size of the radius and/or increase the laminate thickness. This approach may in turn produce other detrimental effects. A larger radius at the ends of an airfoil may reduce the

aerodynamic efficiency of the airfoil. Furthermore, thicker laminates present material processing challenges for high-temperature PMCs, particularly for polyimides, that may lead to an increase in manufacturing defects such as wrinkles and porosity.

Use of high T_g polymer matrices composites could address an expanded range of applications for structural composites in high service temperature environments, if their mechanical properties can be bolstered.

Carbon nanotube (CNT) forests oriented through-thickness have been demonstrated as an effective interlaminar reinforcement for epoxy-matrix laminates, significantly increasing interfacial properties such as impact resistance, shear strength, compression and fatigue [Refs 2-6]. These effects are observed even at low loadings. Furthermore, CNTs exhibit thermal stability comparable to carbon fiber, so they are intrinsically compatible with high T_g polymer matrices.

Increased interlaminar strength, toughness, and fatigue capability using aligned CNTs can relax current design constraints that drive increases in thickness and corner radii for high T_g polymer systems. Improving these key mechanical properties thus has the potential to reduce manufacturing defects and expand the design space. These compounded effects will enable future components with higher aerodynamic and structural efficiency. A higher-performing or lightened revision of an existing component using aligned CNT additives would effectively demonstrate these values: better performing existing systems and expanded design space for future components.

PHASE I: Develop an aligned CNT-based additive material that is compatible with one or more high temperature PMC preregs in current Navy use. Identify current technical limitations (of the current PMC system) and improvement targets to enable wider adoption of high temperature PMCs, particularly in replacement of heavy or complex metallic components. Develop a process for controlled integration of the additive into the composite resulting in repeatable loading levels and morphology. Define and perform a test matrix to demonstrate relevant increases in performance, and verify property trades-off are minimized. Perform analyses to characterize the effect of the additive on damage modes. Develop a Phase II work plan including strategies for scaling, performance optimization and system targeting. Include a component-level technology demonstration in a Phase II work plan.

PHASE II: Identify one or more candidate components for high temperature PMCs where the current mechanical performance limits drive excess component weight or manufacturing complexity into the design; or preclude adoption altogether. Determine figures of merit and targets needed to improve the current component or modified component design. Refine additive material properties and integration methods to achieve stated targets repeatably, and demonstrate via coupon and/or subcomponent testing. Fabricate and test the candidate component(s) using the CNT-based additive to quantify increase in component performance under representative conditions. Quantify and demonstrate CNT synthesis manufacturing readiness level, and CNT-prepreg integration (“transfer”) manufacturing readiness level of 8+.

PHASE III DUAL USE APPLICATIONS: Evaluate and qualify the system for Navy use and procurement including approved manufacturing locations to ensure that Navy end-users have access to the system. Manufacture and make the system available for procurement by Navy end-users.

If an aligned CNT material and processing technology is successfully demonstrated, it could benefit commercial manufacturing industries which use DoD-relevant high-temperature prepreg systems for structural applications.

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KEYWORDS: Composites; Nanomaterials; CNTs; High Tg; Aircraft Engines; Polymer; PMC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-073 TITLE: Low Phase Noise Laser for Radio Frequency (RF) Photonics

TECHNOLOGY AREA(S): Air Platform, Information Systems, Sensors

ACQUISITION PROGRAM: FNT-FY17-02 Submarine Simultaneous Transmit And Receive (SUBSTAR)

OBJECTIVE: Develop a compact, low-phase-noise, semiconductor or diode-pumped solid-state laser to provide next-generation, low-noise-figure radio frequency (RF) photonic capabilities for electronic warfare (EW) applications. Ensure that the 100 mW class fiber-pigtailed lasers emits in the 1.32- or 1.5-micron wavelength range and is packaged in industry standard butterfly-type packages.

DESCRIPTION: Dominance of the electromagnetic (EM) spectrum is critical for DoD. As threat carrier frequencies extend above 20 GHz, electronics technologies are challenged to process wide bandwidths. RF photonics technologies have natural capabilities to above 100 GHz and can augment electronics to provide comprehensive electromagnetic maneuver warfare (EMW) solutions. To penetrate the electronic warfare application space, RF photonics technology requires low noise figures. The best path to achieving low noise figures is the development of low-phase-noise lasers combined with compact phase modulators that have shot-noise-limited noise performance throughout the 1 to 100 GHz frequency range [Ref 4]. Both diode-pumped solid state and quantum dot

semiconductor lasers have been shown to have superior phase noise properties throughout the gigahertz regime inherent in their design due to the slow gain dynamics of rare-earth doped crystals and glasses (solid-state) or due to the discreteness of their energy levels (quantum dot).

PHASE I: Design an approach and determine its feasibility and expected performance. Develop a design that uses 100 mW low phase-noise lasers combined with phase modulators that are compact (50 to 100 cubic centimeters), emit in the 1.32- or 1.5-micron range, and have shot-noise-limited noise performance throughout the 1 to 100 GHz frequency range. Simulations or practical supporting measurement data in this Phase are highly desirable and preferred over literature searches researching prior art. Supporting information stating how the proposed design will meet the power and shot noise limits is advantageous. Develop a Phase II plan.

PHASE II: Fabricate and package a laser in a representative small (25 to 50 cubic centimeters) butterfly package. Perform laboratory measurements of laser amplitude, phase noise, and power output. Ensure, that at the end of Phase II, this packaged laser should be at Technology Readiness Level (TRL) 4, performance measured in a laboratory environment.

PHASE III DUAL USE APPLICATIONS: Mature the laser to a higher TRL level (at least TRL-6) so a transition to a Program of Record can be achieved. Tailor the design to a specific air or submarine platform system to be determined between Phases II and Phase III.

Low phase-noise lasers may be of interest in commercial communication systems for use with modern coherent modulation formats, combined with high symbol rates, both of which stress the need for lower phase-noise lasers.

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KEYWORDS: Photonics; Solid-state Laser; Quantum Dot Laser; GHz; Noise Figure

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-074 TITLE: High Power Microwave (HPM) Waveform-enhancing Sub-nanosecond Semiconductor

Pulse Sharpener

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Weapons

ACQUISITION PROGRAM: ONR Code 352: High Power Microwave (HPM) Basic Research

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an electrically driven, sub-nanosecond, semiconductor pulse sharpener to improve the performance of high power microwave (HPM) pulse generators by reducing/sharpening the rise time of a driving pulse, preserving the trailing edge of the pulse, and increasing the bandwidth of the output.

DESCRIPTION: Wideband (WB) and ultra-wideband (UWB) high power microwave (HPM) source performance parameters can be described in terms of source power or output voltage across a load, pulse repetition rate, pulsewidth, and pulse rise time. When evaluating pulse compression techniques, it is observed that energy density within an inductor is higher than in a capacitor; consequently, the pulsed voltage generated during a short duration at a load may be many times higher than the voltage at which the energy has been stored [Ref 1]. HPM pulse generating sources utilizing inductive storage and discharge techniques to generate high voltage (10s to 100s of kV), at short pulsewidths (~ nanoseconds), are limited in their performance owing to the large trailing edge of the pulse. The performance of HPM pulse generators may be enhanced with the use of a pulse sharpener, which would serve to reduce, or sharpen, the rise time of a driving pulse. One such device employed for this purpose is the silicon avalanche shaper (SAS), which is a fast closing switch capable of switching high voltage (kV) pulses at sub-nanosecond time scales [Refs 2, 3].

During operation, a SAS diode is initially placed in reverse bias. A fast-rising, high voltage driving pulse (~ kV/ns) applied to the cathode initiates a delayed impact ionization wavefront, which translates to a sharp voltage ramp (kV/ps). One example of SAS construction is a typical p+-n-n+ structure, where the width of the n-base layer is on the order of 100–300 μm . Static breakdown voltages of SAS devices can be on the order of 1 kV for a 1 mm diameter device, but differential voltages (dV/dt) strongly depend on the rise rate of the incident pulse and the material composition (Si, SiC, GaN) [Ref 5].

KEY SEMICONDUCTOR PULSE SHARPENER PARAMETERS

- Sharpen the 10-90% driving pulse rise time from 3-5 ns to < 200 ps, with minimal impact to peak pulse amplitude
- Static Breakdown Voltage, V_{br} = 3 kV or higher
- Dynamic Breakdown Voltage = 3 times V_{br}
- Differential Voltage Objective: $dV/dt = 200 \text{ V/ps}$
- Differential Voltage Threshold: $dV/dt = 20 \text{ V/ps}$
- Diode Restoration Time < 2 μs
- FWHM Switching Time < 300 ps
- Peak Current Rating > 1 kA

PHASE I: Develop a concept for a semiconductor pulse sharpener for sub-nanosecond rise time sharpening of a 3-5 ns driving pulse generated from a HPM inductive storage type pulsed power source. Ensure that the resulting device meets the specific electrical and performance characteristics, and is fabricated in a compact form factor to fit within a constrained operational footprint. Ensure that the contacts of the device are flat, stackable, and solderable, such that multiple wafers can be stacked in series, and parallel, and allow for the addition of heatsinks for thermal management. In addition to electrical and performance characteristics, the device should be analyzed for its thermal

properties. Prepare a Phase II plan.

PHASE II: Fabricate single wafer and stacked wafer sub-nanosecond semiconductor pulse sharpeners. Deliver samples to be performance tested. Improvement of key performance parameters such that a pulse output with the 10-90% rise time of a 3-5 ns and a dV/dt of 10 v/ps to a rise time of less than 100ps and a dV/dt of greater than 200 V/ps, while maintaining breakdown voltage, peak pulse amplitude, and compact form factor. Improve device mounts, stacking techniques, and thermal dissipation.

PHASE III DUAL USE APPLICATIONS: Develop manufacturing methods to improve component yield, production time, operational lifetime, and component cost.

Potential applications include: Ultra-wideband radar, Pockels cell drivers, output switches for gas discharge laser systems, perimeter security, and altimeters.

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KEYWORDS: Semiconductor Pulse Sharpener; Sub-nanosecond; Semiconductor Avalanche Shaper; SAS; Silicon Avalanche Shaper; Improved Pulse Rise Time; High Power Radio Frequency; HPRF; High Power Microwave; HPM; Wideband; Solid-state; Ultra-Wideband; UWB; Drift Step Recovery Diode; DSRD

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-075 TITLE: Enabling Technologies for Marine eDNA Sampling

TECHNOLOGY AREA(S): Battlespace, Sensors

ACQUISITION PROGRAM: N45 6.4 Living Marine Resources and FLT/SYSCOM Marine Species Monitoring Programs

OBJECTIVE: Technologies and techniques for sampling and analysis of marine environmental DNA (eDNA) are improving rapidly but many barriers remain. This SBIR topic seeks to enable widespread, inexpensive use of marine eDNA for the accurate, timely identification of biological organisms in the maritime environment using autonomous modes of collection and analysis through the development of both small, inexpensive analysis payloads and enabling technologies for such payloads; in particular, techniques that reduce the amount time for sample analysis, reduce the volume of sample water, reduce false alarms from contaminants, and automatically generate sampling strategies, among many other possibilities.

DESCRIPTION: Remote monitoring of the biologic inhabitants of the world's ocean is extremely difficult. Advances in DNA methods present an opportunity to harness a new technology and fundamentally improve our capacity to monitor biological communities and human uses of the marine environment. Marine eDNA techniques identify genetic signatures that variously persist in the environment. Self-contained analysis payloads suitable for unmanned platforms, especially underwater ones, would greatly enable eDNA applications. This topic seeks both small, inexpensive analysis payloads and enabling technologies for such payloads; in particular, techniques that reduce the amount time for sample analysis, reduce the volume of sample water, reduce false alarms from contaminants, and automatically generate sampling strategies, among many other possibilities.

PHASE I: Develop concepts and determine feasibility of marine eDNA technologies and techniques suitable for unattended operation in an unmanned underwater vehicle, including the identification of methods to reduce eDNA vehicle payload, sample volume, analysis time, and need for filtration of nearshore samples; development of sampling approaches suitable for unmanned underwater vehicles. Develop key component technology milestones and conceptual designs for hardware. Prepare a Phase II plan.

PHASE II: Produce prototype hardware based on Phase I effort. Establish hardware performance and develop a conceptual plan for integration into an unmanned underwater vehicle. Deliver a prototype ready for integration and testing by the Government at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Successful development of marine eDNA technology suitable for underwater vehicle use will open up tremendous opportunities for small businesses to provide marine eDNA capabilities to a wide range of Government agencies having equities in marine biological issues, for example, NOAA National Marine Fisheries, National Ocean Service, Office of National Marine Sanctuaries, Bureau of Ocean Energy Management, U.S. Geological Survey, Fish and Wildlife Service, National Park Service, Environmental Protection Agency, and National Institute of Environmental Health Sciences, among others.

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KEYWORDS: Environmental DNA; Polymerase chain reaction; PCR; Marine Mammals; Bacteria; Viruses; Plankton

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-076 **TITLE:** At-Scale Detection of Hardware Trojans on Chip Circuits

TECHNOLOGY AREA(S): Electronics, Ground/Sea Vehicles, Information Systems

ACQUISITION PROGRAM: Innovative Naval Prototype (INP) - Total Platform Cyber Protection (TPCP), PMW-160, PMW-170

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a method to scan chips on devices at scale to detect malicious implants known as hardware trojans. The Office of Naval Research (ONR) is seeking approaches that are non-destructive, do not require chip removal, and can scan boards and several devices in a timely fashion.

DESCRIPTION: Within the Navy there is a push to improve cybersecurity at all levels from application down to hardware. Many chips are made in other countries and potential hardware trojans could either exfil information or disable critical Navy systems such as weapons, communications, navigation, etc.

The Federal Government and its civilian workforce purchase vast quantities of electronics technologies. Much of this technology is provided from other countries. Supply chain attacks are realistic events. The Navy, DoD, and Federal Government must defend against malicious implants in chip technology. Analyzing chips is a difficult, tedious, and time-consuming task. It quite often involves destructive testing on a sample amount, chip removal, and

some amount of delayering. This approach is not realistic due to the quantities of chips on boards in devices that may be suspicious. ONR is requesting approaches that are non-destructive; do not require decapping/delayering/desoldering; and can be implemented by simply removing the cover and possibly the entire board from the inherent device and then scanned for potential threats, specifically malicious hardware implants. The desired capability should be able to identify chip technology on the boards and make associated references to any existing/provided designs and/or operational capabilities/specifications. Please keep in mind that total or complete knowledge about the chip may not be available to the Government and any capability developed by the small business performer will need to address that possibility to be successful.

PHASE I: Demonstrate through a physical proof-of-concept or a model/simulation that the proposed approach is sound and feasible. The end result should be convincing from a physics perspective and from an ability to conduct this operation at scale on many chips. Develop a Phase II plan.

PHASE II: Develop a working prototype that is capable of maneuvering across a circuit board to assess all the chips.

PHASE III DUAL USE APPLICATIONS: It is expected that with the assistance of ONR, the performer will work with an acquisition group such as PMW-160 or PMW-170 (or another since this SBIR topic applies to many groups) to develop a system that could be used by Navy personnel (civilian or military) to detect the presence of hardware trojans on chips. A commercial device would also be appealing to many U.S. manufacturers selling any number of technologies to both businesses and consumers. Some examples include communications equipment, computers, and Internet of Things (IoT) devices.

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<https://phys.org/news/2017-03-d-x-ray-imaging-finest-chip.html>

KEYWORDS: Reverse Engineering; Hardware Trojan; Chip Scanning; Cybersecurity; Supply Chain

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-077 TITLE: Machine Clustered and Labeled Decision Tracks Derived from AI-enabled Intent Recognition

TECHNOLOGY AREA(S): Human Systems, Information Systems

ACQUISITION PROGRAM: Minerva INP; MTC2 (PMW150); TSOA (MC3)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a watchfloor decision aid service, enabled by recent advances in gaming artificial intelligence (AI), that, to be operationally relevant, must regulate the frequency of recommendations and improve their explainability; and that will identify clusters of sub-decision tracks within a decision track for an AI-enabled game plan in which a similar objective or state was met.

DESCRIPTION: The goal of this SBIR topic is to understand the mechanisms of AI-enabled game play in order to produce optimal strategies for multiple objectives and game states. As the Navy moves towards leveraging AI for decision support, maturing intelligent algorithms for execution plans and explainable AI is imperative. AI algorithms have been shown to produce not only optimal or close to optimal solutions, but also a larger set of eclectic strategies otherwise not derived by humans. An understanding of decision tracks leading to differing solutions/strategies will enable the Navy to be strategic given different mission states. The Navy seeks AI that recommends plans that consist of a set of clustered micro-tasks that optimally lead to the achievement of a specific objective.

Advances in deep reinforcement learning [Ref 1] have enabled agents to take low-level actions at a very high pace in support of higher-level plan execution. Researchers have also shown near human level performance for full games [Ref 2] that involve decisions that cut across classic warfighting domains. For the Naval domain, AI that can act confidently but less often and at the plan level are desired since it is not feasible to send human-based forces commands at machine speeds. To accomplish this, a product that can learn clusters of sub-decision tracks (micro-tasks) within a decision track for an AI-enabled plan for which a similar objective or state was met. Given multiple objectives in an AI-enabled game, the topic's challenge is to use machine learning (ML) to cluster subsets of decisions (micro-tasks) that produce a given objective. These clusters will enable labels for specific game states and provide explainability for an otherwise blackbox AI agent. Tracks of micro-tasks will be approved for execution at the plan level as required by an objective. Newly published methods suggest technical feasibility [Ref 3]. Re-planning will have to be done if the state of a mission significantly changes. Furthermore, within a cluster the mature product should be able to identify a ranking of optimal to suboptimal sub-tracks. While proposers may utilize any data sets where AI was used, it may be helpful to utilize already published Starcraft data [Ref 4]. Inferring explainability from the actions of agents in Starcraft is an active research area whose accomplishments can be leveraged [Ref 5].

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Demonstrate the feasibility of developing operationally relevant techniques to cluster and label decision tracks as plans in an AI-enabled game. Conduct a detailed analysis of literature, commercial capabilities, and state-of-the-art AI/ML techniques relevant to this topic. Identify and begin to mitigate key technical risks to a Phase II prototype. Demonstrate progress. Develop Phase II plans with a technology roadmap, development milestones, and projected Phase II achievable performance.

PHASE II: Move development of prototype techniques from a commercial game to a military simulator such as JSAF, OneSAF, or NGTS. Agent interfaces using JSON messaging can be leveraged. Develop and test against an increasingly complex mission plan that spans all warfighting domains. Develop metrics for decision track clustering and similarity measures. Attempt to identify or develop decision track rankings within clusters. Demonstrate an end-to-end AI-enabled capability at the plan level for at least 3 mission contexts (e.g., sea control or amphibious assault). Work with programs of record and training sites to transition the Phase II prototype.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Produce a final prototype capable of deployment to training centers, operational command and control centers, and as a virtual application. Adapt the system to transition as a component to a larger system or as a standalone commercial product. Provide a means for performance evaluation with metrics for analysis (e.g., accuracy of assessments) and a method for operator assessment of product interactions (e.g., display visualizations). The Phase III system should have an intuitive human computer interface. The software and hardware should be modified and documented in accordance with guidelines provided by the engaged Programs of Record and any commercial partners. Technology development should be applicable to any domain that requires the training of end to end AI for a complex game or mission simulation.

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KEYWORDS: Artificial Intelligence; StarCraft; Decision Support; Deep Reinforcement Learning; Machine Learning; Plans; AI; ML

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-078 TITLE: Small-scale Health Monitoring Device for In-tube Environment Monitoring

TECHNOLOGY AREA(S): Materials/Processes, Weapons

ACQUISITION PROGRAM: Trident II D5 Missile System, ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a novel sensor or suite of sensors to be integrated into a future environmental monitoring system with sensor(s) that will collect environmental conditions for analysis motors and will be exposed to explosive environments.

DESCRIPTION: The Navy has a need for on-motor environment monitoring. Understanding the exposure conditions of a motor allows for better evaluation of motor health and aging trends. A sensor or an array of sensors that provide sensing, on-board power, and data storage is ideal. This effort should produce a sensor or suite of sensors that can monitor near-motor environment at all times, but is not integrated into a larger monitoring system. The approach should consider and recommend a solution for powering the sensor and storing the data or performing the same process through passive means.

The sensors must have the ability to collect temperature and humidity, with the possibility of the following additional measurements:

- Pressure
- Shock
- Vibration
- Strain
- Chemical vapor sensor (e.g., nitric oxide, nitrogen dioxide, nitrous acid, ozone, carbon dioxide, and methane)

This SBIR topic is focused on sensors only and not on an integrated environmental monitoring system, which will be notionally mounted to aft and forward domes of a rocket motor. The sensor(s) should be functional if left on the rocket motor for long periods of time (at least 10 years, but up to 40 or more years) and be self-powered. The sensor(s) should have low power and low voltage requirements, at or below 12V, meet Hazards of Electromagnetic Radiation to Ordnance (i.e., HERO) requirements for off-shore use, and be capable of intermittent use while maintaining calibration within 1% for an extended period of at least 10 years.

PHASE I: Develop a technical concept for motor environmental monitoring sensors. Proposed design concepts should be completed during this Phase. Laboratory-scale experiments and/or modeling to verify the proposed concept(s) for health monitoring sensors should be completed, and the completion of key tests to transition from Phase I to Phase II. Identify risks to the technical approach and develop/evaluate plans to mitigate those risks for Phase II. Coordinate with Navy SBIR liaisons key technical requirements for environmental properties to be measured, size of sensor, application method, lifespan of sensor, power, and data storage/transmission.

PHASE II: Design and develop a prototype of the environmental sensor or sensor array based on the concept(s) from Phase I. Ensure that the design includes, at a minimum, temperature and humidity monitoring capabilities. Ensure that the design yields the ability to apply the sensor on the forward or aft dome of the rocket motor. Complete laboratory tests of the sensor prototype to validate operation and feasibility. Design the test to emulate the

installation, sensing period, removal, and download of the data. Perform laboratory-scale experiments and modeling to verify the concept for environmental monitoring. Test a performance of material compatibility test to ensure survivability of the system over long periods of time.

PHASE III DUAL USE APPLICATIONS: Update the sensor or sensor array design from Phase II efforts. Manufacture an updated prototype and demonstrate use on a fleet asset through certification and qualification of the system for deployment and use in the fleet. This technology has the potential to be used commercially in any industry that has a need for environment monitoring in areas of high hazards.

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KEYWORDS: Solid Rocket Motor; Environment Monitoring; Environmental Sensors; Self-powered Sensors; Explosive Material Monitoring; Rocket Motor Health Management

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-079 **TITLE:** Extremely Accurate Star Tracker

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: Trident II (D5) ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and develop a star tracker (using interferometry fringe methodology developed by NASA's Jet Propulsion Laboratory (JPL)) that is extremely accurate, light weight and consumes little power as compared to current commercial products. The developed star tracker will be designed for potential deployment on the Trident II (D5) weapons system and for astronomical data collections (including measures of stellar photometry, variability, and astrometry) that are used by the Navy.

DESCRIPTION: Current commercial star trackers' size, weight, and power (SWaP) needs preclude the Navy from considering deploying these star trackers to the Trident II weapon system. Acquisition of an accurate, low-weight, small, and power-efficient star tracker would allow strategic weapon systems to be deployed with less expensive maintenance cost while also providing weapons system designers options to increase weapon system performance with less expensive hardware cost and maintenance. Furthermore, the new developed star tracker could assist in exo-atmospheric astronomical data collections needed for Navy, DoD and other commercial utility. The innovation needs

to leverage already developed techniques by NASA JPL into a hardware electronics instruments package that is portable for missile and spacecraft environments. The Navy expects the star tracker to be no bigger than 64 cubic inches, weigh no more than 500 grams, and powered for at least two hours, and that new technology will demonstrate calibration of star tracker focal planes up to 100 times more accurate than current commercial capability. The star tracker will be expected to interface with navigation systems that will be matured through the proposal cycle. Power range for the star tracker should be 5W, or under, of navigation system power.

PHASE I: Develop and define a concept design for a star tracker that employs a NASA JPL interferometric fringes technique to measure stars extremely accurately. Ensure that the star tracker will be very small in size and will require low amounts of power. Work with the Navy to fully understand and document the star tracker SWaP and accuracy requirements since the star tracker is to be no bigger than 64 cubic inches, weigh no more than 500 grams, and powered for at least two hours, and that the accuracy of the star tracker to be up to 100 times more accuracy than current technology with pointing accuracy of 0.04 arc seconds. Identify risks in the proposed concept. Develop Phase II plans that include ways to mitigate those risks.

PHASE II: Produce and deliver a prototype star tracker. Assist the Navy in setting up the prototype star tracker for Hardware-in-the-Loop (HWIL) testing that emulates missile and space craft environments; and includes trouble shooting plus resolving implementation and execution issues. Establish feedback loop with the Navy for implementing changes due to prototype testing.

PHASE III DUAL USE APPLICATIONS: Deliver to NSWCDD/USNO a refined star tracker manufacturing prototype that the Navy can test for its function and portability in their land-based HWIL testing facilities. Provide design and test cases that demonstrate that the star tracker's accuracy is 100 times current technology (based on JPL's techniques); and is small, lightweight, and portable according the requirements matured in Phase I. Assist the Navy in setting up the star tracker manufacturing prototype for HWIL testing that emulates missile and space craft environments; and will include trouble shooting plus resolving implementation and execution issues. Support field qualification testing with Navy hardware and software applications. This product would support commercial aerospace space navigation, telescope pointing and tracking.

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KEYWORDS: Star Tracker; Stellar Photometry; Astrometry; Missile; Spacecraft; Accurate Navigation

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-080 TITLE: Remote Telescope Control Software (RTC SW) System

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: Trident II (D5) ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a standardized, accredited software application that will run on the proposed Remote Telescope Control Hardware (RTC HW) and interface with the United States Naval Observatory (USNO)'s Telescope Control System (TCS) already under development at USNO, allowing for secure client-server access to telescope sites around the world. (Note: USNO has access to numerous sites around the world, but does not staff these sites on a permanent basis, and must thus develop a solution for collecting this data remotely.)

DESCRIPTION: The Trident II (D5) weapon system utilizes information and data collected by various telescope systems. These astronomical data sets need to be measured and monitored periodically to ensure weapons system utility and performance. Today, data gaps exist that require USNO to measure stars from various remote telescopes around the world. These data gaps include current collections of numerous bright stars' photometry and astrometry. A Remote Telescope Control Software (RTC SW) solution will fill this data gap in a manner that is repeatable, affordable and enduring. Current software technology requires human on-site interaction and site-specific software applications to collect and store astronomical data. An innovative software application will allow remote data collections from various sites around the world and will save much labor in manning the telescopes. This SBIR topic is expected to work in conjunction with a proposed hardware counterpart. This sort of HW/SW solution and the access it provides will be required to support future plans for USNO collection of data supporting Naval Surface Warfare Center, Dahlgren Division (NSWCDD) programs. Commercialization of this system would involve providing this solution to DoD and other observatories and laboratories who are facing similar challenges.

PHASE I: Develop and define a concept design that standardizes RTC SW that will run on the proposed RTC HW and interface with USNO's TCS, preferred software language is, either, Python or C++. The TCS description from the Navy will mature during Phase I and be provided to topic proposers. Work with the Navy to construct tests that will ensure the SW application runs on the RTC HW and USNO's TCS. Establish the proper standards and accreditation procedures for the SW application. Identify any risks in the proposed concept. Develop Phase II plans to include ways to mitigate those risks.

PHASE II: Produce and deliver a prototype RTC SW application that will allow for secure client-server access to RTC HW boxes with Navy telescopes at various places around the world and that interface with USNO's TCS. Work with the Navy to fully understand the software standards and software accreditation procedures that must be met to ensure that the SW application meets cyber secure client-server access requirements. Establish a feedback loop for implementing changes during prototype testing. For software and associated hardware configurations, apply appropriate cybersecurity standards as addressed by Security Technical Implementation Guides (STIGS) that is provided by the DoD cyber exchange.

PHASE III DUAL USE APPLICATIONS: Deliver a RTC SW application that is executed on RTC HW and interfaces with USNO's TCS and enables secure client-server access. Provide design and test cases that demonstrate the RTC SW application function. Support remote field qualification testing with USNO on several Navy telescope systems and RTC HW applications in development. Assist USNO in setting up RTC SW including trouble-shooting plus resolving implementation and execution issues at various Navy, DoD, and civilian telescope observatories.

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KEYWORDS: Remote Telescope; Interfaces; Client-server; Remote Telescope; Software Standards; Software Accreditation; Software Application

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-081 TITLE: Automatic Coding Standards Validation Tool

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: TRIDENT II (D5) in support of Strategic Systems Program (SSP) ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an automatic static code analysis tool that can dynamically adapt to changing Navy organizational software standards and will incorporate Strategic Systems Program (SSP)-directed coding standards such as prologue categories (e.g., authors, notes, description, argument list), structured

programming conventions, consistent indentation and comment location, and identification of redundant source code.

DESCRIPTION: Formal Navy software developments employ coding standards for C++ that are required to be met to ensure the software is maintainable, readable, and demonstratively of high quality. Currently these type of standards can only be validated manually, which takes time and resources. As the organization moves to an agile software development process that values the use of automation, an automated static analysis tool for C++ is necessary to identify standards violations.

Hardware requirements dictate that this tool be operational and maintainable on both RedHat Linux on Intel x86 and Solaris Sparc systems and that it is able to be executed stand-alone and integrated in an automated development and testing pipeline (DevOps). The tool should have an option to automatically fix the standards violations on an item-by-item basis.

Currently there is a tool to automatically perform static analysis for C code but no tool to do this for C++ code. The tool should perform analysis and correction processing on software consisting of both C and C++ code. An additional benefit would be that the user can tailor the portion of code to be analyzed and possibly fixed.

SSP and Naval Surface Warfare Center, Dahlgren Division (NSWCDD) will be able to provide feedback to allow for expedient operational tool updates.

PHASE I: Determine technical feasibility of automated static analysis of those standards on C and C++ code, with a chosen/given set of versatile C and C++ standards. Develop approaches to creating a tool that is easy to adapt to different C and C++ coding standards and determine a mechanism for validating the automated tool. Identify risks to the technical approach and develop Phase II plans that include ways to mitigate those risks.

PHASE II: Produce and deliver prototype software and associated test cases. Work with the Navy to fully understand the coding standards implemented and provide a draft installation guide for Linux and Solaris systems and a user's guide. Work with the Navy to troubleshoot the software and resolve implementation and execution issues. Establish a feedback loop with NSWCDD for implementing changes due to findings during prototype testing.

PHASE III DUAL USE APPLICATIONS: Deliver software that can be dropped into NSWCDD automated testing and development environment and distributed to other Navy technical partners. Work with the Navy to provide updates and fix issues. Establish a maintenance agreement that allows evolution of the tool.

This product will perform static analysis according to customizable coding standards. The fact that the coding standards are customizable makes the product marketable to a wide set of commercial software development applications.

REFERENCES:

1. "Systems and Software Engineering - Systems Life Cycle Processes." IEEE 15288, 2015. <https://www.iso.org/standards/63711.html>
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3. "Standard for Technical Reviews and Audits on Defense Programs." IEEE 15288.2, 2014. <https://standards.ieee.org/findstds/standards/15288.2-2014.html>
4. "Department of Defense Standard Practice: Documentation of Verification, Validation, and Accreditation (VV&A) for Models and Simulations." MIL-STD-3022 Chg. 1. <https://www.scribd.com/document/136735764/MIL-STD-3022-Documentation-of-Verification-and-Validation>

KEYWORDS: Automated Testing; Coding Standards; C/C++; Software Validation; Solaris/Linux; Static Analysis; DevOps

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-082 TITLE: Visible to Near-Infrared Integrated Photonics Development for Quantum Inertial Sensing

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Sensors

ACQUISITION PROGRAM: Strategic Systems Programs ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a novel integrated photonic component in the visible to near-infrared wavelengths, with a particular focus on devices suitable for quantum inertial sensing. Develop a method to combine commercially and not commercially available components with the manufacturing process to make the components compatible with the integrated photonics architecture.

DESCRIPTION: Advance the development process in the neglected visible and near-infrared wavelength regime, with a particular focus on components and component combinations most immediately relevant to an ultra-compact, robust, frequency-agile, and narrow-line laser system for quantum inertial sensing. This is of particular interest since quantum inertial sensing has the capability to be a single sensor sensitive to both acceleration and rotation.

The continual movement of laser-based devices from the laboratory environment to the commercial environment increases the demand for more compact, rugged, low power, and easily manufactured versions of their bulky lab-scale brethren. But while commercial interests have pushed for development of such integrated devices at the telecom wavelengths, development in the visible and near-infrared wavelengths has lagged behind. Although applications span a multitude of fields including quantum inertial sensing, optogenetics and bio-sensing, the basic building blocks of an integrated photonics system are universal: a light source followed by a mix of other components, which may include optical isolators, waveguides, beamsplitters, polarization manipulators, shutters, frequency shifters, phase shifters, photodetectors, micro-resonators, and grating couplers [Refs 1, 2].

Certain individual components of such an integrated photonics platform are commercially available in fiber-coupled packages. Indeed, some companies have already developed products that combine two of these components into a single package [Ref 3]. Although these fiber-packaged components are extremely compact compared to free-space optics, each exit and re-entry from a waveguide into fiber and back again results in light loss due to coupling inefficiencies. The compact nature of these fiber-packaged components also demands space for the necessary coupling lenses and fiber routings. The components inside the package may be based on laboriously assembled free-space components rather than on integrated photonics.

Moving beyond discrete fiber packages will require a concerted effort in both material and fabrication development.

Several of the components mentioned, demand materials with special properties, like a high optical gain (for lasers), a strong Faraday effect (for optical isolators), or a strong optical nonlinearity (for phase modulators and optical frequency doublers). Many also require electrical signals to operate, which would have to be included in the fabrication process.

PHASE I: Perform a design and materials analysis to assess the feasibility of the fabrication of the selected integrated photonics component(s), for incorporation into a quantum inertial sensing system. Analyze potential materials, while exploring the risks and risk mitigation strategies associated with each and identifying the most promising option. If the proposed design operates at a wavelength other than 780nm or 850nm (the relevant wavelengths for most quantum inertial sensors) include a detailed plan for how the system can be adapted to work at those wavelengths and the risks involved in that adaptation. Similarly, perform an analysis that details the planned fabrication process, again identifying risks and risk mitigation strategies. Include an evaluation of the anticipated size, weight, electrical power draw, potential losses and environmental (including thermal, magnetic, vibration, and hermetic seal) sensitivities of the final design. The design must (a) demonstrate a performance benefit over existing technology and (b) demonstrate a pathway to a small and compact (goal of less than 0.15in² chip cross section), lightweight (goal of less than 1 ounce) , and low-power (goal of less than 100mW). Finally, justify the need for the development of particular components or combination of components, by creating a detailed plan underscoring the necessary reduction in size, weight, or power afforded by the new device(s) for incorporation into a quantum inertial sensing system. Propose in a Phase II plan, a specific device design for fabrication based upon this analysis.

PHASE II: fabricate and characterize a lot of at least ten (10) prototype devices that will be installed into fiber-coupled and electrically-connectorized packages. Perform characterization of the components, demonstrating their basic performance (e.g., optical power production or handling capability, bandwidth, extinction ratio, electrical power draw, etc., as appropriate for the device in question). Evaluate the device's thermal, magnetic, and vibration sensitivities. Perform tests in accordance with MIL-STD-202, MIL-STD-750, and MIL-STD-883, required to validate the use of the device for the application(s) identified in Phase I. Demonstrate the performance of the device as part of one of those applications. Deliver the ten or more prototypes by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes, continual advancement of integrated photonics in visible and near-infrared wavelengths should lead to production of the design suitable for use in quantum inertial sensing system. The end product technology could be leveraged to bring quantum inertial sensing technology towards a price point that could make it more attractive to the telecommunication and biomedical commercial markets.

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1. Barrett, B., Bertoldi, A. and Boyer, P. "Inertial quantum sensors using light and matter." *Physica Scripta*, 91:5, 2016. DOI: 10.1088/0031-8949/91/5/053006 <https://iopscience.iop.org/article/10.1088/0031-8949/91/5/053006>
2. Munoz, Pascual et al. "Silicon nitride photonic integration for visible light applications." *Optics & Laser Technology*, 112:15, 2017. DOI: 10.1016/j.optlastec.2018.10.059 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5620990/>
3. "Waveguide Based Quantum Devices." AdvR, Inc., 2019. <http://www.advr-inc.com/quantum-devices/>

KEYWORDS: Integrated Photonics; Inertial Sensor; Accelerometer; Navigation; Quantum Inertial Sensing; Near-infrared Wavelengths

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-083

TITLE: High Performance Natural Composite

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Programs, ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a scalable process to increase performance and consistency of natural wood as a structural material.

DESCRIPTION: Natural composites - wood - were the main structural components in the early years of Aerospace. Due to strength constraints and variability of a naturally sourced material, man-made composites soon started taking over the industry. Wood plies have the benefits of being radio frequency (RF) transparent and show little aging. An innovative process that expands the use of natural materials or wood species/types, while keeping the benefits of wood as a composite material, allows the program to continue to utilize previous designs.

Composite lay-up should have the following characteristics:

Nominal Thickness - 0.5 inch

Tensile Strength – Longitudinal > 8.0 ksi Property quantified

Bending Strength – Longitudinal > 5.0 ksi

Shear Strength > 1.6 ksi Property quantified

Internal material damping - Loss Factor = 0.01 or higher

Radio Frequency Transparent in the GigaHertz region of the electromagnetic spectrum (EM) spectrum

Manufacturability – Must be able to form into a complex curvature (doubly curved shell of revolution)

Service Life – capable of lasting longer than 25 years

PHASE I: Conduct a feasibility study for development of a suitable process to strengthen natural composite material that satisfies characteristics defined in the Description. Develop a method of fabrication for subscale articles. Identify technology and manufacturing development challenges and approaches to address during Phase II.

PHASE II: Develop, fabricate, demonstrate, and validate sub-scale component prototypes. Manufacture nine articles in sub-scale prototypes to characterize the capability of the technology and calibrate analysis models. Ensure that the manufacturing process demonstrates scalability and repeatability. Measure physical and mechanical properties and validate that they meet or exceed the characteristics provided in the Description. Conduct mechanical property testing of fabricated specimens and verify adequate performance to advance to full-scale representative components.

PHASE III DUAL USE APPLICATIONS: Provide support in transitioning the technology for Navy use in Strategic Systems Programs. Support the Navy with certifying and qualifying the system for Strategic Systems Programs use. Navy Strategic Systems Programs will provide the assets and test support as Government Furnished Equipment and Services.

Commercial companies that currently use man-made composites for radomes or structural components could find this natural composite as a possible replacement for the material.

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4. Kumpel, A., Barros, P., Burg, C., Velleneuve, F. and Mavris, D. "A Conceptual Design for the Space Launch Capability of Peacekeeper ICBM." Los Angeles, CA: Aircraft Technology, Integration, and Operations 2002 Technical Forum.
https://www.researchgate.net/publication/27523123_A_Conceptual_Design_for_the_Space_Launch_Capability_of_the_Peacekeeper_ICBM

KEYWORDS: Strategic Missiles; Composite Materials; Materials Development; RF Transparent Structural Materials; Ultrastrong Materials; Super Wood; Densified Wood; Natural Composite Materials

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-084 TITLE: Remote Telescope Control Hardware (RTC HW) System

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: Trident II (D5) ACAT I

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a standardized Remote Telescope Control hardware (RTC HW) solution that will allow the United States Naval Observatory (USNO) to deploy telescopes to various places around the world and to assure data and network connection integrity. These RTC HW boxes will include a set of standard interfaces, on-board computing and data storage capability allowing for use in a client-server mode from USNO, and meet all resource monitoring facility (RMF), Information Assurance (IA), and physical security rules.

DESCRIPTION: The Trident II (D5) weapon system utilizes astronomical information and data collected by various telescope systems. These astronomical data sets must be measured and monitored yearly to ensure weapons system utility and performance. These measurements will persist for an amount of time to sufficiently baseline particular stars' photometric variability, which in some cases are expected to span decades. Today, astronomical data gaps exist that require USNO to measure stars from various remote places around the world. These data gaps include current collections of numerous bright stars' photometry and astrometry. An RTC HW solution will fill this data gap

in a manner that is repeatable, efficient, and testable by using standard interfaces, on-board computing, and data storage. The current state of deploying astronomic telescopes is not standardized in terms of data and network connectivity. Current hardware technology requires on-site personnel. Additional cost is incurred by synthesizing various data collection from the dissimilar hardware environments. An innovative RTC HW solution would lessen schedule impacts and cost of data collections by using standardized equipment and remote utility. This SBIR topic is expected to work in a software counterpart under development.

PHASE I: Develop and define a concept design that standardizes RTC HW in a manner that assures data and network connection integrity. Work with the Navy in understanding size, function, and interface requirements for the RTC HW solution that would enable nightly measurement of preselected stars with visual magnitude greater than 10 and the ability to extract measured data on an ad hoc basis. Construct measures that ensure data and network connection integrity and USNO software application. Identify risks to the proposed concept and develop Phase II plans that include ways to mitigate those risks for Phase II. For hardware and associated software configurations, apply appropriate cybersecurity standards as addressed by Security Technical Implementation Guides (STIGS) that is provided by the DoD cyber exchange [Ref 6].

PHASE II: Produce and deliver a prototype RTC HW solution. Work with the Navy to fully understand the RMF and IA requirements, as well as data and network connectivity measures of success. Work with the Navy to understand hardware standards for various software applications to be executed on the RTC HW box including standards and software applications being developed for the RTC system. Provide testing scenarios that ensure RMF and IA requirements are met. Test the hardware interfaces, on-board computing, and data storage capability. Establish a feedback loop with the Navy for implementing changes due to prototype testing. As with cybersecurity standards, RMF and IA requirements will be addressed by STIGS as provided by the DoD cyber exchange.

PHASE III DUAL USE APPLICATIONS: Deliver a RTC HW solution for telescopes deployed by USNO in a manner that works with a USNO software application under development. Provide design and test cases that demonstrate RTC HW interfaces, on-board computing, and data storage capability. Support remote field qualification testing with RTC software applications that are in development. Work with the Navy to set up RTC HW including trouble shooting plus resolving implementation and execution issues at various Navy, DoD, and civilian telescope observatories.

REFERENCES:

1. "Systems and Software Engineering - Systems Life Cycle Processes." IEEE 15288, 2015. <https://www.iso.org/standards/63711.html>
2. "IEEE Standard for Application of Systems Engineering on Defense Programs." IEEE 15288.1, 2014. <https://standards.ieee.org/findstds/standards/15288.1-2014.html>
3. "Standard for Technical Reviews and Audits on Defense Programs." IEEE 15288.2, 2014. <https://standards.ieee.org/findstds/standards/15288.2-2014.html>
4. "Department of Defense Standard Practice: Documentation of Verification, Validation, and Accreditation (VV&A) for Models and Simulations." MIL-STD-3022 Chg. 1. <https://www.scribd.com/document/136735764/MIL-STD-3022-Documentation-of-Verification-and-Validation>
5. "DODi 4650.06 Positioning, Navigating and Timing (PNT) Management." <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/465006p.pdf>
6. "Security Technical Implementation Guides (STIGS) ". <https://public.cyber.mil/stigs/>

KEYWORDS: Remote Telescope; Standard Interfaces; Repeatable; Hardware Interfaces; Connection Integrity; On-board Computing; Data Storage; Photometry and Astrometry

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-085 TITLE: Machine Learning-Based Data Analysis

TECHNOLOGY AREA(S): Human Systems, Information Systems

ACQUISITION PROGRAM: Strategic Weapons Systems: Trident II D5 and D5 Life Extension (LE) ACAT IC

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop, demonstrate and field an algorithm and process for conducting an automated real-time scan of navigation subsystem data from a database for disturbances, abnormal trends, and problems that can learn to predict future disturbances, abnormal trends, and problems, which would be implemented to provide real-time fault analysis and failure prediction for inertial navigation systems (INS).

DESCRIPTION: Data analysis of INS performance has historically been human labor intensive and heavily reliant on the ability of a person or team of people to perform data analysis in a lab instead of in real-time. Typical real-time monitoring of INS performance relies upon the system to create discrete error codes based on physical sensors and conditions. While this approach has been successful in the past, it has limitations and has an element of human error risk in the analysis of large data fields. The use of scanning and evaluation tools based on machine learning (ML) technology would significantly enhance the abilities of the human analyst to focus on problems identified from synthesized data rather than sifting thru raw data streams or reacting to one of many hundreds of discrete alarms that may occur. ML technology has the potential to dramatically reduce the likelihood of an analyst missing anomalies in the analysis of data caused by sensors or equipment that have degraded performance, but not by enough to exceed a human-established threshold or ability for pattern matching. ML technology should also offer the ability to detect higher order abnormalities with INS system performance by aggregating a variety of seemingly unrelated direct sensor error codes. It should offer the ability to classify errors, and have behavior-based or anomaly-based detection that may otherwise go undetected. ML should also offer the ability to conduct extensive data mining to predict a potential system failure and the opportunity to conduct the analysis in real time on the ship instead of time late.

Often times, anomalies caused by sensors or equipment falling into this category go undetected because humans have limitations such as imperfect memory, fatigue, etc., that make them reliant on the tripping of an alarm or passing of an established threshold to identify issues that a machine can learn to identify based on the big data set it was trained with. ML tools can be used to classify data sets to recognize abnormal subsystem behaviors to be flagged for further analysis. After these algorithms are developed to improve the lab analysis, they may be integrated as a real-time out-of-band problem monitor on the associated system. Similar to the way Network Intrusion Detection Systems can monitor network data flow for problem behaviors, these tools could passively monitor the system data for problem trends and behaviors, and then issue warnings to the operators of more significant systemic faults.

With a focus on optimizing system affordability, reliability, maintainability, serviceability, and operability, any proposed design concept, demonstration model, or production model must utilize standard interfaces wherever

possible, leverage commercially available components or elements, be diagnosable and serviceable by qualified Navy sailors for any preventative or anticipated corrective maintenance required at a periodicity more frequently than once every nine months; have a mean time between failure in excess of twelve months; be configuration controlled and upgradable; be modular with an open systems architecture; and include the identification of potentially replaceable components or units to be carried as spares.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DSS and Strategic Systems Programs (SSP) in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Conduct a concept development effort of the requirements outlined in the Description. Identify or develop an analysis methodology or ML technology and process to conduct an automated scan of various data streams related to INS that has the ability to learn to predict future disturbances, abnormal trends, and problems. Conduct feasibility studies of the proposed concept. Develop a Phase II plan.

Phase I will be UNCLASSIFIED, and the contractor will not require access to any classified data (in other words, if the research outcome relates to classified data, the work itself can be performed using "dummy" data of the same level of complexity).

PHASE II: Further develop the proposed concept and build a demonstrational prototype based on the concept. Ensure that the prototype is able to conduct an automated scan of various data streams of INS-related information using provided data and has the ability to learn to predict future disturbances, abnormal trends, and problems. Once the algorithm demonstrates the ability to learn to predict future problems, ensure that it is able to automate a scan on similar data streams as was used for the algorithm training. Ensure that the algorithm is able to report identified anomalies and sufficient background information to simplify root cause analysis of the subject problem/disturbance by the subject matter expert (SME). Develop a transition plan that identifies the scope, effort, and resources required to extend the prototype algorithm and process to additional analysis tasks, to include training for additional combinations of data streams to look for different problems or disturbances; and development of an out-of-band problem detector that could be considered for shipboard installation for real-time disturbance detection. Provide onsite training of the algorithm design, operation, maintenance, and interfaces with the host system.

Participate in a Preliminary Design Review (PDR) event. Install on a test ship for system performance testing. Deliver a Data Disclosure Package (DDP) that includes at a minimum: form, fit, function, operation, maintenance, installation and training data, procedures and information plus the data necessary or related to: overall physical, functional, interface, and performance characteristics; corrections or changes to Government-furnished data or software; and data or software that the Government has previously received unlimited rights to or that is otherwise lawfully available to the Government.

(Note: Though Phase II work may become classified (see Description section for details), the Proposal for Phase II work will be UNCLASSIFIED. If the selected Phase II contractor does not have the required certification for classified work, the SSP program office will work with the contractor to facilitate certification of related personnel and facility.)

PHASE III DUAL USE APPLICATIONS: Work with the Navy to implement the analysis toolkit as described in the Phase III transition plan at a designated Navy lab and as a SSP alteration (SPALT) on designated ships. Provide documentation and support materials to transfer the mature analysis toolkit to Navy SMEs. Ensure sufficient cyber security and software assurance requirements are met in accordance with DFARS Clause 252.204-7012, NIST Special Publication 800-171, NIST Special Publication 800-53, and NIST Special Publication 800-37. In addition, SPALT requirements to enable the software to be deployed at Navy data analysis labs and ships must be met.

Provide an updated DDP prior to fielding that must include at a minimum: any updates to the Phase II DDP and installation and maintenance procedures and processes; cyber security and authority to operate certifications for Navy ship use; qualification requirements and results; demonstrated compliance with SPALT requirements; and testing results.

This ML application has dual use commercial or military applications in any complex system that uses sensors to detect abnormalities, synthesize multiple unrelated data streams, and conduct failure analysis or fault localization of the underlying system such as propulsion or power generation plants, ships, aircraft, and space systems.

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KEYWORDS: Data Analysis; Machine Learning; Pattern Matching; Anomaly Detection; Classification; Data Mining; Behavior Based Detection

TPOC-1: SSP SBIR POC

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-086 **TITLE:** Avionics Packaging Technology

TECHNOLOGY AREA(S): Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: Strategic Weapon System: Trident II D5 and D5 Life Extension Programs - ACAT 1C

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate avionics packaging materials that are low mass; and provide radio frequency (RF) and radiation attenuation, and excellent thermal heat sink properties for use in Submarine Launched Ballistic Missile (SLBM) systems.

DESCRIPTION: Avionics package enclosures provide structural integrity, endo- and exo-atmospheric environmental protection (e.g., thermal, radiation), and Circuit Card Assembly (CCA) attach points, thermal relief paths, and structural stability. Package enclosures used in this program provide passive cooling during flight. Advanced materials could reduce mass and improve thermal management properties. Since the end products have a long shelf life, known or potential outgassing of compounds and material integrity over multiple decades would need to be assessed.

Existing electronics enclosures and materials utilize available materials, machining techniques, what would be considered now as loose mechanical tolerances to accommodate wire wrapped CCAs, large feature size components, and a multi-layered approach to materials that provide different attributes to enclosure needs that are either bolted on or attached via adhesive materials. A multitude of new materials development technologies, such as advanced composites and 3D printing, enable the use of advanced materials and production techniques that reduce lifecycle cost and further attenuate environments. Elimination of multi-step manufacturing processes utilizing lightweight materials that provide the package enclosure with the required material properties could reduce program costs and reduce missile weight.

Material attributes include:

- High thermal conductivity or thermal heat sink capability (min. of 147 W/m-C)
- RF shielding (target of 80dB at 10MHz)
- X-ray radiation shielding (target 5% transmission for Photon Attenuation at 5 KeV)
- Strength to withstand and operate through missile launch and flight environments (e.g., acceleration, shock, vibration, vacuum, thermal)
- Retention of properties for decades when utilized as package enclosure material
- No outgassing of noxious elements or compounds or particles
- Ability to remain fully operational through short duration (<60 minutes) space radiation environments described in MIL-STD 1089
- Assessment of limiting factors or concern areas
- Assessment of cost, reliability, size, and weight (target mass 20% reduction vs traditional fabrication)

PHASE I: Develop a concept and assess its feasibility based on concept formulation, development, and possible validation.

Develop approaches and recommendations for the design and fabrication of avionics packaging using new materials and processes for use in SLBM systems. Conduct a feasibility assessment for the proposed solution showing advancements in contrast to existing devices packaging approaches. Address, at a minimum, the capabilities listed in the Description. Document, in a Phase II plan, the design and feasibility assessment for Phase II consideration.

PHASE II: Develop and validate a prototype (not necessarily hardware). Design and fabricate avionics test packages, including internal circuitry to test operational effectiveness of enclosure. Conduct testing to exercise the designs in relevant environments and collect performance data, which may be used to characterize the capabilities of the design.

PHASE III DUAL USE APPLICATIONS: Manufacture, demonstrate, and integrate the end product Avionics Package into the missile and submarine systems. Provide support in transitioning the technology for Navy use in SSP. Support the Navy with certifying and qualifying the system for SSP use. (Note: Navy SSP will provide the assets and test support as Government Furnished Equipment (GFE) and Services.)

REFERENCES:

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KEYWORDS: Strategic Missiles; Materials Development; Electronics Enclosures; Production Techniques; Shielding; Attenuation

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Questions may also be submitted through DOD SBIR/STTR SITIS website.

N201-087 TITLE: High-Power Superluminescent Diodes for High-Precision Interferometric Inertial Sensors

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Sensors

ACQUISITION PROGRAM: Strategic Systems Programs ACAT IC

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop superluminescent diodes (SLDs) that provide high optical power, wide optical bandwidth, low spectral asymmetry, low gain ripple, high central degree of second order temporal coherence, fast centroid wavelength stabilization, and multi-decade environmental lifetime for use in strategic-grade high-precision inertial sensors such as interferometric fiber-optic gyroscopes (IFOGs) and accelerometers.

DESCRIPTION: The performance requirements for strategic and navigation-grade inertial sensors based on optical interferometry continue to become more stringent, necessitating continued innovation for optical component technologies. For example, IFOGs used in inertial navigation systems for fleet ballistic missile (FBM) submarine applications require unprecedented precision, characterized in terms of long-term bias stability, scale factor linearity, and angle random walk (ARW) performance.

A key component in these types of sensors is the light source. In principle, SLDs are an attractive option for such optical inertial sensors and are indeed employed in a number of commercial off-the-shelf (COTS) IFOGs. However, the relatively low optical power available from COTS SLDs limits the miniaturization of sense coils needed to achieve given ARW requirements, and furthermore is problematic with regard to splitting the optical power between multiple sense coils. In addition, inertial sensor performance may be limited by insufficient optical bandwidth, gain ripple, central degree of second order temporal coherence, centroid stabilization time, and environmental lifetime of COTS SLDs.

Therefore, the need remains for new technical approaches to improve SLD performance for interferometric inertial sensor applications. The objective of this topic relates to advanced SLDs designed for high-precision interferometric inertial sensors. In particular, SLDs are required with 1,550 nm operating wavelength, high optical power, wide optical bandwidth, low spectral asymmetry, low gain ripple, high central degree of second order temporal coherence, fast centroid wavelength stabilization, and at least thirty (30) year environmental lifetime.

PHASE I: Perform an analysis of design and materials aimed at an SLD that achieves stable performance over at least thirty (30) year lifetime for interferometric inertial sensor applications as compared to the current state of the art via novel designs, materials, and fabrication processes. Assess device performance parameters of fabricated test structures; consider all aspects of device fabrication; include a preliminary assessment of long-term environmental stability based on a materials physics analysis; and justify the feasibility/practicality of the approach. Propose, in a Phase II plan, a specific device design for fabrication based upon this analysis.

PHASE II: Fabricate and characterize a lot (up to ten (10)) of prototype SLDs in complete thermoelectrically cooled packages including lens-coupled fiber-optic polarization-maintaining pigtailed, integrated isolators, and electrical connectorization suitable for incorporation into test beds for interferometric inertial sensors. Ensure that characterization testing is in accordance with MIL-STD-202, MIL-STD-750, and MIL-STD-883. Characterization testing comprises (1) optical power as a function of diode current; (2) polarization extinction ratio; (3) spectral characterization including sensitivity of centroid wavelength, optical bandwidth, gain ripple, and spectral asymmetry to diode current, chip-on-submount temperature, and case temperature; (4) and sensitivity of relative intensity noise (RIN) and central degree of second order temporal coherence to diode current, and centroid wavelength stabilization time. Perform an accelerated aging study involving SLDs under environmentally challenged conditions to develop a predictive model of long-term environmental stability. Perform a proof-of-concept study of one or more prototype SLDs in a suitable IFOG test bed. Deliver the prototypes by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Continue development that must lead to productization of SLDs suitable for interferometric inertial sensors. While this technology is aimed at military/strategic applications, SLDs are heavily used in many optical circuit applications including optical coherence tomography (OCT). An SLD that can meet the stringent performance requirements of strategic and navigation grade inertial sensors is likely to bring value to many existing commercial applications. Also, technology meeting the Navy needs could be leveraged to bring IFOG technology toward a price point that could make it more attractive to the commercial markets.

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in-fiber-optical-gyroscopes/10.1117/12.462647.short

KEYWORDS: Superluminescent Diode; SLD; Inertial Sensor; Fiber-optic Gyroscope; Navigation; Optical Power; Light Source

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