DEPARTMENT OF THE NAVY (DoN)
16.1 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

Responsibility for the implementation, administration, and management of the Department of the Navy (DoN) SBIR Program is with the Office of Naval Research (ONR). The Director of the DoN SBIR Program is Mr. Robert Smith, robert.l.smith6@navy.mil. For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed for each topic during the period **11 December 2015 through 10 January 2016.** Beginning **11 January 2016**, the SBIR/STTR Interactive Technical Information System (SITIS) (https://sbir.defensebusiness.org/) listed in Section 4.15.d of the DoD SBIR Program Solicitation must be used for any technical inquiry. For inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

TABLE 1: DoN SYSTEMS COMMANDS (SYSCOM) SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N161-001 to N161-022	Ms. Donna Attick	NAVAIR	donna.moore@navy.mil
N161-023	Mr. Kail Macias	NAVFAC	kail.macias@navy.mil
N161-024 to N161-053	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N161-054 to N161-071	Ms. Lore-Anne Ponirakis	ONR	loreanne.ponirakis@navy.mil
N161-072	Mr. John Thom	SPAWAR	john.thom@navy.mil

The DoN's SBIR Program is a mission oriented program that integrates the needs and requirements of the DoN's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the DoN. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the DoN SBIR Program can be found on the DoN SBIR/STTR website at www.navysbir.com. Additional information pertaining to the DoN's mission can be obtained from the DoN website at www.navy.mil.

PHASE I GUIDELINES

Follow the instructions in the DoD SBIR Program Solicitation at https://sbir.defensebusiness.org/ for program requirements and proposal submission guidelines. Please keep in mind that Phase I should address the feasibility of a solution to the topic. It is highly recommended that proposers follow the DoN proposal template located at www.navysbir.com/submission.htm as a guide for structuring proposals. Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

Technical Volumes that exceed **20** pages will be deemed noncompliant and will be rejected.
The DoN requires proposers to include, within the **20-page limit**, an Option that furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I Options are typically exercised upon the decision to fund the Phase II. **The Phase I Base amount and Period of**

Performance shall not exceed $80,000 and six months; the Phase I Option amount and Period of Performance shall not exceed $70,000 and six months.

Include a header with company name, DoD proposal number, and DoD topic number on each page of your Technical Volume.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria must be met or the proposal will be deemed noncompliant and will be REJECTED.

PERFORMANCE BENCHMARKS: The DoN will NOT evaluate proposals submitted by firms that do not meet the two benchmark requirements for progress towards Commercialization as determined by the Small Business Administration (SBA) on June 1 each year. Please note that DoN applies performance benchmarks at time of proposal submission, not at time of contract award.

The Phase I Base amount and Period of Performance shall not exceed $80,000 and six months. The Phase I Option amount and Period of Performance shall not exceed $70,000 and six months. Tasks for both the Base and the Option should be clearly identified in the 20-page Technical Volume. Costs for the Base and Option should be separate and identified on the Proposal Cover Sheet and in the Cost Volume.

BREAK OUT SUBCONTRACTOR, MATERIAL AND TRAVEL COSTS IN DETAIL. In the Cost Volume, it is important to provide sufficient detail for the subcontract, material and travel costs. Subcontractor costs should be detailed at the same level as the prime to include at a minimum personnel names, rate per hour, number of hours, material costs (if any), and travel costs (if any). Material costs should include at a minimum listing of items and cost per item. Travel costs should include at a minimum the purpose of the trip, number of trips, location, length of trip, and number of personnel. Use the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information.

If Discretionary Technical Assistance (DTA) is proposed, add information required to support DTA in the "Explanatory Material Field" in the DoD Cost Volume worksheet.

The costs for the Base and Option periods should be clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the Technical Volume. If proposing DTA, a combined total of up to $5,000 may be added to the Base or Option periods.

Upload the Technical Volume and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Volume electronically through the DoD submission site (https://sbir.defensebusiness.org/) by 6:00 am ET, 17 February 2016.

After uploading the file on the DoD SBIR/STTR submission site, review it to ensure that it appears correctly. Contact the DoD SBIR/STTR Help Desk immediately with any problems.

DISCRETIONARY TECHNICAL ASSISTANCE

The SBIR Policy Directive section 9(b), allows the DoN to provide discretionary technical assistance (DTA) to its awardees to assist in minimizing the technical risks associated with SBIR projects and commercializing products and processes. Firms may request, in their Phase I and Phase II proposals, to contract these services themselves in an amount not to exceed $5,000 per year. This amount is in addition to the award amount for the Phase I or Phase II project.

Phase I awardees that propose more than $150,000 in total funding (Base, Option and DTA) may not receive a purchase order. Purchase orders are a type of Simplified Acquisition Procedure (SAP) intended to reduce administrative costs, promote efficiency and economy in contracting, and avoid unnecessary burdens for agencies and contractors. The need to issue a Firm Fixed Price (FFP) contract may result in contract delays if the SYSCOM normally issues purchase orders for Phase I awards. FOR ONR TOPICS ONLY: The total Phase I award amount, including DTA, cannot exceed $150K.

Approval of direct funding for DTA will be evaluated for approval by the DoN SBIR office if the firm's proposal (1) clearly identifies the need for assistance (purpose and objective of required assistance), (2) provides details on the provider of the assistance (name and point of contact for performer); and unique skills/specific experience to carry out the assistance proposed, and (3) the cost of the required assistance (costs and hours proposed or other details on arrangement that would justify the proposed expense). This information must be included in the firm's cost proposal specifically identified as "Discretionary Technical Assistance" and cannot be subject to any profit or fee by the requesting SBIR firm. In addition, the provider of the DTA may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g. research partner, consultant, tester, or administrative service provider). Failure to include the required information in the proposal will result in the request for DTA being disapproved. Exceeding proposal limits identified for Phase I ($150,000 for Base, Option, and DTA) without including the required identification of DTA will result in the proposal's REJECTION without evaluation.

If a firm requests and is awarded DTA in a Phase II proposal, it will be eliminated from participating in the DoN SBIR/STTR Transition Program (STP), the DoN Forum for SBIR/STTR Transition (FST), and any other assistance the DoN provides directly to awardees.

All Phase II awardees not receiving funds for DTA in their award must attend a one-day DoN STP meeting during the second year of the Phase II. This meeting is typically held in the summer in the Washington, DC area. Information can be obtained at: http://www.navysbir.com/Transition.htm. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, DC for this event.

EVALUATION AND SELECTION

The DoN will evaluate and select Phase I and Phase II proposals using the evaluation criteria in Sections 6.0 and 8.0 of the DoD SBIR Program Solicitation respectively, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. Due to limited funding, the DoN reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. **NOTE: The DoN does NOT participate in the FAST Track program.**

One week after Phase I solicitation closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, e-mail addresses on the proposal coversheets must be correct.

Requests for a debrief must be made within 15 calendar days of non-award notification. Please note the DoN debrief request period is shorter than the DoD debrief request period specified in section 4.10 of the DoD Instructions

Protests of Phase I and II selections and awards shall be directed to the cognizant Contracting Officer for the DoN Topic Number. Contact information for Contracting Officers may be obtained from the DoN SYSCOM SBIR Program Managers listed in Table 1.

CONTRACT DELIVERABLES

Contract deliverables are typically progress reports and final reports. Deliverables required by the contract, shall be uploaded to https://www.navysbirprogram.com/navydeliverables/.

AWARD AND FUNDING LIMITATIONS

The DoN typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In accordance with SBIR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally in accordance with SBIR Policy Directive section 7(i)(1), each award may not exceed the award guidelines (currently $150,000 for Phase I and $1 million for Phase II, excluding DTA) by more than 50% (SBIR/STTR program funds only) without a specific waiver granted by the SBA.

TOPIC AWARD BY OTHER THAN THE SPONSORING AGENCY

Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds (see above), Head of Agency Determinations are now required (for all awards related to topics issued in or after the SBIR 13.1/STTR 13A solicitation) before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact the original sponsoring agency before submitting a Phase II proposal to an agency other than the one that sponsored the original topic. (For DoN awardees, this includes other DoN SYSCOMs.)

TRANSFER BETWEEN SBIR AND STTR PROGRAMS

Section 4(b)(1)(i) of the SBIR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact its designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. No transfers will be authorized prior to or during the Phase I award. Agency disapproval of a request to change programs will not be grounds for granting relief from any contractual performance requirement(s) including but not limited to the percentage of effort required to be performed by the small business and the research institution (if applicable). All approved transitions between programs must be noted in the Phase II award or an award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

ADDITIONAL NOTES

Due to the short timeframe associated with Phase I of the SBIR process, the DoN does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I goal for time to award. Before the DoN makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact the DoN's evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within two months of notification of selection, the decision to award may be terminated. If the use of human, animal, and recombinant DNA use is included under a Phase I or Phase II proposal, please carefully review the requirements at: http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

Due to the typical lengthy time for approval to obtain Government Furnished Equipment (GFE), it is recommended that GFE is not proposed as part of the Phase I proposal. If GFE is proposed and is determined during the proposal evaluation process to be unavailable, proposed GFE may be considered a weakness in the proposal.

For topics indicating ITAR restrictions or the potential for classified work, there are generally limitations placed on disclosure of information involving topics of a classified nature or those involving export control restrictions, which may curtail or preclude the involvement of universities and certain non-profit institutions beyond the basic research level. Small businesses must structure their proposals to clearly identify the work that will be performed that is of a basic research nature and how it can be segregated from work that falls under the classification and export control restrictions. As a result, information must also be provided on how efforts can be performed in later Phases if the university/research institution is the source of critical knowledge, effort, or infrastructure (facilities and equipment).

PHASE II GUIDELINES

All Phase I awardees will be allowed to submit an **Initial** Phase II proposal for evaluation and selection. The Phase I Final Report, Initial Phase II Proposal, and Transition Outbrief (as applicable), will be used to evaluate the offeror's potential to progress to a workable prototype in Phase II and transition technology in Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding SYSCOM either in the Phase I award or by subsequent notification. **NOTE: All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations (for all DoN topics, this means by invitation only).**

Section 4(b)(1)(ii) of the SBIR Policy Directive permits the Department of Defense and by extension the DoN, during fiscal years 2012 through 2017, to issue a Phase II award to a small business concern that did not receive a Phase I award for that R/R&D. **NOTE:** The DoN will NOT be exercising this authority for SBIR Phase II awards. **Therefore, in order for any small business firm to receive a Phase II award, the firm must be a recipient of a Phase I award under that topic and submit an Initial Phase II proposal.**

The DoN typically awards a cost plus fixed fee contract for Phase II. The Phase II contracts can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 252 of the National Defense Authorization Act of Fiscal Year 2006. The statute set-aside is 1% of the available SBIR funding to be used for administrative support to accelerate transition of SBIR-developed technologies and provide non-financial resources for the firms (e.g. the DoN's SBIR/STTR Transition Program).

PHASE III GUIDELINES

A Phase III SBIR award is any work that derives from, extends, or completes effort(s) performed under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company that was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The DoN will give SBIR Phase III status to any award that falls within the above-mentioned description, which includes assigning SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). Government prime contractors and/or their subcontractors follow the same guidelines as above and ensure that companies operating on behalf of the DoN protect the rights of the SBIR company.

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NAVY SBIR 16.1 Topic Descriptions

N161-001 TITLE: Mid Frequency Active Sonobuoy

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA 264, Air ASW 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 5.4.c.(8) of the solicitation. 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 A-size Anti-Submarine Warfare (ASW) acoustic Mid-Frequency Active Sonobuoy (MFAS) capable of deployment and remote operation from Littoral Combat Ship (LCS), MH-60R, MQ-8 Fire Scout, and P8A ASW platforms, and in compliance with the Chief of Naval Operation (CNO's) recent Integrated Warfare Capability (IWC) initiative requiring integration across platform boundaries.

DESCRIPTION: The need exists for a multi-platform deployable mid-frequency active sonobuoy to enhance the effectiveness of existing Navy mid-frequency sonar systems by using sonobuoys as off-board bi-static and multi-static sensors. The integration of the ASW search capability across platforms has the potential to greatly enhance detection range, localization and track capability by combining the inherent strengths of each platform. The need exists for a coordinated ASW system that provides a wide area search capability, while at the same time providing sufficient standoff distances for friendly forces. The newly developed system must provide a Multi-Platform/Multi-Static (MPMS) ASW capability needed to counter improvements to enemy submarines deployed by potential adversaries.

The Navy's existing tactical ASW systems were designed primarily for mono-static operations. The development of a MFAS will improve the ASW mission capability to better protect the carrier battle group from submarine threats. The use of the MFAS for multi-static ASW operations in conjunction with Airborne Low Frequency Sonar (ALFS), SQQ-89, and existing passive sonobuoys is expected to significantly increase ASW mission capabilities.

Innovative solutions are sought for the following technical challenge areas; (1) competing goals of high acoustic source level, ping duration, and receive array directivity with the size, weight and volume constraints of the A-size form factor (i.e. 36" in length, 4 7/8" diameter, weight not to exceed 39 lbs.), (2) extensive acoustic bandwidth (900Hz-5,050Hz) and mutual interference rejection in the acoustic band of 1.1 kHz to 5 kHz, (3) robust communication links connecting the various coordinated ASW search platforms, and (4) coordinated ASW multi-platform operational concepts required to successfully execute MFAS missions.

The design should include estimates on source level, receiver array directivity, life, survivability and cost. The proposed solution should demonstrate improved spatial coverage in shallow waters and littoral regions during undersea warfare missions by being able to act as source for shipboard and airborne mid-frequency passive systems in bi-static and multi-static environments. Investigate and determine the system operational envelope and design requirements required to achieve a significant system operational performance increase by ability to extend the overall static search area with an active source compared to single omni-directional hydrophone, see http://www.sonobuoytechsystems.com/products. Candidate ASW platforms include Littoral Combat Ship, SQQ-89 Ships, P-8 Maritime Patrol Aircraft, MQ-8C Fire Scout, and the MH-60R helicopter.

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: Design and evaluate the technical feasibility of an A-size Anti-Submarine Warfare (ASW) acoustic Mid-Frequency Active Sonobuoy in terms of ASW mission effectiveness (i.e. probability of detection for a given area coverage), technical risk, developmental/recurring cost, and impact on existing ASW systems. Provide MFAS sonobuoy detailed technical performance specification and design, in-buoy processing if required, remote data processing and data link options technical data in support of a concept of operation development using the system with the MQ-8C, LCS and the MH-60R Helicopter.

PHASE II: Develop a prototype A-size Anti-Submarine Warfare (ASW) acoustic Mid-Frequency Active Sonobuoy system that meets the design criteria developed in Phase I. Conduct demonstration and system verification and validation sufficient to confirm proof of design.

PHASE III DUAL USE APPLICATIONS: Deliver pre-production lots (16 to 32 sonobuoys) of sensors for use in operational testing. Assist in production development as necessary to support flight certification for the newly developed sensor. Assist the Navy with transition of the newly developed system to the ASW community. Successful development of this sensor system has the potential for use in undersea mapping, sea-bed exploration, and navigational systems. The MFAS technology could be used by the oil, mining, and navigational industries.

REFERENCES:
1. Dunaway, D., Proceeding Magazine August 2013 Vol 139/8/1, 326 Article, Creating Integrated Warfighting Capability

2. OPNAV Instruction 3050.25. Warfighting Capability, Capacity, and Wholeness Assessments. 30 July 2012

3. Waite, A.D., (2002). Sonar for Practising Engineers, John Wiley & Sons, Ltd, West Sussex, England

4. Urick, R.J., (1983) Principles of Underwater Sound. McGraw–Hill Book Company, New York

5. Hodges, R. P., (2010). Underwater Acoustics, Analysis, Design and Performance of Sonar. John Wiley & Sons, Ltd, West Sussex, England

KEYWORDS: Acoustics; Sonar; Bi-Statics; Multi-Statics; SQQ-89; Airborne Low Frequency Sonar (ALFS)
Questions may also be submitted through DoD SBIR/STTR SITIS website.

N161-002 TITLE: Alternative Positioning, Navigation and Timing (PNT) Technologies for Global Positioning System (GPS)-Degraded and GPS-Denied Operation

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

ACQUISITION PROGRAM: JSF-MS 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 5.4.c.(8) of the solicitation. 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 systems that allow for affordable, robust, alternative forms of radiofrequency (RF) based Positioning, Navigation and Timing (PNT), providing an available substitute in environments where the Global Positioning System (GPS) functionality is degraded or completely denied.

DESCRIPTION: GPS provides extremely precise PNT information and has been extensively deployed in military systems; however, GPS may not be available or reliable in Anti Access, Area Denial (A2/AD) environments. Inertial navigation systems (INS) and precision clocks may extend PNT for short periods, but are subject to growing drift errors when GPS is not available. Alternatives are needed to compliment GPS navigation in GPS denied environments.

Research, develop, integrate and test innovative, affordable, robust, intelligent, and adaptable precise alternative PNT systems that integrate multiple sensors and sources of information, optimally fusing navigation information and seamlessly transitioning between sources and sensors based on the availability of sources and RF interference present.

Candidate technologies for this project include an integrated military GPS/Inertial Navigation System (INS) which preferably combines enhanced-long range navigation (e-LORAN) signals or possibly ground terrain mapping with chip scale atomic clocks (CSAC). LORAN-C was decommissioned in 2010, as GPS was available to provide superior PNT capability on a worldwide basis. Since then, the government has realized that GPS represents a single point of failure which can be denied through unintentional and intentional interference, and that a robust backup to GPS is needed, as outlined in the National Positioning, Navigation, and Timing Resilience and Security Act of 2015 (H.R.1678). E-LORAN has been identified as a strong candidate as a backup PNT source to GPS. The developed technologies should be suitable for use in manned air systems such as the F-35 Joint Strike Fighter, as well as in space, weight and power (SWaP) constrained air vehicles such as small unmanned aerial vehicles (UAVs) and precision guided munitions (PGM).

The system hardware and software architectures should be designed to minimize life cycle costs and to readily adapt to the inclusion or exclusion or different sets of sensors and measurements for use on different platforms having different requirements and constraints. The system should be compatible with military security, environmental and other requirements for aviation navigation systems.

RF based PNT that utilizes a geodetic model (such as World Geodetic System 1984 (WGS-84) coordinates) in addition to the Coordinated Universal Time (UTC), could potentially operate in a relative sense to meet mission requirements, such as precision approach and landing relative to a carrier.

Specific goals include PNT accuracy, availability, and performance comparable to GPS when GPS is denied over critical mission phases and to suitable performance levels for non-critical mission phases. In addition, jam-resistance 60 decibels (dB) greater than GPS without an anti-jam antenna, timing and frequency performance to support mission requirements, operation in all-weather conditions, operation over land and sea environments having minimal distinguishable features with no or minimal supporting infrastructure, robust operation in RF challenged and other types of challenging environments is desired.

PHASE I: Perform analyses and trades to demonstrate concept feasibility and develop navigation and timing system concept solutions for use in different classes of manned, unmanned, and SWAP constrained air vehicles. Combine GPS/INS with one or more robust navigation and timing technologies in configurations and designs which minimize data fusion errors when combining data from multiple navigation and timing sensor systems. Analyze design and performance to support successful mission operations using representative air vehicles, platforms and mission scenarios.

Consider working with platform prime contractors, navigation system prime contractors and others, as appropriate.

Document the analysis results and designs in reports.

PHASE II: Develop the Phase I designs into test beds and prototype systems, and demonstrate and validate performance. Objectives include demos and tests under operational conditions, e.g. flight tests.

Consider working with platform prime contractors, navigation system prime contractors and others, as appropriate.

Document the results and designs in reports.

PHASE III DUAL USE APPLICATIONS: Refine the design, test and integrate operational systems suitable for use in or replacement of deployed navigation systems in new or existing manned and unmanned air vehicles and/or SWaP constrained air vehicles identified by the small business working with the NAVAIR Program Officer. Document results in reports. This technology may also be used for navigation and timing on commercial air and marine vehicle systems, e.g. commercial aircraft. For example, because of the proliferation of low-cost GPS jammers, the FAA is becoming more concerned about the loss of GPS signals due to RF interference, such as recently occurred in the Newark airport area.

REFERENCES:
1. National Coordination Office for Space-Based Positioning, Navigation, and Timing. (2015). LORAN-C Infrastructure & E-LORAN. Retrieved from http://www.gps.gov/policy/legislation/loran-c/

2. eLoran Technologies. (2015). Retrieved from http://elorantechnologies.com/eloran-technologies/

3. eLoran System Definition and Signal Specification Tutorial, Retrieved from http://www.ursanav.com/sites/default/files/pdfs/news/UrsaNav%20ILA-40%20eLoran%20System%20Definition%20%26%20Signal%20Specification%20Tutorial.pdf

KEYWORDS: GPS; Global Navigation Satellite Systems; e-LORAN; GPS-denied navigation system; signals of opportunity; Inertial Navigation System

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

N161-003 TITLE: Aerial Refueling Tanker and Receiver Aerodynamic Interaction Modeling and Simulation

TECHNOLOGY AREA(S): Air Platform

ACQUISITION PROGRAM: PMA 268 Unmanned Combat Air System Demonstration Program

OBJECTIVE: Develop a modeling and simulation (M&S) approach and toolset to calculate the incremental forces and moments on the receiver aircraft due to tanker wake during aerial refueling operations.

DESCRIPTION: The Navy continues to invest in the development of tactical Unmanned Air System (UAS) capabilities. One important area of investment seeks to extend the range and endurance of tactical UAS aircraft through Autonomous Aerial Refueling (AAR). As part of the Navy's Unmanned Combat Air System (UCAS) demonstration program, the X-47B completed an AAR demonstration in a limited envelope using the Omega B707 tanker aircraft. Similarly, future UAS programs will have requirements for AAR capabilities. Currently, the Navy does not have sufficient aerial refueling simulation capabilities which apply a tanker's wake to a receiver's six-degree-of-freedom (6DOF) flight dynamic simulation. Tanker wakes are known to strongly influence the dynamics of the receiver aircraft particularly when close to engaging the refueling basket. While 6DOF modeling and simulation (M&S) has proven a valuable resource in most phases of a mission, the lack of high fidelity AAR M&S can cause unplanned flight control software redesign, limited flight envelopes, and additional flight test requirements. Though vortex lattice methods have previously been used to calculate wake impact on the receiver at the center of gravity, an improved simulation approach is needed to better capture the wake effect over the entire receiver planform. In most fixed-wing aerodynamic models, forces and moments are calculated via lookup tables that use the air mass properties (e.g. angle of attack, sideslip, etc.) at a single reference point (e.g. center of gravity) on the aircraft body. As a result, simply applying a tanker flow field at the reference point provides only a first order estimate of the tanker's wake effects on the receiver. This approach also does not incorporate moment effects beyond empirically based estimates.

An M&S approach and toolset that calculates the incremental forces and moments of the receiver aircraft due to tanker wake during aerial refueling operations is desired. The toolset should be capable of easily integrating with existing Navy fixed-wing 6DOF aircraft simulations (both realtime and offline), including the CASTLE® simulation architecture. The CASTLE® equations of motion are driven by aircraft body axis forces and moments and include existing variables for accepting external forces and moments. It is anticipated that the communication between CASTLE® and the toolset would be accomplished using a network protocol such as User Datagram Protocol (UDP). CASTLE® documentation and software will be provided during Phase I or Phase II as required and determined by the Navy. Inputs to the toolset may be as simple as the relative position between the aircraft and the tanker/receiver geometry data. Outputs should include receiver incremental forces and moments. The toolset should also allow an externally generated flow field to serve as an input, vice an internally generated tanker wake. In this case, the outputs should still include receiver incremental forces and moments. Possible approaches to this problem may include using vortex lattice, free wake, and/or Computational Fluid Dynamics (CFD) methods, however others will be considered.

PHASE I: Develop a M&S approach and toolset and assess feasibility to calculate the incremental forces and moments of the receiver aircraft due to tanker wake during aerial refueling operations. A key component of this phase includes choosing an approach to calculate the incremental forces and moments of the receiver aircraft based on the non-uniform flow field behind the tanker. Consideration should be given to how the method could be integrated into the CASTLE® architecture.

PHASE II: Develop a prototype toolset that calculates the incremental forces and moments of the receiver aircraft due to tanker wake during aerial refueling operations. This toolset should be capable of demonstrating that the 6DOF simulation response of a receiver aircraft yields the expected response. Validation with other sources of information, including flight test data (to be provided by the government early in Phase II efforts), is desired. The model/toolset shall be delivered to the Navy to demonstrate its capability at the end of the phase II effort.

PHASE III DUAL USE APPLICATIONS: Finalize and transition the M&S toolset to future Navy and commercial development programs, such as UCLASS, to assist in the development of aerial refueling flight control laws, predicting performance, and reducing flight test requirements. Validate with additional sources as required. The toolset developed under this SBIR is relevant in applications beyond aerial refueling. The underlying technologies can be used with traditional 6DOF fixed-wing aircraft simulations to incorporate the 6DOF effects of complex flow fields. Other applications include ship airwake integration and aircraft wake effects in terminal flight phases. The toolset may be useful in studies involving the Federal Aviation Administration (FAA) wake separation standards of departing and landing aircraft.

REFERENCES:
1. Dogan, Atilla, Sriram Venkataramanan, and William Blake. "Modeling of Aerodynamic Coupling between Aircraft in Close Proximity", Journal of Aircraft, Vol. 42, No. 4 (2005), pp. 941-955. Retrieved from: http://arc.aiaa.org/doi/abs/10.2514/1.7579

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KEYWORDS: Modeling And Simulation; Autonomous Aerial Refueling; Unmanned Air Vehicle; tanker wake; tanker downwash; 6DOF simulation

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

N161-004 TITLE: Maritime Traffic Model Aided Tracking

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: PMA 299 H-60 Helicopter 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 5.4.c.(8) of the solicitation. 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 significant capability increase in tracker performance by utilizing improved motion prediction of vessels by exploiting the maritime traffic model these vessels must obey.

DESCRIPTION: Naval forces conducting transits through straits and other congested littoral operational areas are presented with a challenging force protection requirement. Surface traffic density is often high, with many ferries, fishing and pleasure boats, and large cargo ships maneuvering in a small area. State of the art techniques based on high range resolution fingerprinting and emitter exploitation can be used to improve long term tracking performance of feature rich vessels such as naval combatants. However many smaller vessels lack adequate features to provide adequate track re-association. Utilizing traffic models in conjunction with the limited feature sets of these small vessels offers the potential to improve tracking performance.

Design and develop a novel maritime traffic-flow model which adaptively selects the appropriate level of fidelity (micro, meso, and macro) dependent upon the level of available maritime traffic knowledge. Various levels of fidelity should be applied across a geographic region to maximize overall track life expectancy while minimizing computational throughput requirements. Incorporate the maritime traffic model into the tracker kinematic prediction and use dynamically updated maritime traffic information to adaptively refine the track state prediction. By using the local traffic dynamics, the tracker can greatly reduce the miss-associations and mitigate the principle causes of track breaks. Generating these traffic dynamics using both prior knowledge as well as real time assessment is required.

It is recommended, but not required, to interact and collaborate with the original equipment manufacturers (OEM) of legacy radar systems such as the APY-10, APS-153 and ZPY-4.

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: Design and demonstrate the feasibility and approach to significantly improve tracking performance of existing legacy radar systems such as the APY-10, APS-153 and ZPY-4 to include a target signature exploitation capability. Develop a concept using both a priori knowledge as well as real time assessment and evaluate technical feasibility sufficiently to validate the approach.

PHASE II: Develop a prototype system designed in Phase I to provide and demonstrate that legacy radar systems (identified above) can be modified to provide the improved target tracking capability. Perform performance assessments using target layouts and behaviors representative of operational maritime environments provided by the Navy. Expand the design characteristics addressed during the Phase I effort. Deliver a detailed report and prototype system. The report should address the required modifications including estimated cost to integrate this technology into candidate radar systems and the key characteristics required in existing legacy systems for extension to additional capability. Fully documented algorithms should be produced and delivered.

PHASE III DUAL USE APPLICATIONS: Perform final testing and integration in collaboration with the Navy, and potentially the radar system OEM, to update selected legacy systems with the new target tracking capability. Coastal surveillance radar systems could leverage this technology for improved performance in the presence of non-cooperative contacts.

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2. Dragovic, B., Zrnic, N., Twdy, E. & Rooy, D., (2010). Ship Traffic Modeling and Performance Evaluation in Container Port. http://www.anale-ing.uem.ro/2010/A_20.pdf

KEYWORDS: Radar; maritime surveillance; ship traffic; port traffic; maritime tracking; situtational awareness

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

N161-005 TITLE: Compact Ultraviolet (UV) Laser Emitter in the 320-355 Nanometer (nm) Spectral Range

TECHNOLOGY AREA(S): Air Platform, Chemical/Biological Defense, Electronics

ACQUISITION PROGRAM: PMA 272 Advanced Tactical Aircraft

OBJECTIVE: Develop a compact, robust and efficient high-power ultraviolet (UV) laser emitter operating at room temperature in the wavelength range between 320-355 nanometer (nm).

DESCRIPTION: High-power, compact and reliable UV laser emitters in the wavelength range between 320-350 nm are very critical for various naval applications such as countermeasure for aircraft protection, advanced chemicals sensors based on Raman spectroscopy and laser identification detection and ranging (LIDAR).

There are at present commercially available UV laser technologies such as gas and solid-state lasers with frequency conversion that can emit in the wavelength range under 350 nm and produce high powers with narrow linewidths. These technologies, however, are generally too heavy, bulky, inefficient and inadequately ruggedized to meet the Navy's stringent size, weight and power (SWaP) and reliability requirements [1].

There are a couple of potential emerging technologies that could meet Navy SWaP specifications. One of the technologies under consideration for this program is based on the recent advances in technologies of Gallium Nitride (GaN) and related materials that have attained successful realization and commercialization of blue and green light emitting diodes (LEDs) and white lighting devices, and blue laser diodes for optical storage. However, the performance of these laser diodes based on high bandgap AlGaN materials are rendered inefficient primarily due to the inadequate material quality of Aluminum Gallium Nitride (AlGaN), lack of readily available lattice matched substrates resulting in formation of high threading dislocations in the grown layers, poor ohmic contacts and current crowding due to low carrier concentration and mobility, and poor thermal conductivity of the composite of epitaxy materials and substrate [2]. There have been recent advances in epitaxial growth that has alleviated markedly the germination and propagation of dislocations and the improved growth technique combined with novel laser design has a promising potential to mitigate many of the aforementioned issues. Moreover, semiconductor based solutions are readily power-scalable to mitigate the challenge of low emission power from a single emitter via either coherent or spectral beam combining of multiple emitters with single output aperture and excellent beam quality [3].

Another alternative and more mature technology is based on frequency conversion of high-power solid state laser via nonlinear optical process. Since a typical system usually consists of multiple stages of active and passive optical elements, such a system is inherently inefficient and bulky in terms of size and weight. Innovative system designs are therefore needed to minimize the size and weight and maximize the efficiency in order to meet the current laser emitter’s SWaP requirements.

The objective of this program is to develop compact, efficient, high-power UV lasers with continuous wave (CW) or average output power >1 watt (W) if operating in pulsed mode at periodic repetition frequency no less than 1kHz, wall-plug efficiency >10% and beam quality with M2 < 2 in the spectral range between 320 - 355 nm. The size of the laser head is required to be no more than 3 cubic inch. Both of the above-mentioned approaches will be considered if the proposers can propose convincing viable technologies that can meet the performance and size specifications.

PHASE I: Demonstrate the feasibility of a design for a UV laser emitter in the spectral range between 320 - 355 nm that can produce continuous wave (CW) or average output power >1 W if operating in pulsed mode at periodic repetition frequency no less than 1kHz, wall-plug efficiency >10%, M2 < 2 and size no bigger than 3 cubic inches. A viable design path forward for further increasing the output power beyond 1W at room temperature scheme should be proposed and included as part of the deliverable for Phase I.

PHASE II: Develop a prototype of compact UV laser emitter based on the proposed design in Phase I that meets the specifications stated in Phase I. Also demonstrate a viable path forward to power-scale the proposed baseline design in Phase II to beyond 5 W while maintaining beam quality with M2< 2. It is critical to incorporate manufacturing cost reduction as part of the design criteria throughout all the design phases in all phases of this program.

PHASE III DUAL USE APPLICATIONS: Produce three compact UV lasers based on the Phase II final design and perform qualification tests to validate the design and performance on designated avionic platforms in a relevant military environment. A compact, efficient, and high-power UV laser will enable a wide range of commercial applications including: remote detection of biological and chemical compounds; compact atomic clocks for precise timing and navigation; high precision materials processing and real-time medical diagnostics. For example, in Raman spectroscopy specific compounds can be identified with higher precision when exposed to a UV laser compared to an infrared laser because the scattering cross-section is over 100 times larger at UV wavelengths, increasing the Raman signal.

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1. MIL-STD-810G – Department of Defense Test Method Standard: Environmental Engineering Considerations Laboratory Tests (31 Oct 2008). Retrieved from http://everyspec.com/MIL-STD/MIl-STD-0800-0899/MIl-STD-810G_12306/

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KEYWORDS: Lidar; Beam Combining; AlGaN; UV lasers; frequency conversion; GaN

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

N161-006 TITLE: Large Aperture Agile Scanning Mirror

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: PMA 264 AIR ASW Systems

OBJECTIVE: Develop a large aperture, agile, scanning mirror for passive and active optical remote sensors.

DESCRIPTION: Remote sensing of low light level signals from an airborne platform requires a large aperture optical system. To achieve good signal-to-noise ratios, scanning of the system aperture across the scene with a limited field of view is preferred over observing the entire scene with a fixed, large field of view. Further, compensating for changes in aircraft motions such as roll and pitch enables a more accurate reconstruction of the scene from the individual snapshots. Current techniques of implementing a scanning imaging system include mechanically moving a mirror and relaying the image to an optical sensor or mechanically moving the entire optical system and sensor, such as in a ball turret. Both solutions, however, have significant size, weight, and power (SWaP) requirements when considering large optical aperture systems.

Development of a large aperture, agile scanning mirror should achieve apertures with diameters of 12 inches (30 centimeters) or greater with sweep angles of +/- 30 degrees at 10 or more sweeps per second, draw 10's of Watts, and weigh less than 10 pounds by means of innovative techniques [1]. Areas of concern for a next generation scanning system are optical efficiency and platform motion and vibration insensitivity. While current scanning aperture techniques can achieve near 100% optical efficiency, 90% efficiency or greater would be acceptable. Typical platform vibration motion spectra can be found in MIL-STD-810G, Part 2, sections 514.6 Vibration, sub-sections dealing with propeller driven and rotary wing platforms.

The ability for agile scanning addresses both platform movement correction (stabilization) and allows sweep patterns other than line scans. Minimizing size, weight, and power draw of the overall scanning sub-system will allow access to a more diverse group of airborne platforms.

PHASE I: Demonstrate the feasibility of the proposed concept through validated modeling and simulation and identify the primary technical risks of the concept. The Phase I Option, if awarded, should continue to validate the proposed concept in preparation for Phase II.

PHASE II: Develop and demonstrate a working bench-top design for a large aperture, agile, scanning mirror for passive and active optical remote sensors. Sufficiently harden the bench-top design for testing and demonstration under moderate vibration and g-force loading (see MIL-STD-810G, Part 2). Design and develop a working prototype based on the results of the bench-top design. The working prototype must address technical risks, validate the draft specifications, and demonstrate the functionality of the overall design.

PHASE III DUAL USE APPLICATIONS: Document the design and capabilities of the prototype developed under Phase II. Work with government points of contact to develop specifications and first articles that address unique as well as all other concept elements. Support the Navy by finalizing and validating the agile scanning mirror design based on acquisition program needs. Participate, if necessary, in integrating and testing tasks such that the agile scanning mirror can be mated with existing or new sensor systems. Procurement of multiple units may occur. The development of light weight mirror substrates or large arrays of phase locked mirrors has commercial potential for fast scan applications including terrain mapping LIDAR systems.

REFERENCES:
1. H. Xie. (2010). Development of High-Fill-Factor Large-Aperture Micromirrors for Agile Optical Phased Arrays. Final Project Report. Grant FA9550-08-1-0292.

2. Department of Defense Test Standard Method MIL-STD-810G, 31 October 2008, Section 2, p514.6C1 – 514.6C22, p516.

KEYWORDS: Scanning mirror; large aperture; agile scanner; mirror array; image stabilization; MEMS mirror

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

N161-007 TITLE: Immersive Parachute Descent Procedure, Malfunction and Decision-Making Training System

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 205 Aviation Training Systems

OBJECTIVE: Develop a novel reconfigurable device training system that provides immersive Parachute Descent Procedure (PDP), malfunction and decision-making training to allow the survival training community to deliver cross-platform training without the need for multiple training systems or platform specific peripherals.

DESCRIPTION: Current Parachute Descent Procedure (PDP) training is based on antiquated virtual reality technology that has inadequate effectiveness and realism. Additionally, existing training is problematic due to limitations that prevent interfacing with standard flight and parachute equipment. A novel, immersive training system that provides the ability to train aviators on PDPs, malfunctions and decision-making is desired. The training system should address three capabilities gaps: 1) training quality and effectiveness, 2) supportability, and 3) training realism. The training system should provide a reconfigurable interface that supports all Navy standard flight equipment and parachute equipment. All necessary equipment will be identified during the Phase I and Phase II execution, with hands on opportunities at the safety center facilities during kickoff or other collaboration meetings. This would include, but is not limited to, parachute harnesses and riser assemblies for all models of parachutes. Developed technology would provide the ability to demonstrate effectively both standard PDPs (e.g., inflation of the life preserver, releasing the raft when applicable) and parachute malfunction. Malfunction training should allow students to perform corrective actions and provide mechanisms to deliver feedback on performance through performance assessment and debriefing capabilities. The system should support scenarios for training that include both over land and over water options and procedures.

The requested training solution will require innovation and a technical solution from offerors to provide a reconfigurable connection for a variety of aircrew equipment and seat kits, which differ by platform. This is necessary to ensure the delivery of an integrated training solution without the need for a platform specific trainer or simulated/replica equipment only utilized within the trainer. Development a single, reconfigurable device will allow the survival training community to deliver cross-platform training without the need for multiple training systems (variations by platform), and limiting significant single or recurring peripheral costs if a system was designed with simulated/replicated equipment. These costs saving factors increase affordability of the requested system, while also increasing the training fidelity for delivering a critical safety-training curriculum.

In addition to demonstrating and training PDPs and malfunctions, the system should provide decision-making training that provides scenarios and feedback based on a number of environmental factors (e.g., over water, over land, buildings, trees, power lines). To enhance the training delivered through the device, novel performance measurement and assessment technologies are desired. Examples of desired debrief functionality may include:
• Capability to assess crew performance on procedures, decision making and an assessed probability of survival based on performance is beneficial, and/or
• A debriefing visualization tool that integrates a 'what-if'ing' capability to showcase how variations on the essential inspect, inflate, release or steering procedures and/or decisions made would impact the outcomes of the performance observed would help provide a more interactive training solution.

PHASE I: Demonstrate the feasibility of an architecture and/or proof-of-concept of proposed technology to deliver an immersive Parachute Descent Procedure (PDP) malfunction and decision-making training system that provides a reconfigurable interface to support all Navy standard flight and parachute equipment. Anticipated technology challenges that should be addressed in this feasibility demonstration and/or analysis include:
• Ability of the trainee to perform correct and realistic Parachute Descent Procedures on his/her parachute equipment while viewing the virtual environment through a head mounted display, and
• Physical integration of the trainees vest to the virtual environment to support system responses to emergency procedure actions.

The proposed architecture should provide novel and innovative solutions to these anticipated challenges and identify any anticipated risks with selected and alternative solutions. The company shall demonstrate the feasibility of their concept through modeling and simulation. The company should identify technical risks of their concept. The Phase I Option, if awarded, will include the initial design layout and a capabilities description to build into Phase II.

PHASE II: Develop a prototype immersive Parachute Descent Procedure (PDP) malfunction and decision-making training system that provides a reconfigurable interface to support all Navy standard flight and parachute equipment system in order to address the technical risks of their concepts. The company shall develop draft specifications for the different elements of the concept. The prototype shall provide a comprehensive training solution that provides novel and innovative solutions to the visual and physical integration challenges of the required technology. The prototype system testing shall address technical risks, validate the draft specifications, and demonstrate the functionality of the overall concept.

PHASE III DUAL USE APPLICATIONS: The company shall support the Navy in transitioning the technology to Navy use. The company shall develop specifications and first articles for concept unique elements and specifications for other concept which must have specific functionality to implement the immersive Parachute Descent Procedure (PDP), malfunction and decision-making training system and transition technology to U.S. Navy and other military and private organizations. Any aviation organization that conducts parachute descent procedure training as part of the Federal Aviation Administration/Department of Defense (FAA/DoD) requirements could utilize this technology to train individuals.

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4. Chivers, C. J. (6 February 2007). Survival Training for When a Pilot's World Turns Upside Down. NY Times. Retrieved from http://www.nytimes.com/2012/02/07/us/navy-survival-training-for-when-a-pilots-world-turns-upside-down.html?_r=0

KEYWORDS: Training; Parachute Training; Safety Training; Emergency Procedure Training; Decision Making Training; Malfunction Training

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

N161-009 TITLE: Innovative Sensing Fasteners for Aircraft Fatigue Monitoring

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: PMA 274 Executive Transport Helicopter Program

OBJECTIVE: Develop a sensor capability that can be incorporated onto a common aerospace fastener to monitor for in-hole fatigue crack initiation in multi-layered joints.

DESCRIPTION: One of the primary damage modes in layered joints on aircraft is fatigue cracking that originates at fastener through-holes. If fatigue cracks are undetected, they have the potential to cause a joint failure that could result in catastrophic consequences. However, in-hole inspections of joints, particularly the inner layers of joints, are problematic, costly, and time consuming. With current methods, joints need to be disassembled to be inspected. Following fastener removal, each hole needs to be reamed clean, inspected by eddy-current probe, and then have a new fastener installed. Low profile ultrasonic and eddy current sensors are currently being used for Structural Health Monitoring (SHM) applications, typically incorporated onto a structure via flexible films. This technology has shortcomings since it is fragile, sensitive to orientation, and potentially difficult to install on small curved surface areas.

To minimize the number of required fastener hole inspections, an innovative sensor capability, which can be incorporated onto an existing fastener, is sought. The resulting self-sensing fastener should be capable of detecting crack initiation inside of a borehole without requiring any disassembly of the aircraft structure. The self-sensing fastener should also be able to be integrated into the assembly of an aircraft with minimal impact to weight, structural strength, and durability of the parent joints. Lastly, the self-sensing fastener should be capable of interfacing with an existing Health and Usage Monitoring System (HUMS), such as the B.F. Goodrich systems currently being utilized aboard H-53E/K, H-60R/S, and H-1 (Ref 7). The ultimate goal is to perform a full system airworthiness qualification onboard a Navy or Marine aircraft, which will include test and evaluation of structural strength, fatigue, environmental, vibration, and shock per MIL-STD-810, electromagnetic environmental effects (E3) per MIL-STD-464, and electromagnetic interference (EMI) per MIL-STD-461.

PHASE I: Determine feasibility for the development of a sensor capability that can be incorporated onto common aerospace fasteners, such as AN or Hi-Lok series. Demonstrate feasibility of the self-sensing fastener concept by bench testing in a lab environment. Develop appropriate models required to design a sensor network with self-sensing fasteners.

PHASE II: Build a prototype self-sensing fastener based upon Phase I approach. Evaluate data quality and accuracy by fatigue testing a simple lap joint with a self-sensing fastener installed. This data should be collected with using an existing aircraft HUMS recorder or with a standalone data aggregator that has the ability to interface with an existing aircraft HUMS unit. Develop a plan for full system airworthiness qualification onboard a Navy or Marine aircraft.

PHASE III DUAL USE APPLICATIONS: Perform a full system airworthiness qualification onboard a Navy or Marine aircraft, specific target platforms to be provided during Phase II as appropriate. Evaluate qualification test results and provide procurement specification for transition to an actual production platform. Consider a qualification plan for commercial applications. The development of these sensors will have broad commercial applications for structural health monitoring of mechanical joints on commercial aircraft, ships, and civil structures such as bridges.

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4. MIL-STD-461F: Department of Defense Interface Standard: Requirements For the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (10 Dec 2007).

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7. B.F Goodrich (UTC Aerospace) HUMS. <http://utcaerospacesystems.com/cap/systems/sisdocuments/Health%20and%20Usage%20Management%20Systems%20(HUMS)/Health%20and%20Usage%20Management%20Systems%20(HUMS).pdf>

KEYWORDS: Sensor; Maintenance Reduction; Structural Health Monitoring; Fastener; Damage Detection; Condition Based Maintenance

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

N161-010 TITLE: Novel Method to Utilize Multi-scale Physics-based Technique for Crack Path Determination in Fiber-reinforced Composites

TECHNOLOGY AREA(S): Air Platform, Space Platforms

ACQUISITION PROGRAM: PMA 275, V-22 Osprey

OBJECTIVE: Develop an innovative technique utilizing peridynamic theory to determine crack path in fiber-reinforced composite structures.

DESCRIPTION: Accurate prediction of crack growth behavior is essential in determining inspection intervals and maintenance schedules of aerospace structures where failure could lead to catastrophic consequences and loss of life. The financial costs involved when an in-service component is found to contain a defect is a major factor in the search for numerical methods to predict 3-D crack propagation. Damage initiation and subsequent propagation in fiber-reinforced composites are not understood as clearly as metals because of the presence of stiff fibers within soft matrix material causing inhomogeneity. Failure of fiber-reinforced composites involves a progressive series of events with discrete failure modes such as matrix cracking, fiber-matrix shear, fiber breakage and delamination. The presence of such failure modes result in stiffness reduction. This leads to stress redistribution in the layers and constituents. The ability to predict crack path progression in fiber-reinforced composite structures is essential in the design of new aircraft and the sustainment of legacy fleet. This effort will provide a pro-active approach in the design of next generation air vehicles as they will be constructed from lighter, stronger materials such as fiber-reinforced composites. Reliable methods to predict 3-D crack propagation will reduce maintenance inspections and life of in-service components can be extended providing huge monetary savings.

Lack of predictive capability for crack propagation paths in fiber-reinforced composite structures under cyclic loading continues to prevail despite the extensive amount of research. Simulating damage initiation and subsequent global structural failure is one of the most active topics in computational mechanics. Several mathematical models and numerical methods have been developed over the years to assess various limit states such as failures due to permanent deformation, cracks, or de-cohesion/delamination in composite materials. Current numerical methods are damage based or rely on discrete cracks. They are generally computationally expensive and require a fine scale description of structural and mechanical properties.

Although the existing failure criteria for isotropic materials are applied to many problems with acceptable success, there still exist challenges when predicting the evolution of an arbitrary crack shape that may be non-planar. Often these are multiple cracks exhibiting complex pattern forming within non-planar 3-D surfaces. The presence of manufacturing or service related residual stresses and the sequence of load interactions introduces additional challenges, requiring more complicated numerical techniques. Existing numerical methods for calculating fracture parameters encounter challenges due to this topological evolution.

Although mature, powerful, and versatile, finite element analysis (FEA) simply fails to predict failure initiation and complex crack growth because the FEA formulation is not mathematically suitable for the simulation of failure. The standard theory of classical continuum mechanics has certain limitations when addressing crack initiation and growth in materials because partial differential equations of motion include spatial derivatives of displacement components which are not valid in the presence of displacement discontinuities such as cracks.

An alternative theory, known as the peridynamic theory, is a nonlocal theory that does not require spatial derivatives and removes the obstacles concerning the prediction of crack initiation and growth in materials based on classical continuum mechanics. Peridynamic theory is formulated using integral equations as opposed to derivatives of displacement components. This feature allows crack initiation and propagation at multiple sites, with arbitrary paths inside the material, without resorting to external crack growth criteria. Peridynamic theory has the capability to handle multi-scale modeling for both length and time, and address discontinuities and non-linearity. Peridynamic theory has the potential to serve as a basic model across all scales, avoiding the difficulties inherent in multi-model coupling. In addition, peridynamic theory has the ability to efficiently link with many microscale models including molecular dynamics.

There is a need for a novel physics based method to determine the crack growth and path in fiber-reinforced composite structures using peridynamic theory. The proposed computational models must underpin the true physical processes rather than empirical correlations and deal with mechanisms operating at different length scales. This capability will provide insight into crack initiation, growth in fiber-reinforced composite materials, and enable improved failure prediction and remaining useful life estimation. This effort will produce a theoretical basis, technique and tool that can be integrated into a continuum code for crack path prediction and that is computationally efficient and accurate.

PHASE I: Demonstrate the feasibility of an analytical technique/method for crack path prediction in fiber-reinforced composite structures using peridynamic theory and applying this method for example case studies. Compare the results obtained from proposed peridynamic approach with available finite element or other advanced methods using benchmark problems.

PHASE II: Develop and demonstrate a prototype tool utilizing the multi-scale/multi-physics based framework developed in Phase I. Demonstrate the use of tool through the analysis of a representative component of interest. Implement the proposed model in a continuum code for crack path prediction in simulated service conditions while validating with experimental data.

PHASE III DUAL USE APPLICATIONS: Transition the multi-scale/multi-physics tool for use with commercially available computational tools to predict fiber-reinforced composite damage progression on Navy aircraft platforms. The results of this research will be useful in design of new aircraft as well as sustainment of in-service fleet. The software will determine the crack growth and path in fiber-reinforced composite structures and help in predicting remaining useful life. The developed technology will be integrated with existing computational software, making it commercially available to address the design and in-service maintenance issues faced by many industries besides naval applications such as space, commercial aircraft, etc.

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KEYWORDS: Fatigue; multi-scale; crack path; fiber-reinforced composites; physics-based; Peridynamic

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

N161-011 TITLE: Turbomachinery Distortion Characterization by Non-intrusive Measurement Methods

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: Joint Strike Fighter - Propulsion

OBJECTIVE: Develop a non-intrusive measurement capability to quantify the distortion profile at the inlet of the fan and compressor of an aircraft engine.

DESCRIPTION: Characterization of distortion (pressure, temperature, flow angle, density) at the inlet of fans and compressors is typically done during development, or in a test environment, through the use of pitot probes [4]. These probes can only be used during developmental stages due to their intrusive nature and potential to dislodge or break loose, potentially causing domestic object damage (DOD). Within the engine operating envelope, complex distortion profiles are experienced due to aircraft maneuvers or environmental effects such as steam, armament or jet blast ingestion. These distortion profiles are not all tested due to their stochastic nature. The capability to characterize the inlet distortion for in-service aircraft engines is currently not available. While in service, fans/compressors on aircraft engines run into structural, operability or performance issues that are caused by inlet distortion that may be different from those modeled or replicated during static ground tests even with complex distortion screens. To determine root cause of a performance or structural issue, it is critical to have the ability to quantify the severity and intensity of these distortion profiles at the inlet of the affected compression system. Having this capability would allow identification and avoidance of critical inlet flow distortion that can negatively impact operability and performance as well as structural integrity.

Current systems used to characterize pressure and temperature distortion are arrays of probes arranged in rakes that are immersed in the flow path. Typically, flow angle is never measured due to measurement complexity, as such, it is usually analytically modelled. Aside from being intrusive, these systems are vulnerable to Foreign Object Damage (FOD) as they are exposed to whatever is ingested by the engine. Additionally, the probes themselves can be a potential source of internal domestic object damage to downstream components. To develop this capability with conventional technology would result in designing a set of rake and probe arrays specific to the aircraft engine application. This is a costly proposition and also would require a considerable amount of lead time.

Proposed sensor design should be non-intrusive to the flow stream, should avoid extraneous excitation and be easily accessible from turbomachinery exterior. Easy installation is desired on different Navy engines without adversely affecting the flow stream, the turbomachinery performance or becoming a source of domestic object damage. The system should be capable to characterize distortion to a better accuracy than the current methods that are available only during development and testing. The output should be able to be converted into numerical distortion descriptors that can be used in computational models to generate impact of distortion on performance or operability. The proposed sensor design should not create adverse effects such as pressure losses or introduction of a synchronous engine order forcing function.

During the design of the non-intrusive system, consideration of sensor design to characterize the distortion parameters (like, pressure, angle, temperature) as well as data acquisition and processing systems and their foot print on the engine carcass, should be kept as a high priority.

It is desired for the resulting technology to be configurable to various engine platforms.

It is recommended, though not required, to collaborate with original engine manufacturers (OEMs).

PHASE I: Demonstrate technical feasibility and proof-of-concept of the sensor system and data acquisition to quantify the distortion profile at the inlet of the fan and compressor of an aircraft engine. Provide conceptual design and cost estimate for the overall system.

PHASE II: Develop a detailed design, and perform fabrication and validation of a prototype for the sensor system, data acquisition and processing systems. The validation should include component type bench testing simulating engine operating conditions to demonstrate overall system capability. Demonstrate a fully functional system prototype. Proposers are encouraged to work with the OEM, academia or other institutions for testing opportunities. NAVAIR technical personnel will assist with access to engines for testing, if necessary.

PHASE III DUAL USE APPLICATIONS: Complete any operational testing required to prepare for and demonstrate a fully functional non-intrusive sensor system to characterize pressure and temperature distortion on a relevant engine platform if available or if the opportunity exists. Configure and transition validated system to appropriate platforms. The system developed should be useful in characterizing pressure and temperature distortion at the inlet of fans/compressors of propulsion systems (military and commercial). The system will be widely applicable not only in military aircraft engine application, but would also have usage in commercial, ground based, marine, automotive and other areas, where distortion plays a significant role in reduced performance and operability.

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KEYWORDS: Compressor; Distortion; Characterization; non-intrusive; Excitation; Foreign Object Damage (FOD)

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

N161-012 TITLE: Next Generation Lithium-ion (Li-ion) Batteries (NGLB) with Novel High Energy Anode Architectures

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Sensors

ACQUISITION PROGRAM: PMA 208, Aerial Target and Decoy Systems

OBJECTIVE: Develop Next Generation Lithium-Ion Batteries with Novel High Energy Anode Architecture.

DESCRIPTION: As naval aircraft electrical power demands are increasing, the full potential of Li-ion battery technology must be realized to meet such demands. Li-ion battery technology has unique advantages – increased capacity (~3X) and decreased weight (~1/3) in comparison to the lead-acid and nickel-cadmium batteries currently used in aircraft. The power and energy demands of the aircraft system have increased significantly over the years and the systems have become more complex. There is a need for lithium-ion cells that allow higher capacity, smaller cells and innovative product designs. Lighter, high energy density batteries with more power capability have an overall positive impact on system complexity and reliability. Such Li-ion batteries use graphitic carbon with inherent, desirable properties such as large reversible Lithium (Li^+) intercalation, good electrical conductivity, and stable solid electrolyte interface (SEI). However, there are several drawbacks associated with the use of carbon including its relatively low specific capacity (372 mAh/g), poor rate capability in high-current applications, increasing internal resistance with cycling and age, as well as safety concerns due to thermal runaway conditions as a result of thermal exposure, overcharge and overheat conditions. Also, the formation of dendrites produced and grown during cycling, penetrate the separator causing an internal electrical short of the cells leading to battery fire accidents. The current cost of Li-ion batteries at > $800/KWh is extremely high. Novel, higher capacity anode materials are needed that store more energy, exhibit longer cycle life for reduced total ownership cost, are lighter weight, and are safe to use for Navy applications.

Higher energy alloy anode materials provide distinct advantages. They significantly reduce the amount of material needed to make cells and the number of cells needed for building the complete battery module. In addition, the amount of supporting hardware needed to construct the battery is reduced, resulting in SWAP-C benefits (space, weight and power - cooling) as well as reducing battery costs ($/KWh basis).

A number of potential alternatives to carbon have emerged recently. Metal alloy anodes (ex. Si, Ge, Sn) with advancements (ex. nanostructures, composites) are promising anode materials for NGLB. For example, silicon has a theoretical capacity of 3590 mAh/g, almost ten times higher than graphite. The higher working potential of silicon (0.5 V vs. Li/Li^+) in comparison to that of carbon (0.05 Vs. Li^+) prevents Li metal deposition and, ultimately, reduces the risk of safety incidents. However, there are several technical challenges of Si; for example, during cycling; there are multiple amorphous phase transformations, which result in reduced cycling performance. Si suffers from huge volume changes (~ 400%) during the dealloying process, which leads to loss of electrical contact between the particles, resulting in rapid loss of capacity during cycling and reduced total life of the cell and the battery. If such drawbacks are overcome, then the use of this material as an alloy anode offers promise for higher capacity, higher energy density, and longevity. It will allow for the use of smaller, lighter cells and higher safety margin for the battery as well as the potential for reduced cost due to the abundance of the raw materials.

The benefit that metal alloys hold can be realized for NGLB if innovations with novel architectures that ensure extended battery life cycle are made. Novel, high capacity anode alloys with innovative architectures with the following features are sought: 1) increase in energy density per volume and weight while maintaining extended cycle life with high Coulombic efficiency, 2) demonstrated improvement in safety, and 3) reduction in the overall battery cost, which will enable the development of NGLB.

The developed battery system, 28V/270VDC battery with the advanced high energy density anodes, must be compatible with current aircraft operational, electrical, and environmental requirements. The functional battery must meet the requirements called out in NAVSEA S9310-AQ-SAF-010 [4], and MIL-PRF-29595A [5] which are performance and safety specifications, respectively.

For example, the requirements include sustained operation over a wide temperature range from - 40 to +71 degrees Celsius and exposure to +85 degrees Celsius. Other requirements that need to be met are the following: ability to withstand carrier based shock and vibration loads, altitude range up to 65,000 feet per MIL-STD-810G [6], and electromagnetic inference up to 200 V/m, per MIL-STD- 461 F [7]. The battery product developed must also meet additional requirements of low self-discharge (< 5% per month), extended cycle life (> 2000 cycles at 100% DOD), and long calendar life (> 6 years of service life).

PHASE I: Design and develop an innovative concept to realize high energy density for metal anode alloys and demonstrate the feasibility at full-cell level. Perform preliminary safety, electrical, and performance evaluations.

PHASE II: Develop a prototype and demonstrate the functionality of NGLB over a wide-temperature range, in harsh environments, including Navy unique salt fog, and extended life cycle (over > 1000 cycles). Develop a plan for future scale-up for large scale manufacturing of NGLBs.

PHASE III DUAL USE APPLICATIONS: Finalize the fully functional aircraft-worthy NGLB product. Consisting of battery modules/pack, battery management system, connectors, and control systems, with performance specifications satisfying the targeted acquisition requirements (ex. F/A-18, F-35, H-60). The batteries must pass qualification and certification testing. Commercialize the technology and develop a cost effective manufacturing process focusing on DOD and civilian market applications. The potential for commercial application and dual use is high. Beyond the Navy application, there are applications for electric vehicle, consumer portable electronics products, and commercial aviation sectors.

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6. MIL-STD-810G – Department of Defense Test Method Standard: Environmental Engineering Considerations Laboratory Tests (31 Oct 2008). Retrieved from http://quicksearch.dla.mil/

7. MIL-PRF-461F – Department of Defense Interface Standard: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (10 Dec 2007). http://quicksearch.dla.mil/ http://quicksearch.dla.mil/

KEYWORDS: Li-ion battery; safety.; Next Generation; Metal anodes; High energy density; Cycle life

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

N161-013 TITLE: Image Correspondence Figure of Merit (FOM)

TECHNOLOGY AREA(S): Sensors, Weapons

ACQUISITION PROGRAM: PMA 201 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 5.4.c.(8) of the solicitation. 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 algorithm and a software simulation system that can reliably determine and predict the quality of correspondence between two images of different types, modes, sources, or perspectives.

DESCRIPTION: The current mission planning capability for image-guided weapons is limited and undocumented. When planning to employ these weapons, images are used to aid in the target acquisition process and to guide the weapon to the target. This is usually accomplished via some method of comparing images acquired prior to launch with images captured by the weapon while approaching the target. Images used during the mission planning phase may be from any of a number of sources and may be screened for potential best or optimal success in aiding the weapon, based upon content, clarity, and/or mode. What is needed is a simulation or method that can compare images and provide a measure or figure of merit (FOM) for the level of correspondence that should be expected, so that the best image can be selected and used.

For example, when planning an image-guided weapon mission, operators are currently instructed during the weapon's mission planning to add or remove features to improve the weapon's ability to establish a correspondence, but no feedback is given to the operators letting them know if what they are doing is improving the correspondence or not. With the FOM, operators will receive instant feedback on whether the feature they added or removed improved the likelihood of correspondence or not. With the simulation, operators will also be able to simulate the weapon's end-game performance. This way they will know whether or not this portion of the overall mission will be successful before executing it.

When multiple images are available, the mission planning system can use the FOM, i.e., statistical measure, and the simulation to find the image that would give them the highest success rate for the mission. For example, the simulation would only look at the images with a FOM greater than a pre-determined critical value, i.e., images with the most unique features identified, and simulate the weapon's performance using the planned profile in a design of experiment. This will determine how many times the weapon correlated to within tolerance using each image. Using these results, the simulation would provide the best image needed to achieve mission success.

What is needed is a simulation and a FOM to support mission planners of image-guided weapons. Being able to do both would provide a more robust solution operationally, which is what is desired. Also, the simulation with a fly-out capability would be very useful in developing trust in the new capability with mission planners. That is, mission planners will be able to see a simulated performance of the weapon.

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: Design, develop, and describe the proposed method mathematically and provide a model or MATLAB TM simulation that demonstrates how the FOM is created. Document the proposed method with some results from a few examples.

PHASE II: Refine the model or simulation and provide a prototype executable software system that can be used to test many input samples from different sources and sensor types. Develop documentation to support an independent test and evaluation of the proposed capability.

Planning to use/test some classified imagery, which would require the developer to have adequate processing capabilities and cleared personnel. Classified imagery would be provided by the Government

PHASE III DUAL USE APPLICATIONS: Develop an application programming interface (API) so the simulation can be integrated with and become part of a mission planning system. Provide support for the method or simulation until the Government can assume ownership and responsibility for its deployment and sustainment. Applications to Homeland Security, Law Enforcement.

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KEYWORDS: Targeting; imagery; Modality; Correspondence; Registration; Algorithm

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

N161-014 TITLE: Robust Electronics for Aircraft End Speed Indicator

TECHNOLOGY AREA(S): Electronics, Sensors

ACQUISITION PROGRAM: PMA-251 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 5.4.c.(8) of the solicitation. 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 technology that enables an aircraft end speed system to operate without failure in the shock, vibration and temperature extremes experienced in steam catapult spaces aboard aircraft carriers.

DESCRIPTION: Naval aviation depends on catapults to enable aircraft to operate safely on aircraft carriers. An important subsystem of the aircraft launch is the Digital End Speed Indicator (DESI). The DESI uses reluctance sensors mounted towards the forward end of the steam catapult to determine the launch speed of aircraft. This data is used as part of the performance information to indicate the health of the catapult. In addition, the DESI is used to keep track of shot count, date, time of launch, Capacity Selector Valve setting and sensor health.

The current DESI system electronics aboard carriers is experiencing numerous failures due to the shock, vibration, and temperature extremes of the Steam Catapult Central Charging Panel space where the system resides. The Navy needs development of technology to enable electronics to operate in this environment without failure.

The new system shall meet MIL-STD-167-1, Type I Vibration, MIL-STD-461 Class A4 EMI: CE101, CE102, CS101, RE101, RE102, RS101 & RS103, MIL-STD-810 Method 507 Procedure 1 Humidity & MIL-S-901 Grade A, Class I, Type A Shock, with continuous operation at an ambient operating temperature of 135 F.

PHASE I: Determine the feasibility of developing an Aircraft End Speed Indicator (AESI) system that will meet MIL-STD-167-1, Type I Vibration, MIL-STD-461 Class A4 EMI: CE101, CE102, CS101, RE101, RE102, RS101 & RS103, MIL-STD-810 Method 507 Procedure 1 Humidity & MIL-S-901 Grade A, Class I, Type A Shock, Ambient Operating Temperature of 135 F. Develop a conceptual design for electronics that can withstand the aforementioned specifications. Determine proof of concept through analysis and/or targeted lab demonstrations. Provide defendable estimates for cost, reliability and maintainability.

PHASE II: Develop and demonstrate a prototype Aircraft End Speed Indicator. Include health monitoring capability into the system. Initial testing of the system will be on the Catapult Workspace demonstrator progressing to full scale system testing at the NAVAIR Test facilities or similar test facilities. During a final demonstration, the system should provide system health monitoring and full-scale performance to verify that the system can meet environmental robustness, shipboard shock and vibration, and maintainability requirements per the military specifications listed in the Description and Phase I paragraph. A Mean Time To Repair (MTTR) of one (1) hour for any equipment below deck (03 Level) shall be maintained.

PHASE III DUAL USE APPLICATIONS: Manufacture and install, on a candidate USS Nimitz Class Aircraft Carrier, six (6) AESI's to function as shipboard evaluation prototypes (two (2) are spares) for a minimum of one (1) year, prior to back-fitting the entire fleet of carrier vessels and ground catapult installations. This system could substitute for any system such as undersea drilling operations or commercial space operations requiring a high accuracy, harsh environment, and health monitoring system. There is also commercialization potential with the foreign military sales (such as the French Navy).

REFERENCES:

1. NAVAIR 51-15ABE-2, Digital End Speed Indicator (DESI) System, Technical Manual

2. MIL-STD-167-1, Type I Vibration

3. MIL-STD-461 Class A4 EMI: CE101, CE102, CS101, RE101, RE102, RS101 & RS103

4. MIL-STD-810 Method 507 Procedure 1 Humidity

5. MIL-S-901 Grade A, Class I, Type A Shock

KEYWORDS: Maintainability; Health Monitoring; Environmental Robustness; End Speed; Performance; Accuracy

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

N161-015 TITLE: Collaborative Undersea Warfare Mission Planning for Manned and Unmanned Vehicles

TECHNOLOGY AREA(S): Ground/Sea Vehicles, Human Systems, Information Systems

ACQUISITION PROGRAM: PMA 281, Strike Planning & Execution 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 5.4.c.(8) of the solicitation. 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 mission planning software tool that optimizes the Undersea Warfare (USW) mission planning environment across multiple platforms/multiple domains (air, surface, and subsurface) with diverse sensors allowing for USW assets to develop integrated mission solutions that include advanced 3-D visualization techniques and the optimization of existing software algorithm processes.

DESCRIPTION: Increases in stealth and offensive capabilities of today's sophisticated submarines have resulted in increased USW challenges. In the past, a single USW asset would work independently from other platforms, each with their own unique area of responsibility. Given today's challenging targets and environmental conditions, there is a need for increased coordination of various USW assets to achieve a greater probability of detection/interdiction of targets of interest.

In order to gain a better understanding, improve situational awareness, and achieve tactical advantage, advanced visualization techniques and software algorithm processes are desired to aid USW mission planners. An integrated tool, using novel graphical user interfaces (GUI) to assist planners in developing sensor deployments, gain better understanding of other platforms' sensor capabilities, and determining how changing variables (e.g. Target of Interest (TOI) depth, change in sensor depth, water column changes, etc.) will increase or decrease the likelihood of detection is required. Applying advanced visualization techniques will provide mission planners the ability to see the problem space in three-dimensions with the effects of dynamically placing (select, drag, and drop) sensors (position and depth) and display the effected detection areas (based on percent of detection) and gaps in coverage. It is critical that the mission planning of each individual USW asset be displayed in conjunction with other mission planning activities to achieve greater awareness and make recommended sensor deployment options for other platforms. Sensors to be considered include; passive acoustic, active acoustic, electronic support measures (ESM), and electro-optical/infrared (EO/IR). USW platforms include aircraft (SH-60R, P-3, P-8) submarines, surface combatants and Unmanned Aerial Vehicles (UAV).

The overall goal is to initially integrate the proposed software tool into the Joint Mission Planning System (JMPS) environment. Note that in Phase II the contractor will receive a Navy Mission Planning System Style Guide that is currently being drafted.

The prospective contractor(s) may require access to classified information for Phase II. 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 any subcontractors 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: Design and develop advanced visualization techniques and optimization algorithms for existing sensor and mission planning software processes for manned and unmanned collaborative USW mission planning. Develop novel GUI display concepts that show how dispersed manned and unmanned platforms would plan, distribute and collaborate in the USW environment. Demonstrate the feasibility of optimizing the developed multi-platform, multi-sensor planning and show the sensor coverage areas and gaps that also includes identifying technical risks of the proposed concept. The Phase I Option, if awarded, will include the initial design layout and a capabilities description to build into Phase II.

PHASE II: Based on the results of Phase I efforts, develop prototype of the proposed software processes to address the technical risks of the concept. Develop draft specifications for the different elements (GUI, visualization and algorithms) of the concept. Further develop and apply the advanced visualization techniques and processes for USW mission planning concept from Phase I and sensor/physics models to sensor performance planning. Demonstrate a prototype of the optimized dispersed planning system and the ability to achieve an acceptable mission plan that allows for greatest detection probability.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning and integrate the software functionality into JMPS and other Navy use. Develop specifications and first articles for concept unique elements and specifications for other concept elements which must have specific functionality to implement the end product. Finalize the product for test and integration into JMPS for effective USW mission planning capability. This software tool capability would be highly suitable for government agencies - that includes Department of Homeland Security, Coast Guard, and commercial maritime operations.

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KEYWORDS: Collaborative Mission Planning; Unmanned; Undersea; Manned; Vehicles; Mulit-platform

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

N161-016 TITLE: iPhone Operating System (iOS) Framework and Application Development for Electronic Kneeboard

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

ACQUISITION PROGRAM: PMA 265 F/A-18 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 5.4.c.(8) of the solicitation. 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 iPhone Operating System (iOS) framework and application(s) for moving the Weaponeering and Stores Planning (WASP) program, flight and mission planning, emergency procedures, and other relevant mission tools to the Apple iPad scheduled to be implemented into the Fleet for what is referred to as the "Electronic Kneeboard."

DESCRIPTION: The Navy currently uses paper manuals, instructions, and documentation, as well as hand calculations, during flight to ensure mission success. Completing such tasks manually can be time consuming and, in some instances, may hinder mission success. It is projected that the F/A-18 Fleet will be outfitted with the "Electronic Kneeboard," or an electronic version of information that is traditionally on paper. This new approach to storing and presenting data to the pilot is going to be on the Apple iPad, a user-friendly hardware with which many pilots have familiarity. Moving mission planning, WASP, emergency procedures, approach charts, and other relevant mission tools is not, however, as simple as loading a word document onto the iPad. It is unreasonable to expect a pilot to know command-line coding and background programming language; therefore, proper windows, icons, menus, buttons, and more must be implemented seamlessly into the applications (apps) (i.e., software that operates on the iPad) [1]. Considerations for human-machine interfacing, cognitive capabilities, and situational awareness are lacking.

The development of useful apps, similar to those listed previously (e.g., WASP, flight and mission planning, emergency procedures), for the electronic kneeboard, and subsequently, a comprehensive, standardized application suite and software architecture that will be appealing and intuitive to the user is desired. This architecture should be modular, simple and extensible to the needs of the Navy fostering further application development within the Department of the Navy (DoN).

While developing the apps, plan the graphical user interface (GUI) in regard to the goal of each app (e.g., the number of "swipes" or "taps" that are required to access relevant information for the pilot) [1, 2]. For example, when searching for an emergency procedure, a pilot should be able to easily access the appropriate information very quickly and accurately. Cognitive psychology has greatly overlapped with GUI design in recent years – including considerations of perception, attention, memory, learning, and decision making [2]. Apps and software architecture development should include evidence of addressing these areas of study where applicable.

Performers should assess costs and benefits of different presentation parameters (e.g., luminance, tab/swipe, location of information) and limitations of the human psychomotor system - especially in the flight environment [3, 4, 5]. The final product should provide multiple apps that can be used in-flight and a framework that software developers within the DoN can develop, test, verify, and/or modify further app development.

This topic will remain unclassified throughout Phase I. Access to classified data will be required in Phase II in order to demonstrate the prototype. The Technical Point of Contact (TPOC) will work with the small business to obtain all clearances.

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: Develop one or more applications for the electronic kneeboard. Provide documentation that demonstrates the suitability of the design into military platforms performing operational flights. Conceptual framework for DoN software development, testing, verification, and/or modification is required as well in order to demonstrate feasibility. A proof-of-concept demo and supporting documentation to demonstrate thoroughness of planning for next phase should be provided along with a Technology Readiness Level (TRL)/Manufacturing Readiness Level (MRL) assessment.

PHASE II: Further develop the applications for testing in a relevant environment, and demonstrate performance in a simulated or actual flight environment. Ensure the programming framework for DoN application development is completed and ready for testing. During this phase, performer should engage appropriate PMA, PEO, and/or appropriate contract support via the TPOC to discuss options for in-flight test in Navy aircraft. If this is cost- or time-prohibitive, testing in commercial or private aircraft is acceptable. Tests during this phase should demonstrate the superiority of the applications compared to the standard paper kneeboard currently used. Feasibility of aircraft/fighter integration should also be demonstrated. TRL/MRL assessment should be updated.

PHASE III DUAL USE APPLICATIONS: Transition the application software and programming framework into the F/A-18 platform by providing the apps and framework to appropriate testing-and-evaluation (T&E) programs. Contacts described in Phase II should be aware of technology by Phase III and providing in-flight T&E during Phase III. Concurrent with in-flight T&E, performer should develop commercialization plans for the private sector. Many of these applications would be useful in the private sector as iPads have been implemented into civilian/commercial aviation as well. The standardized DoN framework is modifiable and applicable to the private sector. Private/commercial platform emergency procedures or platform specific documentation transitioned to application format could be commercialized as well.

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KEYWORDS: Electronic Kneeboard; Apple iPad; iOS; graphical user interface; cognitive psychology; software architecture

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

N161-017 TITLE: Efficient On-Aircraft Composite Repair Process Requiring Minimal Support Equipment

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: PMA 276 H-1 Helicopter Program Office

OBJECTIVE: Develop an efficient on-aircraft repair process, requiring minimal support equipment, for structural components made of organic-matrix composite materials that can restore structural capabilities of those components.

DESCRIPTION: Currently the Navy uses a Double Vacuum Debulk (DVD) process to repair damaged graphite/epoxy and fiberglass/epoxy composite components. This process works, however it only brings the component back to less than full strength. This process is done by impregnating dry fabric with resin, manually laying up the plies and debulking in a separate piece of support equipment. The debulked ply stack is then placed on the repair area and cured. This process, which limits the size of the repair, is expensive and creates logistical challenges when repairs are needed on aircraft in small detachments. A repair process is desired that provides repair patches of the same or better quality, but minimizes required support equipment and is less labor intensive.

The proposed process should minimize the amount of support equipment required to reduce the logistics requirement. The repair patch should be a bonded organic-matrix composite that can be cured on aircraft, requiring no fasteners. The total time required to prepare and cure the repair patch should be minimized, and is not to exceed 8 hours. The repair process must be able to cure composite laminates at least 0.120 inches thick while minimizing porosity of the part, and the repaired laminate must be able to pass specified ultrasonic attenuation threshold requirements to ensure the porosity of the part is below 4%. The process must be able to produce patch sizes at least 15 by 15 inches, and the ability to produce larger patches is desired. The process must accommodate repairs on parts with complex curvature and variable shapes. The process must work on a radius of curvature as small as 4 inches or less, be able to be performed on parts oriented vertically or horizontally, and be able to be performed on sandwich panel configurations as well as laminated skins typical of airframe construction. The repair materials must provide properties equivalent to or better than the current wet layup DVD process using AS4 carbon fiber and EA 9390 resin system. The materials used in this repair should minimize low temperature storage requirements (i.e. typical freezer-type requirements) and maximize shelf life, with a desired shelf life of one year when stored at room temperature. At no point in the process can the structure being repaired be exposed to temperatures greater than 275 degrees F, and the final repaired product must have a wet glass transition temperature of at least 230 degrees F. The repair process must be able to be performed in an uncontrolled environment, such as in an aircraft hangar or outdoors.

PHASE I: Design and determine the feasibility of a composite repair process that meets all of the topic criteria as discussed in the Description. Utilizing this proposed process and material, produce a flat panel that is a minimum of 15 by 15 inches and a minimum of 0.120 inches thick. This panel must be shown to pass an inspection that will verify the part has less than 4% porosity throughout. Provide initial substantiating data to show that the repair process can provide properties equivalent to or better than a DVD panel using AS4 carbon fiber and EA 9390 resin system.

PHASE II: Develop and demonstrate the prototype composite repair process to ensure the process provides repeatable, reliable repairs of sufficient quality (4% porosity) and equivalent to or better mechanical/physical properties. Fabricate specimens for mechanical and physical testing using the developed process. Fabricate demonstration panels of the geometries and orientations outlined in the Description. The testing must include a limited set of screening tests sufficient to ensure acceptable properties and process repeatability that is to be developed by the company and approved by the government. Deliver any required support equipment. Provide a business case analysis of the process showing the savings that can be achieved as compared to the current DVD process.

PHASE III DUAL USE APPLICATIONS: Complete mechanical coupon and element level testing sufficient to produce data to qualify the materials/process and determine material design allowable values for the use of the process. Complete an operational procedure to define all process requirements along with specifications detailing the requirements for all repair materials. Transition the repair process for Navy, fleet or commercial application use. This topic would apply to composite structures using a compatible material system that would need repair, including commercial aerospace applications along with any other commercial applications such as automotive or wind energy.

REFERENCES:
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KEYWORDS: Composite; Composite Repair; Structural Repair; aircraft repair; carbon fiber; on-aircraft

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

N161-018 TITLE: Physics-Based Maritime Target Classification and False Alarms Mitigation

TECHNOLOGY AREA(S): Air Platform, Sensors

ACQUISITION PROGRAM: PMA 299 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 5.4.c.(8) of the solicitation. 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 near real-time computationally efficient machine learning techniques to significantly improve classification performance of Inverse Synthetic Aperture Radar (ISAR) imagery Synthetic Aperture Radar (SAR) imagery and High Range Resolution (HRR) based maritime classification aids in the presence of vessels not resident in an existing classification database from returns.

DESCRIPTION: Improved maritime situational awareness is an ongoing Navy operational need. Current state of the art maritime classification aids using ISAR, SAR and HRR returns rely on extensive databases containing individual vessel dimensional information (i.e., length overall, superstructure(s) location and dimensions, mast(s) positions). When presented with vessels not in the database inability to classify or improper classification may result. In some instances the particular fine-class of vessel may be resident in the database but subtle variations of the topside configuration generate classification challenges. Here we seek to leverage the complex-valued radar returns from a limited number of viewing angles and knowledge of scattering physics of canonical shapes (e.g., point scatters, dihedrals, trihedrals, flash, multiple poles, etc.) to develop a physical description of the vessel suitable for inclusion in the classification database. The complex-valued radar returns should map directly into a description of surface feature such as edges, corners and gaps. The objective is to accomplish this task in near real-time using machine learning approaches capable of being hosted on legacy maritime radar systems (APY-10, APS-153, ZPY-4 or ZPY-3) which may have limited computing resources.

Prospective contractor(s) may need access to secure information in Phase II. 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 subcontractors 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: Contactors will develop concepts to leverage scattering physics to improve target detection and classification performance. Firms will demonstrate the feasibility of the concepts for technology development, target detection and classification improvement, and insertion in existing legacy APY-10, APS-153, ZPY-4 or ZPY-3 radar systems. The company should identify technical risks of their concept. The Phase I Option, if awarded, will include the initial design layout and a capabilities description to build into Phase II.

PHASE II: Using sponsor provided radar data collections, demonstrate the ability to generate vessel classification attributes suitable for inclusion in existing database structures. It is expected that the approach will provide classification attributes within 5% of actual value for 90% of combatant or non-combatant vessels with length overall greater or equal to 60m vessels which are completely illuminated, provide sufficient Doppler Resolution (5 pixels for a mast), SCR> 20dB and heading information accurate to 2 degrees. Based on the results of Phase I efforts and the Phase II Statement of Work (SOW), the company shall develop a prototype system to address the technical risks of their concepts. The company shall develop draft specifications for the different elements of the concept. The contractor shall provide details, including costs, on any modifications that might be needed for legacy radar systems to insert improved target detection and classification techniques into those radar systems. Conduct limited modification and tests in multiple maritime environments provided by the Navy to demonstrate performance with respect to intended use.

PHASE III DUAL USE APPLICATIONS: The company shall support the Navy in transitioning the technology to Navy use. The company shall develop specifications and first articles for concept unique elements and specifications for other concept elements which must have specific functionality to implement the end product. The firm will support the Navy in integrating the classification attribute generation approach [into selected legacy system in collaboration with the sponsoring agency. Coastal surveillance and air traffic control radar systems could leverage this technology for improved performance in the presence of non-cooperative contacts such as in port security systems.

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1. Hwang, J-K, Lin, K-Y, Chiu, Y-L, & Deng J-H, 2006, Automatic Target Recognition Based on High-Resolution Range Profiles with Unknown Circular Range Shift, Signal Processing and Information Technology, 2006 IEEE international Symposium, 283-288.

2. Bae, J., & Goodman, N.A.,2011, Automatic Target Recognition with Unknown Orientation and Adaptive Waveforms, Radar Conference (RADAR) 2011 IEEE, 1000-1005.

KEYWORDS: Maritime Surveillance; Signature matched; aspect matched; target classification; diverse waveform transmission; machine learning

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

N161-019 TITLE: Multi-Frequency Shock Survivable Fuze Components

TECHNOLOGY AREA(S): Electronics, Weapons

ACQUISITION PROGRAM: PMA 280, Tomahawk Weapons 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 5.4.c.(8) of the solicitation. 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 new technology for a system consisting of a firing switch, delay element and high voltage capacitors capable of surviving high amplitude and high frequency shock environments experienced in multi-warhead systems and during high speed penetration of hardened ship hull targets combined with the more traditional lower amplitude and frequency shock environment experienced during deeply buried target penetration.

DESCRIPTION: Current U.S. Navy anti-ship weapons use mechanically out-of-line fuzes with hot bridge wire detonators with fixed pyrotechnic functioning times, thus limiting their potential effectiveness and operational flexibility. The development of in-line fuzes with a firing switch, delay element and high voltage capacitors would increase overall weapon effectiveness against surface and land targets. There is potential for considerable advancement of the technology utilizing a firing switch, delay element and high voltage capacitors. While the U. S. Air Force has invested in hardened fuzing for prosecuting hard and deeply buried targets, the survivability of these systems in multi-warhead systems and anti-ship weapons may be difficult to achieve as they are vastly different environments. Pyroshock associated with multi-warhead systems is a complicated severe environment proven difficult to survive. Compounding the pyroshock environment with penetration of steel targets results in an environment that has its own set of requirements for performance and survivability.

Anti-ship warheads tend to be smaller than warheads for hard and deeply buried targets. In addition, ship hulls are typically steel rather than concrete. Unlike land targets, ship targets yaw and pitch depending on sea state, reducing the ability to control weapon impact obliquity. These factors will increase the peak acceleration and frequency of the shock transmitted to the firing switch, delay element and high voltage capacitors. In order to robustly prosecute ship targets, a firing switch, delay element and high voltage capacitors must be designed to survive ship penetration environments in addition to hard and deeply buried targets.

Current and anticipated DoD budget constraints increase the likelihood that new weapon systems and new payloads for existing weapon systems will be required to be effective against a wide variety of targets in order to reduce total ownership costs and maximize operational flexibility. The survivability of a firing switch, delay element and high voltage capacitors technology in delayed multi-warhead systems is high risk due to the demanding pyroshock and penetration environments. The ability to survive a notional shock response spectrum from 500 Hz to 100,000 Hz in the longitudinal, vertical and lateral directions with G levels between 4.00E+02 to 2.00E+05 and a maximum transient duration of 0.25 msec is desired.

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: Design and develop suitable technology concepts for a system consisting of a firing switch, delay element and high voltage capacitors that must survive severe shock environments. Model and/or demonstrate the concept's ability to survive the environments. Address risks for potential future development of concepts. Use notional shock spectrum provided in the Description. Additional information regarding shock spectrum will be provided by the government to assist in the further development of the concepts.

PHASE II: Manufacture a prototype based on the Phase I design, and develop new methodologies to test the newly developed hardware. Bench level testing to validate functionality of the design (such as fire capacitor charge time with min arm power voltage, fire capacitor charge time with max arm power voltage, voltage on fire capacitor, bleed down time of fire capacitor, electrical testing at ambient, -40C and 70C for the system between 24 to 34 Vdc.) should be performed before testing against a wide sweep of shock frequencies. The shock test should replicate as close as possible a notional shock response spectrum from 500 Hz to 100,000 Hz in the longitudinal, vertical and lateral directions with G levels between 4.00E+02 to 2.00E+05 and a maximum transient duration of 0.25 msec. Survivability of the hardware and functionality of the system as designed are the objectives of the testing. The hardware should remain powered through-out the shock event and function as intended.

PHASE III DUAL USE APPLICATIONS: Develop a full scale representative manufacturing and quality assurance process for the survivable firing switch, delay element and high voltage capacitors. Transition and integrate the finalized system to Tomahawk weapon system programs and platforms. The system developed could potentially be used for the mining industry or oil and gas industry where multiple delayed fuzes must survive the shock produced by the effects of earlier fuzes.

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1. Impact, Werner Goldsmith, ISBN: 0486420043, 9780486420042 Paperback; Mineola, New York: Dover Publications, November 1, 2001

2. Stress transients in solids. John S. Rinehart. ISBN-10: 0913270482. Published 1975 by HyperDynamics in Santa Fe, N.M

3. MIL-STD-1316E. DoD Design Criteria Standard; Fuze Design, Safety Criteria for (10 Jul 1998). http://everyspec.com/MIL-STD/MIL-STD-1300-1399/MIL-STD-1316E_2510/0

4. MIL-STD-331C. DoD Test Method Standard: Fuze and Fuze Components, Environmental and Performance Tests for (22 Jun 2009)

KEYWORDS: Shock Mitigation; Shock; Fuze; Electronic Safe and Arm Device; High Voltage Capacitor; Electronics

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

N161-020 TITLE: Human Computer Interfacing (HCI) for Autonomous Detect and Avoid (DAA) Systems on Unmanned Aircraft Systems (UAS)

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 262 Persistent Maritime Unmanned Aircraft Systems

OBJECTIVE: Develop and validate Human Computer Interfacing (HCI) for governing the interaction of autonomous Detect and Avoid (DAA) maneuvers and human-initiated inputs, creating a holistic DAA capability. This would include display format of conveying current and impending autonomous maneuvering information. The HCI developed as a result of this project could apply to future DAA algorithm validation for Group 3-5 fixed-wing unmanned aircraft systems (UAS).

DESCRIPTION: Detect and Avoid (DAA) capabilities are a mix of human-in-the-loop (HITL) and autonomous components. For UAS, likely requirements will include DAA systems that provide autonomous capability for last-resort collision avoidance. Currently, standards and designs do not exist for how these collision avoidance maneuvers (determined and executed by the unmanned aircraft (UA) without human input) will be governed with respect to other human-initiated inputs. This challenge is unique to UAS as the pilot and the algorithms are not co-located and as such, time delays exist.

There are several questions to be addressed with regard to these collision avoidance maneuvers. For example, during which scenarios do algorithm inputs take precedence over human inputs (including pilot abort option)? What information regarding UA algorithm "intent" (possible impending maneuvers) needs to be presented to the human? Should the human be provided with only the "best" (algorithm-decided) maneuver or with a range of all maneuvers that are projected to have acceptable outcomes? What role does the human have in accepting, rejecting, or overriding maneuvers determined by the UA? How is link latency mitigated? We must consider that human inputs are made using what the human understood at one point in time and the UA might currently have different information available. Also, possible UA "intended" maneuvers to be presented to the human could be outdated by the time the human views them. How do rules of precedence and intent change when command and control (C2) downlink and uplink is interrupted, or when the algorithm determines a maneuver is required and no time for the human to respond can be allotted?

Guidance will be solicited from Subject Matter Experts (SME) experienced in manned aircraft operational rule sets, UAS operation, pilot displays and design, human factors, and system safety. Surveys, or other instruments that leverage industry experience and solicit expert preferences, will be considered during guidance development.

The display parameters, such as encounter geometry and time delays, should be varied as to sufficiently cover a variety of conditions. One-way communication delays can be assumed to be between 2 and 5 seconds. Consideration should be given to displays which closely mimic the 2-D Traffic Alert and Collision Avoidance System (TCAS) displays used in manned aircraft.

Human performance measures, such as response latency and collision avoidance success rate, will be used to evaluate the HCI and the interaction of algorithm and human inputs.

The HCI should assume that DAA algorithm outputs are in the form of bank and pitch commands to the flight controls, and will also output a time until the maneuver needs to be executed.

This SBIR will develop HCI that when integrated as a holistic DAA design will enable UA platforms to operate in mixed use airspace, resulting in greater mission capability for future unmanned Naval aviation programs. This will reduce use of additional assets in accomplishing missions, enabling significant reductions in life-cycle cost through increased time-on-station with fewer requirements for support aircraft and procedures.

PHASE I: Develop HCI design covering all logical possibilities of autonomous versus human-initiated controls, as well as the design of displaying the intended and actual DAA-determined maneuvers.

Validate the design with pilot SMEs. Translate the design into algorithms (software) for laboratory simulations. Develop simple displays that show the encounter between the UA and the collision threat aircraft. Determine the most efficient manner for which to display recommendations and alerts to operators. Provide simple algorithm maneuver decisions that are displayed to the pilot.

PHASE II: Prepare design documentation (to include functional requirements and interfaces) and develop prototype software for the HCI. Demonstrate the HCI in a laboratory simulation. Include integration of existing DAA algorithms into HITL simulations of realistic collision avoidance scenarios. Phase II should result in a tested, TRL-6 software product with associated design documentation that shows promise for transition to acquisition.

PHASE III DUAL USE APPLICATIONS: Refine and validate the software implementation. Assist with transition of the final software application/suite into Navy (and/or other DoD agencies) systems. The HCI will interface with existing DAA algorithms on a Group 3-5 fixed-wing UAS and become part of the ground-based control station and airborne mission computer software. Integration will include software safety, system safety, and airworthiness evaluations common to military platforms. The Triton UAS may be the first platform to transition this software. The technologies developed in this SBIR are relevant to any other government agencies or private companies that operate or develop autonomous systems. While focused on UAS operation, the certification techniques developed in this project would also have applicability to autonomous ground, maritime and land-based air vehicles. Additionally, the test/demonstration techniques developed in this project would have direct relevance to the FAA's efforts to certify and integrate state and commercial unmanned systems into the National Airspace System

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1. Parasuraman, R., Sheridan, T. B., and Wickens, C. D. (2000). Fellow, IEEE: A Model for Types and Levels of Human Interaction with Automation. IEEE Transactions on Systems, Man, and Cyberkinetics-Part A: Systems and Humans, 30(3)

2. Parasuraman, R. & Riley, V. (1997). Humans and automation: Use, misuse, disuse, abuse. Human Factors: The Journal of the Human Factors and Ergonomics Society, 39(2), 230-253.

KEYWORDS: Airworthiness; Autonomy; Flight Control; Human Interface; Unmanned Aircraft (UA); Detect and Avoid (DAA)

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

N161-021 TITLE: Variable Amplitude Passive Aircraft Vibration and Noise Reduction

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 231 E-2D Advanced Hawkeye Program Office

OBJECTIVE: Develop an improved tuned vibration reduction solution for application to propeller excited high vibration levels in Navy turboprop aircraft.

DESCRIPTION: Many current and emerging Navy turboprop aircraft experience high vibration and noise levels in crew spaces. This results in crew fatigue and reduced work effectiveness, and is particularly objectionable in the E-2D aircraft. The addition of aerial refueling capability for the E-2D will significantly lengthen mission duration, making this vibration and noise level issue even more detrimental to crew effectiveness.

The key frequencies of the propellers are the first four blade pass frequencies. These frequencies are very stable over the entire flight envelope. Prior studies looked at tuned mass dampers (Ref 1) (TMDs) and tuned vibration absorbers (Ref 2) (TVAs), which have shown great promise to reduce tonal noise in such aircraft applications. Shock waves from turboprop blade tips impact the nearby fuselage structure and inject significant vibration energy into the aircraft structure at the blade pass frequency and harmonics. Navy aircraft structures have low vibration damping characteristics, as compared to commercial aircraft. There is also relatively little sound barrier and sound absorption treatment in military aircraft due to the weight and cost of such treatments. This vibration energy is able to pass through the fuselage structure and re-radiate into forward and aft crew spaces.

TMDs have shown promise in addressing particular fuselage vibration modes in commercial aircraft. Commercial turboprop aircraft typically operate with variable rotation speed propellers. The drawback of TMDs are that the spring elements, typically made from viscoelastic materials, change stiffness and damping properties, and therefore tuning frequency, very significantly with temperature. Temperatures in the interior of commercial aircraft are typically held within a narrow range. This is somewhat less true in military applications.

TVAs have shown promise in Navy turboprop aircraft vibration reduction applications. They typically have very stable, or invariant, frequency tuning, regardless of temperature and other atmospheric property variations. This is a most favorable property, since many Navy turboprop aircraft have very stable propeller turning rates over the flight envelope. A drawback of TVA use is that they tend to have a narrowly limited vibration amplitude range of application. Higher than design installed vibration levels can result in mass elements grounding out, or vibration behavior going non-linear, resulting in a loss of vibration reduction performance.

A vibration reduction treatment is desired, addressing the above stated design drawback to the current TVA vibration reduction solution. The developed TVA treatment concept should be capable of being “tuned” to a given attachment location, with a particular attachment location impedance, and baseline vibration level at a specified frequency of interest. The desired solution should maintain tuning frequency, but modulate TVA mass response amplitude, so that it does not respond in a nonlinear fashion or “ground out” by having the damper mass contact the TVA bracket, or the aircraft structure, and either damage it or lose effectiveness, at the range of responses seen at a particular attachment location.

Of primary interest is an innovative design approach to address this linearity and response amplitude limit issue, in such a way as to allow ready manufacture of one, or a small number of TVA models, to address a range of attachment location vibration properties.

PHASE I: Demonstrate vibration reduction effectiveness of TVA concepts on laboratory structures that show the above described design properties. A successful demonstration will show the following features.
A) Demonstrate a TVA concept(s) vibration reduction treatment that can be tuned to a stable, amplitude-independent response frequency (installed).
B) Demonstrate that the TVA concept(s) shows good vibration reduction over a large response dynamic range.
C) Demonstrate that the TVA concept will allow adjustment to change the allowable dynamic range.

PHASE II: Develop the TVA concept demonstrated in Phase I into a prototype vibration reduction treatment that can reasonably, and safely be mounted to an aircraft structure. Note that specific installation location concerns and possible attached aircraft structure durability concerns would exist with or without the improved TVA design changes of this SBIR topic. It is intended that these concerns would be addressed during the production damping treatment design phase, and are outside the scope of this effort. The successful prototype will demonstrate the following features:
A) Demonstrate pure tone vibration reduction effectiveness with simulated excitations on an aircraft structure provided by the Navy.
B) Demonstrate pure tone vibration reduction effectiveness of prototypes on an aircraft structure under representative propeller induced loading.
C) Demonstrate that the prototype is adjustable to the vibration dynamic range occurring at a number of attachment locations, with only minor “tuning” adjustment, but no parts changes.
D) Show that the design features of the TVA prototype(s) are likely to show good performance* over the very wide range of temperature and environmental conditions encountered by Navy military aircraft. Good performance would be that attachment of the prototype damper results in vibration of the base structure during test excitation that is not higher than response of the base structure when a traditional TVA is attached, measured at the design frequency, and has regions or conditions where base structure vibration is reduced as compared to a traditional TVA of similar properties.
E) What is reasonably safe? TVA prototypes must not require use of materials or design features that outgas harmful vapors, or that cannot be made durable enough for application to military aircraft in harsh operating conditions. Materials must be ones with stable properties over a 10 – 20 year life.

PHASE III DUAL USE APPLICATIONS: Finalize the most promising TVA prototype into a manufacturable vibration reduction solution suitable to be applied to US Navy turboprop aircraft. This is the culmination of the Phase I and II efforts into a transitioned product which will be further validated in operational testing conducted in this Phase III effort. TVA vibration reduction solutions that are found to be effective for US Navy aircraft applications are very likely to have other viable applications to DoD and commercial aircraft, ground vehicles and machinery damping applications. Commercial aircraft, vehicles and machinery with stable vibration frequencies would similarly benefit by a treatment that can reduce local vibration levels. Vibration affects durability of fragile parts, such as circuitry, and customer perception of quality.

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KEYWORDS: tuned vibration absorbers; tuned mass dampers; vibration reduction; passive dampers; Durability; Noise Control Technologies

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

N161-022 TITLE: Shaped Radome and Embedded Frequency Selective Surface Modeling for Large-Scale Platforms

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMA 290 Maritime Surveillance Aircraft

OBJECTIVE: Develop software tool(s) that accurately predicts on-platform electromagnetic interactions with realistic antenna radome covers, including those with an embedded frequency selective surface (FSS).

DESCRIPTION: Depending on their design, protective and aerodynamic radome covers can have a significant impact on the installed radiation patterns of the antenna(s) behind them, which is usually deleterious to the application supported by the antenna. This important fact must be considered when new or upgraded antenna systems supporting applications such as high-bandwidth data links, electronic attack (EA), non-cooperative target identification, anti-jamming capability, etc., are being planned for integration under a radome with a new or existing platform. For example, multi-bounce interactions between the antenna and the radome or between different parts of the radome can produce secondary beams and raise sidelobe levels. In addition, radomes can modify an airframe's radar signature and distort the signature contribution of structures behind them. Furthermore, radomes sometime embed a frequency-selective surface (FSS) layer to filter electromagnetic waves as they pass through their cover. The design of a FSS, combined with the FSS's conformity to the radome shape, frequently leads to cross-polarization effects and grating lobes that affect radar signatures and installed radiation patterns in complex ways.

Current state-of-the-art tools based on ray-tracing techniques are available for predicting installed antenna performance and radar signatures on electrically large airframes (UHF and above) described by realistic 3-D CAD models; however, , their material modeling capabilities, (based on tables of reflection and transmission coefficients for thin dielectric layers), are too simple to accurately model the impact of radomes. For example, the thickness of each radome varies continuously across the radome, requiring a finely grained stair stepping of separate coating tables to capture this variation, and this is extremely difficult to configure in practice. In the case of a FSS radome, the FSS and surrounding radome layers can be simulated as a planar periodic structure to build the table(s) of coefficients. This approach, however, loses important phenomenology, such as distortion and truncation of the FSS lattice when applied to the actual radome structure. Further, such tables must strip out any information about cross-polarization scattering and grating lobes generated by the planar FSS simulation code because the ray-tracing codes are powerless to exploit this information, at least in current practice. Often, the problem boils down to insufficient geometric characterization, since exploiting this additional information requires knowledge of how the FSS elements are oriented within the radome and somehow communicating this to the ray-tracing code.

An innovative approach is needed to modeling radomes and FSS radomes in ray-tracing codes that can account for variable thickness, cross-polarization, grating lobes, and other higher-order effects. This approach must be able to exploit detailed information generated by rigorous simulation of the periodic FSS structure, and do so in such a way that can properly account for deformation and truncation of the FSS lattice when applied to realistic radome shapes.

Successful applicants will demonstrate access to mature and proven ray-tracing technology for solving installed antenna and radar signature problems on general high-resolution structures, particularly large-scale airframes, including the rights to modify these tools, in order to eventually integrate the new algorithms. As part of the solution, the tool user must be able to visualize the radome and its deformed FSS lattice within the Graphical User Interface (GUI), and the user must have simple controls for adjusting the deformation and truncation details. It is also important that such modeling and visualization capability be incorporated in a proven and mature ray-tracing tool that can solve general-purpose installed antenna and radar signature problems on realistic airframe CAD models. The capability must be able to handle problems of antennas and arrays located behind radomes while capturing interactions with the rest of the platform.

PHASE I: Develop and demonstrate asymptotic ray-tracing algorithms for modeling radomes of continuously varying thickness, with and without FSS layers, that address the modeling deficiencies. Identify an existing FSS code or full-wave solver that is well suited to provide higher-order effects data on the FSS to feed these new algorithms. Demonstrate that the new algorithms can exploit these higher-order outputs, such as cross-polarization scattering coefficients and additional propagating modes (i.e., grating lobes). Cross-validate these new algorithms with explicit, full-wave solutions on suitably scaled problems while additionally demonstrating how these new techniques could be integrated with these tools to solve the large-scale problem (e.g., radomes positioned in front of an antenna and attached to a full-scale aircraft).

PHASE II: Develop a prototype tool or tools for predicting radiation patterns of antennas/arrays behind radomes and their radar signatures. The tool(s) should interface to a functioning FSS code or full-wave solver for simulating the planar periodic lattice and that is delivered with the tool(s). Implement the tool(s) with a GUI for problem setup. The GUI design should emphasize ease-of-use in the context of configuring and visualizing arbitrary radome shapes. Also develop and implement an algorithm within the same tool(s) for conforming an FSS lattice to the radome. The tool should provide simple controls for adjusting the deformation and truncation of the FSS lattice while providing 3-D visual feedback on the conformed lattice.

PHASE III DUAL USE APPLICATIONS: Integrate the FSS/radome simulation capability developed in Phase II with a robust ray-tracing tool(s) for predicting installed radiation patterns and radar signatures of general 3D structures described by high-fidelity CAD models. The integrated tool(s) should support simulations of realistic airframes with one or more antennas or arrays located behind radomes. The technology developed under this topic will provide significant modeling-and-simulation benefits to a variety of commercial and military applications wherever antennas and arrays are installed behind radomes on platforms, including aircraft, ships, spacecraft, and fixed installations. The resulting tool(s) will also be invaluable in advanced radome and FSS radome design.

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KEYWORDS: Modeling And Simulation; Antenna; Computational Electromagnetics; Radar Signature; Radome; Frequency Selective Surface

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

N161-023 TITLE: Sinking Hose System for Amphibious Bulk Liquid Transfer System (ABLTS)

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

ACQUISITION PROGRAM: Amphibious Bulk Liquid Transfer System (ABLTS): non ACAT program

OBJECTIVE: Develop a new submersible hose system for the Amphibious Bulk Liquid Transfer System (ABLTS). When not in use, the hose must be stowed-flat on a hose-reel similar to ABLTS. Once deployed and full of the working fluid, the specific gravity of the hose must make it negatively buoyant, causing it to sink and rest on the seafloor.

DESCRIPTION: The current ABLTS hose is buoyant, made of synthetic yarns that are circular woven and encapsulated in an elastomeric polyurethane lining and cover. A series of clump-weights and mooring lines are installed along the length of the hose to keep it in position as it floats on the surface. Hoses on the surface are readily susceptible to damage via surface-craft, ocean currents and weather conditions. This results in considerable cost for hose replacements and patches, a continual risk of fuel spillage, an Anti-Terrorism/Force Protection (AT/FP) target for sabotage and a subsequent reduction in the long-term operational availability of the system.

A sub-surface hose design is sought for the ABLTS system. This hose must be collapsible and expeditionary for flat stowage and deployment off a hose-reel, similar to the existing ABLTS. Once deployed, the hose must sink to the seafloor, where it shall remain until operations are concluded (up to 365-days). It's important to note that the near-shore environment in which the fuel system must be deployed and maintained causes stresses on the hose. The presence of currents causes line pull loads on anchor points where the hose is secured (stabilized) to the seafloor. The surf zone will cause any bottom-laid and unburied hoses to abrade. Note that hoses are not routinely anchored nor buried in the surf due to safety concerns for the personnel setting the anchors and the difficulty retrieving the anchors.

Hoses should be designed for man-handling, manufacturing feasibility, and durability. Current ABLTS hoses weigh 3 pounds per linear foot, and collapse readily without causing damage. While a lie-flat sinking-hose option can be heavier, every effort should be made to achieve a balance between affordability and weight. Current lie-flat ABLTS hose costs approximately $12 per foot.

The specifications of the proposed hose solution, when developed into a working system, should meet the following logistics foot print and capability:

The hose must be affordably producible with use of existing manufacturing infrastructure. Hose should be available in similar lengths and diameters to the existing ABLTS fuel-hose (5,000-ft, 6in diameter). The hose line pull strength must be no less than 15,000-lbs. Minimum hose burst pressure must be 1,200 psi. Optimal working pressure is approximately 600 psi.

For transportability offshore, as well as ease of assembly, the system should be contained in the existing standard ABLTS hose-reel. The hose and its associated connectors must be able to be setup and deployed within 8 hours. Innovative concepts for hose deployment would be of interest. Current footprint on MSC ships is considered maximum allowable due to space constraints on deployment assets.

PHASE I: Determine feasibility of developing a flexible, collapsible hose that will sink in seawater when full of fuel or water. Provide calculations and design plans for fabrication of a relevant length of working prototype hose. Computer models of hydrodynamics induced on the hose due to surge, wave, or currents as it interacts with the seafloor are desired. Laboratory scale demonstration would be desirable but not required as a Phase I deliverable.

PHASE II: Fabricate and demonstrate a fully functioning lay-flat hose prototype, with demonstrable negative buoyancy in seawater using JP-8 fuel. Tests should demonstrate in-water weight and wear effects induced by hydrodynamics shown in Phase I. Prototype shall be demonstrated in basic offshore test.

PHASE III DUAL USE APPLICATIONS: Based on the results of Phase II, the small business will manufacture a full-length hose (5,000-ft) system for Navy use in an operationally relevant environment. The small business will support the Navy with testing and validation of the hose to certify and qualify it for Navy use. Simple system operation and maintenance will also be considered in evaluating possible wider DoD implementation. The solicited technology will be applicable to larger Humanitarian Aid, Disaster Relief situations, as well as for oil-field applications.

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KEYWORDS: Fuel hose; negative bouncy; collapsible hose; expeditionary; hose reel; sinkable; sea state 4

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

N161-024 TITLE: Ruggedized, Condition-Based Maintenance for Vacuum Insulation Systems

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS320, Electric Ships Office; PMS501 Littoral Combat Ship 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 5.4.c.(8) of the solicitation. 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 small-scale vacuum maintenance device for use in Navy cryogenic and superconducting applications.

DESCRIPTION: The demand for lightweight, high current density (gravimetric and volumetric) electrical power architecture is driving development of key superconducting technologies including motors, generators, power cables, and degaussing cables. All of these technologies rely on a vacuum insulation system to minimize heat leak into the cryogenic space. A vacuum will degrade over time due to outgassing of materials from thermal cycling and to slow losses of vacuum pressure. As the vacuum degrades, the performance of Multi-Layer Insulation decreases and higher heat leak into the cryogenic system occurs. The result is either the inability to maintain the cryogenic environment (thereby reducing the superconducting state), or the cryogenic system output needs to be increased to keep up with the higher heat load.

The Navy is currently considering the use of distributed high temperature superconducting (HTS) systems such as HTS degaussing (Ref. 1), HTS motors and generators, or HTS power distribution systems. These systems contain cryogenic spaces insulated with multi-layer insulation (MLI) and held to deep vacuum levels of 1x10-4 torr or better. The vacuum space in the cryostat is a necessary part of the thermal insulation solution that minimizes the heat transfer between the volume containing the cryogenic fluid and atmospheric temperatures. Maintaining this deep vacuum level in the cryostats is essential to the operation of these systems. As the vacuum degrades over time, the reduction in insulation increases the heat load to the system thereby putting additional strain on the limited available cryogenic cooling. This increase in the heat load to the cryogenic system will cause an increase in the operating temperature of the entire system and will decrease the performance of the superconductor.

During the course of normal operations, shipboard systems will be powered down. This will result in periodic thermal cycling which will release cryo-pumped contaminants. These natural warming cycles will degrade the vacuum further, leading to additional heat loads if not pumped out. Over time, materials in the vacuum space naturally outgas, requiring the need for gettering material to trap the released contaminants and manage the rate of outgassing. Typically, vacuum spaces are periodically maintained by manual intervention every 5-10 years for each vacuum space. This maintenance can be eliminated through the integration of an autonomous vacuum system. A cost avoidance of up to $550K per ship can be realized over the designed 30-year life of each ship by incorporating the vacuum maintenance system. The integration of this component will also increase damage tolerance of the system through active pumping; an approach commonly used to manage small vacuum leaks in vacuum insulated systems and still achieve the highest level of system efficiency. A ruggedized, periodically activated, vacuum maintenance system that maintains a high vacuum level in the cryostat and increases the mean-time between maintenance (MTBM), will reduce the total ownership cost of HTS systems.

Current state of the art technologies incorporate ion pumping technology, turbomolecular pumps (Ref. 2 and 3), and getter materials to obtain and maintain vacuum levels. The Navy is looking for a novel device using any of these or similar technologies to periodically pump or maintain the vacuum to an acceptable level of 1x10-4 torr over a 30 year ship life. The device needs to be capable of sensing degradation in the vacuum level of a system and activate the compact vacuum system when the vacuum level is greater 1x10-3 torr. The vacuum system must be able to pull vacuum down from 1x10-1 torr to 1x10-6 torr, and will discharge to atmospheric pressures (foreline pressure = 760 torr). The vacuum system must connect to a cryostat and be easily installed or replaced. The vacuum space must not lose vacuum pressure if the pump experiences a loss of power or if the pump is in a standby mode. In addition, the vacuum pump must be small (approximate volume of 35in3, or 3”diameterby 5”long) and lightweight (about 2-5 lbs. or less). Given the environment, the vacuum pump must be immune to electromagnetic interference (EMI), and should be rugged in order to handle a shipboard environment. Any proposed solution must be designed to survive shock and vibration qualification testing by the Navy. Finally, the vacuum pump must be affordable ($1,000 - $2,000) since there will be 50-100 units per ship for a full ship degaussing system.

PHASE I: The company will develop a concept for a small-scale vacuum maintenance device for use in Navy cryogenic and superconducting applications. They must demonstrate the feasibility of a novel vacuum pump to operate with Navy cryogenic systems as defined in the description. The company will perform bench top experimentation, where applicable, as a means of demonstrating the identified concept and establish validation goals and metrics to analyze the feasibility of the proposed solution. The Phase I final report shall capture the technical feasibility and economic viability for the proposed concept that can be matured further if awarded a Phase II. The Phase I Option, if awarded, will include an initial layout and capabilities description to build the prototype in Phase II.

PHASE II: The company will develop, fabricate, and demonstrate a small-scale vacuum maintenance device prototype based on the work conducted in Phase I and the Phase II Statement of Work (SOW). In the company’s laboratory environment, they will demonstrate that the prototype meets the performance goals established in Phase I and the Phase II SOW. The final prototype operation will be verified in a representative laboratory environment and results provided and evaluated. A cost benefit analysis and a Phase III installation, testing, and validation plan will be developed. Based on lessons learned in Phase II through the prototype demonstration, a substantially complete design of a vacuum pumping system should be completed and delivered that would be expected to pass Navy qualification testing.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the small-scale vacuum maintenance device technology for Navy use onboard ship. This includes teaming with appropriate industry partners to provide system integration and to provide a fully qualified vacuum pump. A reliable small-scale vacuum pump may be of use in land based HTS power cables and power delivery applications. When land based HTS power cables transition from R&D projects to commercial installations, maintaining vacuum levels will help lower the maintenance of the system alleviating the need for repeated vacuum processing.

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KEYWORDS: Vacuum pump for superconducting systems; getter materials; superconductor; cryostat; high-temperature superconductor (HTS); vacuum maintenance of cryogenic systems

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

N161-025 TITLE: Digital Early Warning Receiver (EWR) for the Next Generation Submarine Electronic Warfare (EW)

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 435, Submarine Electromagnetic Systems; SIRFSUP 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 5.4.c.(8) of the solicitation. 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 Early Warning Receiver (EWR) for the Next Generation Submarine Electronic Warfare (EW) Suite.

DESCRIPTION: The Navy uses undersea platforms in many applications where covert, extended persistence is required. The next generation of submarine EW is developing a framework that distributes digital data products to reconfigurable data consumers. The current Early Warning Receivers (EWR) on submarines do not fit this architecture. The submarine fleet is looking for a digital EWR that will provide digital data products to the control room, the Electronic Support (ES) room, and the AN/BLQ-10B (V) electronic warfare system.

The EWR is a critical component in the submarines sensor suite and is considered a "safety of ship" item. It is imperative that it works at all cost. Currently, the EWRs on submarines are crystal video detectors. They are very dependable and rugged, but there are significant problems with these types of receivers. Some of these issues include an inability to report to operators any signals outside of the audible range of humans, inability to identify complex intrapulse modulations, inability to identify/display complex emitter patterns, and many others.

The digital EWR has to exhibit tremendous sensitivity (less than ~70 decibels or below 1 milliwatt (dBm) in a 1 GHz instantaneous bandwidth) and multi-tone Spur Free Dynamic Range (greater than 70 decibel (dB) in a 1 GHz instantaneous bandwidth). The digital EW receiver has to operate in extremely dense environments (greater than 5 million pulses per second) and provide Pulse Descriptor Words (PDWs) for every detected pulse to a high-speed network (currently 40 gig-ethernet, moving to a 100 gig-ethernet). The digital EW receiver has to operate in environments with strong continuous wave (CW) interferers without being captured and has to operate with different mast inputs for the RF sources. The digital EW receiver has to operate over an RF range of 250 MHz to 20 GHz and be scalable upward in 20 GHz sections.

Currently, the submarine force has introduced very capable EW receivers that are much more effective against the higher Pulse Repetition Frequency (PRF), lower power emissions of today, but they do not fit into the Next Generation Submarine EW Architecture. The new, digital EW receivers need to provide digital data products for other consumers to utilize. Currently, the receivers are self-contained boxes that drive displays and speakers.

With submarines moving to all-digital data products (sonar has ARCI, combat control is moving to Any Display Anywhere, and Electronic Support Measure (ESM) is moving to the Next Generation Architecture for sub EW) the need to get the EW receiver into this digital availability is crucial. By moving EWR to digital data products, the Navy can save money and maintenance by utilizing existing display surfaces instead of adding their own.

The Phase II and Phase III effort will 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.

PHASE I: The company will design and demonstrate, through simulation or limited lab testing, the feasibility for developing a modular, digital Early Warning receiver concept that meets the requirements stated in the Description section. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop a digital Early Warning receiver prototype for the candidate system developed in Phase I. The company will develop and refine RF processing and digital data generation, perform bench level lab experiments to demonstrate performance, and demonstrate this capability in a representative form factor as a minimum. Companies participating in Phase II will be required to prepare a plan to transition the technology to the Navy under Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the digital Early Warning system to the AN/BLQ-10B (V) program of record through PMS435 Submarine Electromagnetic Systems program office. A modular digital EW receiver to significantly improve submarine survivability in the future through the ability of making the digital data products (representing the RF spectrum) available to any display will significantly improve submarine situational awareness. The option of digital EW receiver technology should prove useful in many applications. The more specific digital EW receiver has applicability to homeland defense, law enforcement, and private-security systems.

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KEYWORDS: Electronic Warfare; digital signal processing; Submarine next generation EW architecture; early warning receivers; Doppler radar signals, High PRF radar systems

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

N161-026 TITLE: Fault Current Limiting (FCL) Distribution Cable

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320, Electric Ships 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 5.4.c.(8) of the solicitation. 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 inherently fault current limiting cable topology for DC or AC distribution systems that immediately reacts to fault conditions and is suitable for shipboard use.

DESCRIPTION: Future ship classes are expected to continue to trend toward a fully Integrated Power System (IPS), which will optimize and leverage installed electrical generation to meet the high power demand of future loads. The anticipated propulsion load is expected to fall within the range of 20-80 MW and will be driven by installed electrical power generation ranging from 10-40 MW per generator set. Other future high power loads will include rail guns, lasers, and high power radars. The ability to distribute this amount of power in an IPS requires increased distribution power densities across all components of the power system including fault protection systems as well as the conductor carrying the electrical power. Limiting fault currents and clearing or isolating fault sources is required in an IPS to quickly recover to an operational state. High temperature superconductors (HTS) are an ideal candidate technology area to increase volumetric and gravimetric power distribution densities in the conductor while having the ability to provide fault current limiting capability. Currently, there is only one HTS FCL cable installed in the US at the ConEd Utility in NYC. Any offerors of a solution to this topic will not be expected to build off of ConEd Utilitys work.

HTS power cables are a mature technology and verified through many land based demonstrations including multiple in-grid installations. A few of these demonstrations have included fault current limiting capabilities within the HTS cable design. Land based HTS power cables do not have the degree of size, weight, safety, and energy efficiency demanded by naval applications and they require large cryogenic cooling solutions and cable terminations. All land-based demonstrations have used liquid nitrogen as the cryogen, which provided key dielectric properties as well as a large thermal mass useful in stabilizing HTS conductor temperatures. Due to safety and logistic requirements, the use of liquid nitrogen in naval superconducting systems has not been considered a viable option for shipboard HTS applications. Prior work in using HTS in a Navy degaussing application has used gaseous helium (GHe) as the cryogen which eliminates asphyxiation concerns in the event of a catastrophic cable breach and enables complete cryogen containment when warmed up to room temperature. Similar considerations are required for a fault current limiting HTS (FCL-HTS) cable. The challenges of using GHe in power cables are further exacerbated by including the FCL characteristics, which may force the use of a liquid cryogen. If this path is taken, logistic and safety concerns must be addressed including proper cryogen containment or proper venting off board the ship.

Developing a FCL cable for the Navy that is scalable from 20-100m requires novel solutions. Proposed solutions should consider the ability to limit fault currents instantaneously in either an AC or DC cable configuration as well as manage the logistical and safety challenges associated with cryogen containment specific to the Navy's use of the technology. The FCL cable should have an instantaneous recovery time once the fault has been isolated or cleared. Deviations from the instantaneous limiting and clearing characteristics of the cables shall be clearly identified in the proposal. Scalable solutions are desired with anticipated full scale FCL cables having a nominal rating on the order of 1-8 kA with voltages levels on the order of 1-18 kV. The Navy will work with the company to test and certify the FCL cables for Navy use.

A future DC distribution system having a cable that can also function to protect itself will enable a more affordable system that increases performance over existing distribution systems and can limit the amount of equipment onboard ships. Production cost of the cable should be approximately $3-6K per meter of HTS FCL wire for the highest capacity. The cost of the terminations, cryogenic system, containment, and ventilation will result in additional cost that is not strongly correlated to the per meter cost. Since this is an advanced technology that has not yet been fielded, cost may vary widely with design and conductor choice. The inherent fault current limiting capability of this cable reduces the burden placed on power conversion equipment to handle excessive currents allowing the conversion equipment to be smaller and cost less. This will lead to a distribution system potentially lighter and more affordable over the life of a ship.

PHASE I: The company will develop a concept and demonstrate the feasibility of a novel fault current limiting cable design that meets the needs of the Navy as defined in the description. The company will identify the technical feasibility of the proposed concept and demonstrate the concept through modeling, analysis, and bench top experimentation where appropriate. The Phase I final report shall capture the technical feasibility and estimated production costs for the proposed concept that can be matured further if awarded a Phase II. The Phase I Option, if awarded, should include a layout of the initial design and list of capabilities.

PHASE II: The company will develop and fabricate a prototype fault current limiting cable based on the Phase I work and Phase II Statement of Work (SOW) for demonstration and characterization of key parameters and objectives. The FCL prototype shall be designed for rated voltage and tested demonstrating the current limiting characteristics at a reduced scale voltage. Dielectric integrity of the FCL cable must be demonstrated in a normal operation state as well as in the current limiting state by appropriate means. The Phase II prototype FCL cable shall be delivered to the Navy for further performance testing. Based on lessons learned in Phase II through the prototype demonstration, a substantially complete design of a FCL cable system will be completed with updated drawings that would be expected to pass Navy qualification testing.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the technology for Navy use. This includes market research, analysis, and integration with appropriate industry partners to stand up production level manufacturing capabilities and to provide a fully qualified FCL cable. The FCL is expected to transition to the Electric Ship Office for incorporation into shipboard power systems. The company shall develop manufacturing plans to facilitate transition to the Navy. HTS power cables have wide spread application in land based electric grid applications. Electric utilities are currently assessing the technology as a means to increase distribution capacity in fixed volume infrastructure. Additionally, high power computing applications such as data centers have interest in the current density that HTS cables can provide. All of these applications require fault current limiting capabilities.

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KEYWORDS: HTS cable; fault current limiting; high temperature superconducting; cryogenic cooling solutions; gravimetric power distribution; superconducting

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

N161-027 TITLE: Shallow Water Communications for Mine Warfare

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS495, Mine Warfare Program Office – Mine Improvements 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 5.4.c.(8) of the solicitation. 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 secure communication capability for Navy mine warfare systems to enable two-way remote command and control of a minefield deployed across the hostile littoral environments.

DESCRIPTION: Underwater communication technologies for mine warfare applications need improved performance in order to be operationally useful for commanding and controlling a minefield; in particular, reduced power consumption, increased range, and more reliable data reception and transmission in a littoral environment. Reduction of power consumption of at least 15% and/or increased range of at least 25%, when compared to existing commercial-off-the-shelf (COTS) acoustic modems is desirable. Effective command and control of mine warfare systems requires two-way communication with reliable data transmission and reception over a range of 1000+ meters. Data is expected to consist of simple commands and confirmation signals, using Low Probability of Detection (LPD) and Low Probability of Intercept (LPI) techniques with standard encryption protocols to prevent interception or spoofing.

The objective of this topic is to develop an innovative, secure wireless communications technology for use on mine warfare systems to enable command and control in the hostile littoral environments. This technology will enable warfighters too remotely “turn on,” “turn off,” and/or reprogram the targeting logic of the minefield to respond to mission needs. Additionally, this could be used to remotely terminate a minefield after hostilities have ceased, saving significant cost and labor typically required to clear minefields. The desired solution is a receiver/transmitter, including any required signal processing, that is able to receive a signal from a remotely located, underwater command source and transmit a confirmation signal and system status back to the original source. Lifecycle costs will be reduced up to $100k per mine deployed by allowing remote termination of a minefield, which is typically very expensive and time consuming to clear and is required by international law after hostilities have ended.

A variety of underwater communications technologies exist for a variety of applications, including cabled networks and wireless communications. For the intended application, only wireless communication is operationally useful. Potential modes of communication include acoustic, optical, seismic, electromagnetic, or a combination of modes. Acoustic communication is one of the most common underwater communication technologies. However, in a littoral environment acoustic communication is far more difficult due to unfavorable signal to noise ratio (Ref. 1). Additionally, waves, bubbles, and wind noise increase ambient noise and affect sound propagation and attenuation that adversely affect acoustic communication (Ref. 2). A proposed solution to this problem is to increase the signal amplitude; however, this requires increased power.

Magnetic inductive communication has been demonstrated in a relevant environment; however, the signal is exponentially reduced as range increases making two-way transmission over the desired distances difficult (Ref. 3). The system should include involved innovative signal processing and multi-modal transmission and reception methods, including both hardware and software, in order to achieve the desired performance.

PHASE I: During Phase I the company shall complete a preliminary design for the proposed communication system which optimizes range between nodes while minimizing power consumption . The design should include details and tradeoffs on network topology, spacing between nodes, system hardware, data rates, power requirements, and software architecture. Key components and expected performance shall be specified. A systems analysis shall provide convincing evidence of the feasibility of the design. The Phase I Option, if awarded, should include the initial layout and capabilities description to build the prototype in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop and fabricate a fully capable prototype communications system that meets the Navy's requirements as discussed in the Description. The company will demonstrate in a laboratory setting that performance metrics can be achieved and test and verify the prototype under a representative littoral environment. A cost benefit analysis and a Phase III transition plan will be developed. Evaluation results will be used to refine the prototype into an initial design that will be delivered and meets Navy requirements per SOW. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the technology to the Mine Improvements Weapons (MIW) program. Based on successful completion of Phase II, this product will be integrated into a remote command and control capability for naval mines. The company will support integration and validation efforts through in-water testing on inert mines which will be functionally representative, as well as supporting qualification through the Fuze and Initiator System Technical Review Panel (FISTRP), Software System Safety Technical Review Panel (SSSTRP), and Weapon System and Explosives Safety Review Board (WSESRB). The deliverables for Phase III include engineering design models to support in-water testing and design documentation in a technical data package (TDP) which will be a component of a larger production effort for the entire MIW system. This technology is directly applicable to the geophysical exploration of the ocean for oil, methane hydrates, gas, and other natural resources and the undersea pipelines and cable laying industry.

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3. Sojdehei, J.J. "Magneto-Inductive Communication Demonstration Report," CSS/RD-00/13, July 2000.

KEYWORDS: Signal processing; littoral environment; mine warfare; underwater communication; low power data transmission; improved signal to noise ratio.

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

N161-029 TITLE: Shipboard Cabling using Rugged Wavelength Division Multiplexing

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, AEGIS Integrated Combat System.

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 5.4.c.(8) of the solicitation. 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 robust shipboard cabling solution using Rugged Wavelength Division Multiplexing (RWDM)

DESCRIPTION: Current shipboard communications cabling is comprised mostly of large, heavy copper cable which is costly to procure and expensive to run throughout the ship. Additionally, the complexity of installing connectors between systems significantly drives production costs higher. Operationally speaking, legacy communications systems have difficulty handling digital data signals associated with newer technologies. This requires larger and a greater number of cables to support capability improvements. Systems maintenance then requires additional materials and components, which exacerbates the issues. Wavelength Division Multiplexing (WDM) is an alternative approach to data transfer which converts digital/analog data signals to optical signals of varying wavelengths of light which are then combined and transmitted through a single optical fiber. This signal conversion and data multiplexing enables bidirectional communications over one fiber strand and exponentially increases the data transmission capacity of the networked system. The telecommunications industry has been using WDM for many years, however, signal conversion is limited to ethernet signal processing and does not address the wide spectrum of Navy data inputs that would require optical conversion in order to implement fiber optic cables and/or WDM conversion technology solutions. Using Rugged Wavelength Division Multiplexing (RWDM) with a modular architecture to support conversion of multiple data source types will provide for elimination of legacy problems by allowing for fewer cables with higher capacity and fewer specialty connections. RWDM allows for a more cost effective installation of lightweight fiber optic cables because it addresses the conversion of all of the Navy's data sources and supports more reliable and efficient data transfer.

The Navy shipboard communications network is an arrangement of data inputs, user consoles, converters, adapters, and radio terminals interconnected with high-speed, general-purpose computers and programs. These include but are not limited to Navy Tactical Data System (Ref. 1), serial links, ethernet, general purpose input/output (I/O), and video (High-Definition Multimedia Interface (HDMI)/Digital Video Interface (DVI)) components. Combat data is collected, processed, and composed into a picture of the overall tactical situation that enables the force commander to make rapid and accurate evaluations and decisions. These systems are laden with communications occurring over numerous and diverse links using a wide range of protocols where each link requires unique cabling solutions between subscribers and clients. Many shipboard cabling solutions are expensive, heavy, large, and consume Size, Weight and Power (SWaP) allocations of the ship. These diverse designs require complex connectors that are labor intensive to install and increase installation costs. As data processing technology evolves, legacy point-to-point links using analog components must still be able to interface with newer digital system elements (Ref. 2) which require signal converters to integrate and process data. Commercial technology is unable to provide analog to digital data conversion for the Navy Tactical Data System and has a very limited ability to convert the diverse range of Navy shipboard communication network data inputs for processing in a RWDM environment. Advanced sensors and radars are driving increases in data transmission requirements in order to capture the operational effectiveness of the new system elements. Within this hybrid system of digital and analog signaling, the latency of internet protocol (IP) based interfaces, especially for information that is encoded or decoded, is not ideal due to signal conversion deficiencies associated with current technology such as remote video encoders. Secured and unsecured information distribution is limited due to link and protocol restrictions. To overcome these many limitations, an innovative prototype system that provides a more robust cabling and data conversion solution to multiplex and distribute signal-processing requirements is essential.

An innovative prototype system that ruggedizes wavelength division multiplexing to distribute all platform communications over Electromagnetic Interference (EMI) / ground loop immune fiber (Ref. 3) is crucial where each link has a unique wavelength that provides interference free distribution. This system should integrate with existing hardware without creating additional or complex installation requirements or procedures. The three current copper cable types (Parallel A, Parallel B, and Low Level Serial E/D) should be replaced with a fiber optic cable capable of multi-channel data transmission with rates in excess of 10 gigabits per second. This cable type/size reduction should result in at least a 70% reduction in the system weight of shipboard cabling while still enabling communication link redundancy. The solution should provide for establishing secure links through data encryption at entry and exit points (Ref. 4). Sample links to multiplex include but are not limited to Ethernet, NTDS, Video, time distribution (IRIG-B, NTP or PTP), GPIO, and RS-232, and RS-485 serial connection ports (R.ef 4). Latency-free distribution of video and audio throughout the ship is necessary to provide real time fidelity to the Navy personnel when reacting to live video from cameras.

This RWDM system will increase mission capability by allowing for additional sensors, tactical displays, and consoles to be incorporated into the AEGIS Weapons System. The addition of more equipment is possible because RWDM technology enables a more reliable transfer mechanism through fiber optic cabling with increased data transfer rates and volume. Reduction in legacy copper cabling reduces both acquisition cost and system weight. RWDM technology allows for the optimization of electronic components within combat system cabinets enabling system redundancy in fewer electronics cabinets. This reduces overall system acquisition and maintenance cost and improves overall system reliability and performance.

PHASE I: During Phase I, the company will show the feasibility of developing a robust shipboard cabling solution to migrate Navy communication infrastructure to Wavelength Division Multiplexing (WDM). Phase I concepts will be developed to provide the necessary architecture and components to convert and connect all Navy communication links. The feasibility will be shown through a system performance requirements comparison for data transmission/latency rates of existing copper cable/connectors to the proposed RWDM system. Preliminary impacts to weight and cost for the system shall also be assessed during Phase I and compared to current communication approaches. The Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work, a prototype robust shipboard cabling solution will be developed and provided at the end of Phase II that will combine the outputs of many digital-to-optical converters by a wavelength division multiplexer into a single fiber for distribution on any platform. Phase II will include the detail design of the system to satisfy Navy requirements for data volume and latency, size, weight, system redundancy, and compliance with Ref. 3 and 4. Land based testing will be performed as scheduled through PEO IWS 1 to validate system performance and define system integration requirements. A Phase III qualification and transition plan will be provided at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: During Phase III, the company will support the Navy in qualifying the robust shipboard cabling solution for the AEGIS Integrated Combat System. The system should be able to handle both real time/non-real time, switched/non-switched and secure/unsecure communication (Ref. 4 and 5) in a similar manner by providing hardware and engineering support to PEO IWS 1.0 Ship Integration & Testing personnel for shipboard installation and certification activities. Commercially available fiber optic systems using wavelength division multiplexing approaches do not typically combine the number of types of data streams associated with the technology that will be developed under this topic. Multiplexing enhancements developed under this effort could reduce the number and types of fiber optic cables used by commercial telecommunications companies

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1. Boslaugh, David. When Computers Went to Sea: The Digitalization of the United States Navy. ISBN 0769500242. Piscataway: The Institute of Electrical and Electronics Engineers, Inc., 1999.

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3. Military Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, MIL-STD-461E, 20 August 1999.

4. Military Standard, Input/Output Interfaces, Standard Digital Data, Navy Systems, MIL-STD-1397C(SH), 1 June 1995.

KEYWORDS: Wavelength division multiplexing; Navy Tactical Data System; Remote Video Encoders; Electromagnetic Interference (EMI) / ground loop immune fiber; hybrid system of digital and analog signaling; communication link redundancy

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

N161-030 TITLE: Safe High Density Undersea Power Source

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 485, Maritime Surveillance Systems, Distributed Systems Group (DSG)

OBJECTIVE: Develop a high power density source required for longer system life of an autonomous undersea surveillance system.

DESCRIPTION: The Shallow Water Surveillance System (SWSS), AN/WQR-5, is a new type of Distributed/Netted System (DNS) acoustic sensor technology that autonomously detects and reports submerged contacts. This topic seeks novel power sources that can provide electrical energy to SWSS for as long as technologically feasible to achieve enhanced performance. The envisioned power source will directly reduce total operating cost by decreasing the number of SWSS units required over the duration of the surveillance mission.

Currently, the SWSS program uses a Li-CFx/MnO2 (Lithium-Carbon Monofluoride/Manganese Dioxide) battery chemistry and each D-cell (930 total) has the capacity of 16Ah (at approximately 250mA). The SWSS battery volume is limited to 4154 in3 (18.91 in diameter x 12.5 in height + 18.077 in diameter x 2.5 in height). Current total power is 39kWh @ 27 volts average with 23A peak current.

In order to increase warfighter capabilities, the SWSS program is looking for an innovative higher density power source to enhance and specifically increase overall system persistence. This will reduce the number of systems deployed to provide the same area coverage, over the mission life. This power source requires innovation in design and construction, and must be compliant with Navy safety standards. Reference (1) provides the Standard Practice for Department of Defense System Safety, references (2), (3) and (4) discuss the Navy's Lithium Battery Safety Program and reference (5) is the Unmanned Systems Guide for DoD Acquisition.

A successful submission will supply 100-120 kWh at 27 volts average with 23A peak current in total power operating at continental shelf depths greater than 100 feet. Possible solutions could include a seawater battery, which is inert until activation in seawater, or some other means such as a microbial fuel cell, which will provide the Navy with a safer delivery module for autonomous undersea power. References (6) through (9) discuss additional technical information for the problem. Additionally, the SWSS program office is seeking a 15% cost reduction over the Li-CFx/MnO2 battery currently used in the SWSS.

Standard methods and technology available today rely on lead-acid, alkaline, or lithium batteries to deliver energy. However, the lithium battery has become a major safety concern and increasingly difficult to get Navy and commercial certified for military use and limits additional deployment options that include commercial transport due to existing safety guidelines. References (2) through (4) establish the stringent safety guidelines for the selection, design, testing, evaluation, use, packaging, storage, transportation, and disposal of lithium batteries. The small volume available to host the power source inside the SWSS node must hold sufficient energy to power the system for as long as technologically feasible. This will save deployment and procurement costs of SWSS. While SWSS represents the primary transition opportunity for an innovative new power source, the technology may also be integrated into future PMS 485 Distributed Systems Group (DSG) programs to include both shallow and deep water Distributed Netted

Sensor (DNS) systems and unmanned underwater vehicles (UUVs).

PHASE I: Develop a concept for a safe high-density undersea power source that meets the requirements as stated in the description section. The small business will validate the concept and demonstrate the feasibility via analytical modeling and a limited lab demonstration. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the small business will develop and deliver a prototype and design for a safe high-density undersea power source for evaluation. The prototype will demonstrate that it can meet Navy safety standards and SWSS requirements as defined in the Phase II SOW. Performance will be demonstrated at the small businesses' laboratory facilities or at a facility that is commercially available.

PHASE III DUAL USE APPLICATIONS: The small business will be expected to support the Navy with integrating the safe, high-density undersea power source into SWSS. The small business will finalize design and fabricate production prototypes to power SWSS or a designated transition Program of Record (PoR) for as long as technologically feasible so that the PoR can achieve the required performance specifications. The small business will support safety certification and validation testing for unlimited Navy use to include testing at a government facility authorized for certification at the cost of the PoR sponsor (PMS 485). The safe high-density undersea power source will be useful in any undersea application that needs safe high-density power that is certified for transport on naval vessels and commercial aircraft. Specifically, autonomous undersea vehicles could benefit the gas and oil industry as well as Department of Homeland Security in monitoring ports and coastal waters.

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1. Standard Practice for Systems Safety (MIL-STD-882E.) http://www.system-safety.org/Documents/MIL-STD-882E.pdf

2. NAVSEA Technical Manual S9310-AQ-SAF-010, Second Revision. http://www.public.navy.mil/navsafecen/Documents/afloat/Surface/CS/Lithium_Batteries_Info/LithBatt_NAVSEA_TMS9310.pdf?Mobile=1&Source=%2Fnavsafecen%2F_layouts%2Fmobile%2Fview.aspx%3FList%3D8006e

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KEYWORDS: Undersea vehicle power; safe, high power undersea battery; safe undersea battery; autonomous undersea power; small volume, high energy density undersea battery; power source for SWSS

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

N161-031 TITLE: Efficient, Low-Loss Combiner Technology for Affordable Transmit and Receive Module Manufacturing

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Air and Missile Defense Radar (AMDR)

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 5.4.c.(8) of the solicitation. 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 low-loss microwave power combiner technology that is compatible with gallium nitride (GaN) based transmit and receive (T/R) modules.

DESCRIPTION: Future Navy radar and electronic warfare (EW) systems will be based on radio frequency (RF) transmit and receive (T/R) module architectures where dozens (perhaps hundreds) of T/R modules are packed tightly behind the array face (Ref. 1). Typically, each individual T/R module contains two or more monolithic microwave integrated circuit (MMIC) high-power amplifiers (HPAs). Within the T/R module, the HPA outputs are combined with a power combiner to supply a required output power, which is determined by system performance and cost trade-offs. Gallium nitride (GaN) on silicon carbide (SiC) MMICs provide the current state-of-the-art for HPA performance and the Navy has invested heavily in GaN to bring the technology to a high level of performance and reliability (Ref. 2). By contrast, far less attention has been given to other key components in the output power path of the T/R module.

A number of previous projects have addressed circulator and limiter technology, but the focus of these efforts has typically been to enhance receiver protection, reduce size and weight, or increase bandwidth. Other projects have addressed supporting technologies such as T/R module packaging and thermal management that, though important, do not directly address performance. Within the T/R module, the one remaining component in the transmit chain that has remained largely unexamined is the power combiner.

For T/R module designs that combine multiple HPA outputs, the power combiner is integral to the design. Different combiner types have specific features that become part of the trade-space available to the T/R module designer. In general, the complexity and size of the power combiner increases with the number of HPAs that are combined, with the combining efficiency decreasing (Ref. 3). Increasing bandwidth has the same trade-offs. Typically, power combiners used in current T/R modules are direct applications of, or variations on, well-established coupler designs such as the Lange coupler, which has advantageous characteristics, such as wide bandwidth, but is quite large (Ref. 4). These couplers are usually implemented in thick film printed circuit form on ceramic substrates. The technology is mature, reliable, and affordable. The resulting components are easily integrated within the T/R module and are compatible with the automated assembly techniques that are critical to T/R module affordability. Unfortunately, with this technology, the combiner is a relevant source of RF losses and consumes a significant amount of space within the module. The Navy seeks an improved, low-loss, and compact power combining technology at the T/R module assembly level. The current technology is mature but the Navy seeks innovative technology with the potential for real improvement.

Combiner efficiency is the key parameter since the entire reason for combining multiple HPAs is to optimize output power. Efficient combining results in a lower heat load on the HPA GaN MMIC, improving reliability. Ideally, the combiner should shield the HPA from load pull effects and present a good output match. However, significant restrictions, arising from performance, reliability, sustainability, and compatibility considerations, complicate the requirements for power combiner technology. First among these is the proposed technology must be compatible with existing GaN-based T/R module technology. This enables transition of the technology to near-future Navy systems such as the Air and Missile Defense Radar (AMDR) in the form of technology updates without requiring fundamental system architecture changes while future designs also benefit. Reliability is also a paramount concern and proposed technologies must have reliable life expectancies comparable to the combiner technology they will replace (a T/R module service life of at least 15 years may be assumed). Finally, affordability being a prime concern, proposed technologies must be compatible with existing automated assembly processes standard to the industry (e.g. pick-and-place assembly) so that it may be easily inserted into the manufacturing process. As a guideline, a 50% increase in combiner cost over that of current thick film on ceramic technology is acceptable.

This topic serves to increase mission capability by enhancing basic sensor (radar and EW system) performance such as detection range. A secondary benefit is increased system efficiency, which translates into reduced cooling load and, as a result, decreased operating cost. The Navy is making a huge investment in T/R module based phased array systems that incorporate hundreds of modules in each array face. Extracting the maximum power possible from each T/R module optimizes system performance and produces the greatest return on investment in the system. This topic seeks to optimize power output without requiring any changes to system architecture, power supply, or the form factor of individual T/R modules. Therefore, this topic serves to increase capability at the lowest possible cost.

PHASE I: The company will develop a concept for innovative, low-loss, and compact power combining technology compatible with GaN HPA based T/R modules that meets the requirements stated in the topic description. The company will demonstrate the feasibility of their concept in meeting Navy needs and will establish that the concept can be feasibly produced. Sample testing, modelling, simulation, and analysis will establish feasibility. The Phase I Option, if awarded, would include the initial layout and capabilities description to build prototypes in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop prototype power combiners and the associated techniques for integrating the combiners with GaN HPAs consistent with current T/R module designs and assembly practices as described in the description. The prototypes will be evaluated to determine their capability in meeting the performance goals defined in the Phase II SOW and the Navy requirements for improved power combiners for T/R modules. Performance will be demonstrated by the company through prototype testing over the required range of parameters including numerous thermal cycles. Testing may be augmented by modeling and analytical methods. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The prototype will be delivered at the end of the Phase II. An automated assembly plan will be required to demonstrate compatibility with automated T/R module manufacturing practices. The company will prepare a Phase III development plan to transition the technology for commercial use to supply Navy needs.

PHASE III DUAL USE APPLICATIONS: The company will be expected to produce its combiner technology and support the processes required for its successful use in future Navy radar and EW systems. The company will develop and fully document the processes required to integrate the technology for use by industry according to the Phase III development plan. The technology will be evaluated to determine its effectiveness in full-rate production of T/R Modules incorporating GaN MMIC HPAs. The US domestic RF amplifier business supplies commercial as well as military markets. Advances in compact transmitter technology, though first implemented in military systems, eventually transitions to commercial product lines. Since this topic seeks to develop a fundamental product for power combining at the MMIC integration level and not a specific military application, the potential for commercial application is significant. The potential commercial market is essentially unlimited, should the technology prove cost competitive.

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KEYWORDS: Power combiner; high-power amplifiers; GaN MMIC; Lange coupler; pick-and-place assembly; T/R module

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

N161-032 TITLE: Tactical Video Distribution to Shipboard Consoles, Video Walls, and Tablets

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 10.0, SSDS Integrated Combat System

OBJECTIVE: Develop an innovative video distribution capability to improve Command and Control information sharing to warfighters for mission execution.

DESCRIPTION: The Surface Navy requires a system that distributes all tactical displays to Combat System consoles, video walls in Command Control spaces, and to portable tablets to allow for information sharing regardless of physical location throughout the ship. The innovative designs developed will allow the Navy to incorporate a video distribution system that will capture all critical video displays and transmit them to consoles, video walls, and portable tablets while aboard Carriers and Amphibious ships.

Warfighters onboard ships rely on timely information to make crucial decisions to execute their warfare missions. Consoles, which contain the information required to evaluate situations and make decisions, are not always available to shipboard personnel due to their location on the ship at any given time. Critical Command and Control information is resident in limited systems onboard ships and is very rarely distributed to the many workspaces. Greater critical information has become available on ships, which provide complete and accurate information to make tactical decisions. Improved technologies (Ref. 1 and 2), now make it possible to provide complete information to the warfighters onboard the ships. The desired technology is needed to capture the multiple video displays and distribute them to tactical consoles, video walls, and portable tactical tablets for warfighters in a secure fashion throughout the ship to improve mission execution.

The Video Distribution currently employed on Navy ships is limited to tactical spaces and does not provide the flexibility of providing video feeds of critical information throughout the ship. The availability of these video feeds should consider the structural design of the ship, and will require an analysis for determination of specific transmission mediums required to provide the availability of services limited to internal spaces, and select external weather deck locations (bridge wings, hangar bays, stern deck, and others based on fleet input). The system must be capable of collecting up to 10 video inputs and provide a method of distribution to various displays (video wall, computers, and secure tablets) and the ability to securely transmit and distribute throughout the ship, to include through watertight bulkheads without transmitting beyond the ship boundaries. The system must be transmitted to secure connection tablets that the Commanding Officer and other key personnel can carry as they go about their daily routine.

The video distribution system must capture 95 percent of critical tactical information and use a single distribution system for the information to all tactical watch stations. It must be viewable on a securely connected tablet implementing user verification protocols.

Currently on the ships, the tactical information is on standalone systems or only viewed in select compartments. This limits the timeliness to make decisions when complete and accurate information is not available in all spaces or at common display system consoles. Commanders are not always in the Combat Information Center (CIC) as they conduct their daily business. This creates a situation where the commanders are viewing outdated critical information, which may affect critical decision-making. Having the flexibility to view the information in a multicast video distribution system at any console, video wall, or secure portable tablet allows for Commanders and watch standers to make timely decisions based on having all information available when needed. The system will be required to display information at time rates (frequency of update) comparable to existing display refresh rates. The system will be required to undergo testing for integration with hosting hardware (HW) in a navy designated laboratory to preclude degradation of operational systems (HW specifications to be provided as government furnished information (GFI)). The system will be capable of meeting security and system interoperability certification requirements as specified by Department of Defense Instruction DoD 8330.01 May, 2014. The scheduling of testing in all phases will be coordinated through the procuring office.

Tactical decisions need to be made from detailed information and current systems provide some information on standalone systems. The Navy needs an integrated video distribution system to provide the necessary information to make time critical decisions. The ability to provide the video on tablets that can be used throughout the ship will be extremely beneficial to the Commanding Officer, Executive Officer, and the Operations Officer as they are not always at locations that have the tactical information readily available to make time critical decisions when called by the Tactical Action Officer or Officer of the Deck.

The company will provide a complete system available for testing at a land based warfare system test site and support installation and deployment aboard a navy ship for an at-sea test during a strike group work-up exercise .

PHASE I: The company will develop a concept for a multicast video distribution system that will meet the requirements described above. The company will demonstrate the feasibility of the design concept through software demonstration or use of commercially available software and hardware, to include approaches for material (component) selection and testing, as well as analytical modeling and simulation with anticipated cost analysis. The concept analysis should demonstrate the video distribution design has the capability to meet operator requirements for making tactical decisions at the same or reduced period. The concept will include a proposed approach for certification and testing utilizing guidance issued by the office of the director test and evaluation. The Phase I Option, if included, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will demonstrate the ability to collect up to 10 video inputs and distribute them to various displays (video wall, computers, and secure tablets) and ability to transmit through steel walls via prototype. The prototype system will also include 10 portable tablets, possessing security features to allow use throughout the ship, and capable of connecting to the video distribution system. The Navy will evaluate the system on performance of video distribution of critical information to necessary viewing stations and range of video distribution to secure tablets.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning a complete video distribution system accessible via company provided secure portable tablets into Ship Self-Defense System (SSDS) Advanced Capability Build 20 and Technical Insertion 20, planned for deployment in fiscal year 2022. Testing will be accomplished at a land based warfare system test site and then deployed for an at-sea test during a strike group work-up exercise. The video distribution system described in this SBIR topic paper could have private sector commercial potential for any security firm that has mobile surveillance patrols or distributed control of surveillance. Also, supervisors remote from command centers could benefit from a distributed monitoring system provided to tablets or other mobile devices.

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2. Schmidt, T. Waehlisch, M., Fairhurst, G., RFC 5757: “Multicast Mobility in Mobile IP Version 6 (MIPv6): Problem Statement and Brief Survey.” February, 2010. The Internet Engineering Task Force ®, https://tools.ietf.org/html/rfc5757 . 17 Apr 2015.

3. DoD Test and Evaluation Management Guide. December 2012, Sixth Edition. http://www.dau.mil/publications/publicationsDocs/Test%20and%20Evaluation%20Management%20Guide,%20December%202012,%206th%20Edition%20-v1.pdf. 29 Sep 2015

4. Department of Defense Instruction 8330.01. May, 2014. http://www.dtic.mil/whs/directives/corres/pdf/833001p.pdf. 29 Sep 2015

KEYWORDS: Video distribution on ships; common display system; Naval Command and Control; multicast on a closed system; critical command and control information; Combat Information Center

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

N161-033 TITLE: Low Power Fiber-based Laser Range Finder

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS435, Submarine Electromagnetic 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 5.4.c.(8) of the solicitation. 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, fiber-based, low power laser range finder to accurately point and resolve ranges.

DESCRIPTION: The Navy is developing a new panoramic imaging mast and upgrading existing masts. The size of these new masts will be similar in size to existing traditional submarine periscopes for which general information is widely available. These masts will offer much lower space and power allocation to a laser rangefinder than the previous generation. In addition, it is desirable to lower the transmit power of the laser rangefinder while maintaining the range in order to reduce the probability of counter detection. These challenges necessitate development of an innovative optical fiber-based delivery laser range finder (LRF) decoupled from the imaging system's optical axis (reference 1). A fiber based LRF will allow the transmitter to be located separately from the remainder of the components, reducing space requirements in the mast. The laser range finder must have a low probability of intercept and must transmit lower power than typical currently available products (references 2 and 3). Any new mast or legacy mast could benefit from such an LRF. The LRF must accurately point and resolve ranges. Compact fiber based laser range finders are discussed in reference 4. The laser must be able to fit within limited space and would ideally be located about three feet away from the masthead. Firing and directing of the laser range finder through the imaging system's optical axis may not be possible. The architecture of new imaging masts for the Virginia and SSGN class submarines may not allow the laser beam to share the optical axis with the visible camera's optical axis.

The following capabilities for the fiber-based, low power laser range finder are desired.
• Eye safe emissions
• Equivalent performance to that described in reference 4, or equivalent performance to commercially available laser range finders such as the FLIR systems MLR-10K or the ROX FVKM-NCBA
• Innovative solutions to reduce laser energy detection from threat sensors, such as employing covert waveforms, having a low pulse energy (less than 1mJ), employing non-common wavelengths, and others
• Total volume, without the fiber, less than 80 cubic centimeters

The Navy requires the technology developed to enable the insertion of a laser range finder into submarine mast systems to reduce space requirements where a mast must be smaller and to remove a heat source from above the water, which has signature implications.

The capability proposed in this topic will enable enhancements to mission capability and performance through introduction of an innovative new laser range finder capability. The removal of the laser generation from the sensor head and transmission of the laser through optical fiber will allow removal of a heat source from above the water, with obvious signature and reduction in mast size implications. In addition, reduction in laser power as implications on signature as well.

PHASE I: The company will define and develop a conceptual design for a compact, fiber-based, low power laser range finder that meets the requirements described above. The company will demonstrate the feasibility of the concept through laser range requirements and show that the concepts can be feasibly developed into a useful product for the Navy. Material testing and analytical modeling will be analyzed to establish design feasibility. The Phase I Option, if awarded, will include a design layout and capabilities for the Phase II prototype.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a scaled fiber-based, low power laser range finder prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II SOW and the Navy requirements for laser range finding. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will be delivered at the end of Phase II and meets Navy requirements. The company will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use for the Submarine Electromagnetic Systems program. The company will develop a laser range finder for evaluation to determine its effectiveness in an operationally relevant environment. The company will support integration and testing aboard operational platforms. Commercial use of this technology includes a lightweight fiber based laser range finder for unmanned aerial vehicles (UAVs), land surveys, and commercial navigation systems. These are examples of systems that are being miniaturized on a yearly basis and would benefit from smaller, lower power laser rangefinders.

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KEYWORDS: Laser Range Finder; fiber laser; low probability of intercept; active imaging; off-axis detection; panoramic imaging mast

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

N161-034 TITLE: Radio Frequency over Fiber (RFoF) for the Next Generation Submarine Electronic Warfare (EW) System

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: SIRFSUP, Scalable Integrated RF Systems for Undersea Platforms; PMS 435, Sub Electromagnetic 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 5.4.c.(8) of the solicitation. 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: To develop a modular, low cost, high performance Radio Frequency over Fiber (RFoF) to be utilized by undersea platforms.

DESCRIPTION: The benefits of Radio Frequency (RF) over Fiber (RFoF) is well documented (ref. 3) but the performance penalty has always been too great to seriously consider it for primary Electronic Warfare (EW)/Intelligence, Surveillance, and Reconnaissance (ISR)/Signal Intelligence (SIGINT) applications on submarines. To date, the noise figure, cost, and dynamic range issues have not been resolved. The benefits that RFoF would bring to submarine EW/SIGINT applications would be revolutionary.

The current state of the art RFoF is unable to compete with traditional copper runs in cost, sensitivity, dynamic range, reliability, and manufacturability (ref. 3). However, there have been tremendous improvements (driven by the commercial communications sector) in size, weight, and power (SWaP) and in overall manufacturability and reliability. There have been significant improvements to the noise figure problem (in the past, RFoF traditionally had noise figures greater than 31 dB) set and significant improvements to the dynamic range problem (in the past, RFoF traditionally had dynamic range limitations on the order of less than 50 dB). Unfortunately, one benefit usually comes at the expense of the other (ref. 3).

The submarine community is looking for new RFoF technologies that solve all the previously discussed problem sets to be utilized in the next generation of non-penetrating modular mast concepts for future submarine masts. By developing tethered modular antenna sections, undersea platforms will be able to more covertly accomplish their missions and allow an ability to communicate back while minimizing surface exposure time (ref. 1). For these tethered payloads to be realized, it is imperative that we solve the RFoF problem. The submarine force is looking for RFoF solutions that exhibit noise figures of less than 10 decibel (dB) across extremely broad band instantaneous bandwidths (greater than 20 Gigahertz (GHz) is the goal), with multi-tone spur free dynamic ranges in excess of 80 dB 4 GHz instantaneous bandwidths.

The submarine community believes that if this can be achieved, tremendous benefits will be found in the overall situational awareness of the submarine platform through improved angular resolution will be found (on the order of greater than 6 degrees Root Mean Squared (RMS) improvement). Improved system RF performance (specifically system noise floor flatness, overall system loss improvements over great distances, and n-order spurious-free dynamic range (SFDR) improvements greater than 20 dB) against mixed (low power with high power) signal environments(ref. 1 and 2) can be achieved. This will open doors to tethered RF antenna sets greatly improving the overall situational awareness of the submarine community (ref. 2).

These capabilities will allow the unmanned platform to stay below the surface (allowing for more covert operations) but still allow for the offloading of critical data elements when required. In a submarine environment, this technology will significantly enhance the performance capabilities of the current and future submarine modular masts. In an ISR role, this allows the platform to stay deep (minimizing surface exposure) but still allows the platform to get the appropriate receive sensors to the surface.

RFoF will greatly simplify the RF front ends we currently employ, reducing overall cost and improving system reliability. The submarine community is looking for solutions that will cover the RF frequency range of 10 kilohertz (KHz) to 50 GHz in modular extendable solutions.

The Phase II and Phase III effort will 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.

PHASE I: The company will define and develop a concept for a modular, reconfigurable RFoF capability as stated in the description section above. The company will demonstrate the feasibility of the concept through modeling and analysis to show that the concept can potentially fit in a submarine antenna set. The Phase I Option, if awarded, should include an initial layout and capabilities description to build the prototype in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop a prototype to demonstrate the performance of a modular, reconfigurable RFoF capability that can fit in a Submarine antenna through employment of an actual submarine imaging mast or a realistic surrogate. A successful prototype will demonstrate the modularity and reconfigurable nature of the RFoF capability. Phase II will include development and delivery of a hardware prototype. The company will develop a clear, concise transition schedule or plan that will demonstrate how to transition from the prototype stage to the engineering development model for insertion into the SIRFSUP Program of Record (POR) acquisition office.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the RFoF antenna system to Navy use in the Undersea Platforms. The company will finalize the design and fabricate a capable undersea platform payload module, in accordance with the Phase III SOW, to evaluate and determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation, in accordance with AN/BLQ-10B (V) POR, to certify and qualify the system for Navy use and for transition into an operational environment. The option of digital EW receiver technology should prove useful in many applications. The more specific digital EW receiver has applicability to homeland defense, law enforcement, and private-security systems.

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KEYWORDS: Fiber Optics; RF over Fiber (RFoF); spur free dynamic range; Electronic Warfare (EW); Intelligence, Surveillance, and Reconnaissance (ISR); submarine imaging masts

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

N161-035 TITLE: Underwater Near Field High Data Rate Non-Acoustic Communications

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 394A (Undersea Research and Strategy) Sea Shield technologies.

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 5.4.c.(8) of the solicitation. 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 non-acoustic full duplex High Data rate communications path between a submerged attack submarine and an external entity at short, tactically useful ranges.

DESCRIPTION: The goal of this SBIR topic is to devise a means to conduct High Data Rate underway communications at short-to-very short ranges (100 meters or less) using non-acoustic means between a host submarine and payloads such as the Large Displacement Unmanned Undersea Vehicle (LDUUV), Swimmer Delivery Vehicles (SDV), or other similar vehicles (references 1 and 3). This topic has previously been studied in academic and government sponsored research (references 2 and 3). These studies show how optical modulation (vice acoustic) can be utilized to transmit information underwater, and what wavelengths of light best propagate. The intent of this SBIR is to leverage the existing body of knowledge of this topic for application to current Navy Unmanned Underwater Vehicle (UUV) and launch and recovery programs such as the Universal Launch and Recovery Module (ULRM).

The submarine force has a requirement to extend the sensor reach and influence of the attack submarine force. The ULRM helps address this requirement by providing a large diameter payload interface for the Virginia Class SSN and Ohio Class SSGN submarines which is capable of submerged launch and recovery of LDUUV and other potential payloads.

Many proposed missions for the LDUUV and other UUVs will require extensive data-taking and eventual transfer to the host submarine, surface ship, or shore facility for data reconstruction and analysis. In the event of a multi-day mission involving bathymetric or sonar surveys, the required data transfer will rapidly become extremely large (Gigabytes of information). Current design concepts for ULRM require the submarine to recover the UUV or payload and conduct required data transfer or mission uploads using wet-mate connectors, extremely short range Wi-Fi, hard drive replacement by the operator, or some other means.

The ability to securely transfer very large amounts of data to the host submarine via a short-range, secure, communications path would provide significant tactical and operational advantages to the submarine fleet. Furthermore, a non-acoustic (blue laser or similar communications path) provides advantages of acoustic security over a higher frequency acoustic modem. Current underwater acoustic modems can provide a transmission bandwidth of approximately 10Kbps while a blue/green laser modem could potentially operate with a bandwidth up to 1Gbps or greater. Current technology requires a submarine to retrieve a UUV onboard to conduct data exfiltration following a tactical mission. This process can take a significant amount of time (up to hours depending on the means used) or require manned access to the vehicle. This requirement decreases the operational availability (Ao) of the UUV and also reduces the ability of the SSN to conduct multiple missions simultaneously.

An ideal design solution would allow a submerged submarine to conduct two-way high data rate communications of 1Gbps with an undersea vehicle (unmanned or otherwise) operating in close proximity. It would use a non-acoustic transmission medium (such as blue green laser) that operated at wavelengths that would readily propagate through the ocean environment to short ranges up to 100m but not less than 10m. Power requirements for data transmission on the antenna and receiver will be constrained by energy limitations of the smaller undersea vehicle. An ideal design solution would require no more than 75 Watts of the available power so that efficient and rapid data transfer can be conducted and still leave adequate margin for further operations. A Targeting and Tracking System (TTS) will also be necessary to account for two free-swimming bodies and could employ a traditional mechanical gimbal or non-traditional manner to affect the TTS.

The design solution should be scalable such that, if it proves feasible, alternative communication paths between two submarines or submarines and other naval or airborne assets (at greater tactical ranges) can be employed. A submarine could electronically poll a UUV in close proximity, retrieve tactically relevant mission information without conducting a recovery evolution, and then pass new tasking on to the UUV. This capability will introduce mission flexibility into a commanding officer's use of the UUV. The ability to conduct high data rate underwater communications will also help improve the ability of the submarine force to conduct Special Operations Force (SOF) missions when communicating with SOF submersibles or other submarines operating in close proximity.

It is desired that development efforts be focused on multi-wavelength interlacing and/or high Pulse Repetition Frequency (PRF) to achieve the desired baud rate that can be readily leveraged to address this operational challenge. If a feasible, affordable technological solution can be devised, the Program intends to develop for possible incorporation in the ULRM program. This will improve the ability of the submarine to better execute multiple mission areas using external payloads such as the LDUUV, SOF vehicles, and potentially Unmanned Aerial Vehicles (UAV).

PHASE I: In Phase I, the company will develop a concept for a non-acoustic full duplex High Data rate communications path and assess the feasibility of this concept, taking into account the special challenges of this application (such as expected submerged light propagation, and power restrictions of UUVs). Product outputs should include recommended solutions and a prototype concept. The feasibility of this concept should be demonstrated through modeling and simulation. The Phase I Option, if awarded, should detail the design and capabilities for Phase II.

PHASE II: In Phase II the company will develop a non-acoustic full duplex High Data rate communications path prototype based on the recommended design concept from Phase I which demonstrates the performance detailed in the description and specified by the Phase II Statement of Work (SOW). Desired output of Phase II is a component level prototype suitable for standalone (not installed on a SSN or UUV) testing in an ocean environment. Success in Phase II would entail a successful prototype demonstration of the ability to reliably transmit High Data Rate at significantly greater bandwidth over existing acoustic and non-acoustic modems in an ocean environment at a range of 10m (threshold) to 100m (goal). Testing can be performed in the Naval Undersea Centers of Excellence, or commercially comparable facilities, as specified in the Phase II SOW. Successful exit from Phase II will include a transition plan for entry into the Acquisition Program to be executed as part of Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the non-acoustic full duplex High Data rate communications path technology to Navy use. The company will deliver a detailed design suitable for incorporation into an existing Program of Record such as the Universal Launch and Recovery Module (ULRM). Tactically useful designs will be incorporated into the Detailed Design process for the ULRM, LDUUV, and other programs for operational testing and eventual fielding. The oil and gas field exploration industry is the largest commercial user of Unmanned Undersea Vehicles (UUV). They employ tethered Remotely Operated Vehicles (ROV) and UUVs to explore ocean floor bathymetry and survey existing oil field ocean floor structures such as pipelines and wellheads. If developed, this technology could be employed by commercial users to transmit hydrographic and sonar survey data to operating and analysis stations more rapidly than existing processes allow.

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KEYWORDS: Universal Launch and Recovery Module (ULRM); laser communications; Large Diameter Unmanned Undersea Vehicle (LDUUV); Blue-green laser; high data rate transmission; two-way high data rate communications

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

N161-036 TITLE: Reduced Cost Fabrication of Optical Sapphire Hyper-hemispheres for Submarine Masts

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: PMS435, Submarine Electromagnetic Systems

OBJECTIVE: Develop a cost effective set of tools or processes for fabricating sapphire hyper-hemispheres or similar shaped optical window components.

DESCRIPTION: The Navy is developing multi-spectral imaging masts, modules, and components that exist outside the pressure hull of a submarine. The appropriate material selection for optical windows for multi-spectral (visible and infrared) systems is limited, consisting of a variety of ceramic materials as well as industrial sapphire that produce affordable submarine imaging mast components. However, these materials are expensive to manufacture into multi-spectral windows. In addition, some optical windows exist in systems covering large fields of view, which results in curved windows similar in construct to a fish eye lens. These shapes add additional challenges to the manufacturing process.

Sapphire is currently the most technically mature material for multi-spectral windows. Sapphire is a very hard material and very expensive to grind to shape when dealing with curved surfaces and components of the thickness required in a subsea environment.

The Navy seeks to develop innovative machining tools or processes to reduce the time of grinding a hyper-hemispherical window by 50% in order to produce affordable submarine imaging mast components to support future production programs. This would lead to multi-million dollar savings in production costs. Examples include ultrasonic machining and laser based machining (references 1 and 2). Appropriate ways to reduce cost would include objectives such as increasing the material removal rate during grinding or decreasing downtime to perform in-process metrology during fabrication. In addition, use of sapphire for hyper-hemisphere will lead to life cycle support cost avoidance of greater than $10M due to the inherent durability of the material. The normal development process of any optical component would consist of grinding the raw materials, polishing, and coating. These new innovative machining tools or processes would replace the current grinding process.

PHASE I: The company will develop a concept for a set of tools or processes for grinding multi-spectral windows to specific shapes for which drawings will be provided. The company will demonstrate the feasibility of the concepts in meeting Navy needs. In addition, the company will present calculations of the time required for sapphire (multi-spectral window) grinding. Sample material grind or analytical modeling will establish design feasibility. Phase I Option, if awarded, will include the initial layout and capabilities description for the process or tools in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a prototype of the tools or processes for grinding sapphire to specific shapes for evaluation as appropriate. This tooling will be used to manufacture an Optical Sapphire Hyper-hemisphere to demonstrate the cost reduction. The prototype tools or process will be delivered at the end of Phase II. The company will prepare a Phase III transition plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: During Phase III the company will support the Navy in transitioning the process for manufacturing of Optical Sapphire Hyper-hemispheres for Submarine Masts technology to Navy use for the Task Oriented Technology Insertion Mast (TOTIM) program. The company will utilize the developed process to manufacture and thoroughly evaluate optical window components for evaluation to determine the effectiveness in an operationally relevant environment. Commercial use of this technology includes sapphire lens and window development. Sapphire is rapidly becoming a commonly used optical component that must be produced at lower cost across all elements of its development.

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1. Mahmud, Yaseen; Morgan University, “Ultrasonic Machining”, April 1999; http://www.eng.morgan.edu/~mahmud/IEGR563/ultra.html

2. Purcher, Jack, “Apple Reveals Laser Cutting Techniques for Processing Sapphire”, 20 March 2014., http://www.patentlyapple.com/patently-apple/2014/03/apple-reveals-laser-cutting-techniques-for-processing-sapphire.html

KEYWORDS: Hyper-hemisphere; multi-spectral head window; sapphire head window; ultrasonic machining; laser based machining; imaging mast

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

N161-037 This topic has been removed from this solicitation

N161-038 TITLE: Shipboard Additive Manufacturing (AM)/3D Printing

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: Quality Metal Additive Manufacturing (QUALITY MADE) FNC

OBJECTIVE: Develop a NAVSEA qualified material and an Additive Manufacturing (AM) methodology to produce defect free parts and maintain geometric tolerances in a shipboard environment.

DESCRIPTION: The Naval fleet suffers from long lead times to obtain replacements for broken, worn, or otherwise failed parts. When underway, failed parts can only be replaced if the ship's supply center, which has limited inventory space, has the parts in stock. AM will offer the potential to reduce supply chain issues through shipboard manufacturing of replacement parts on an as-needed basis. The only other method currently available to replace failed parts include very expensive ship and/or helicopter transport to at-sea vessels. AM creates parts through layer-by-layer deposition from a three dimensional Computer Aided Design (CAD) model thereby allowing a wide range of parts to be created using a single manufacturing system. Currently available Commercial Off the Shelf (COTs) AM systems deposit material using established methodologies and produce known dimensional tolerances. These AM methodologies are designed for printing on land, in controlled environments, and for purposes that do not require the material to meet strict Flame, Smoke, and Toxicity (FST) requirements.

In order for the fleet to take advantage of AM printing while underway, the challenges associated with transitioning AM to an at-sea environment must be overcome. These challenges include passing appropriate material requirements and mitigating adverse effects of the shipboard environment. Development of a closed loop feedback system would assist in ensuring dimensional part quality during ship motions.

All materials used aboard ship, regardless of the final purpose of the part, must pass NAVSEA FST requirements. Material and part certification will follow traditional land based certification routes and use authorization for only specific materials and components at sea. Previous testing has shown that currently available polymeric materials do not pass FST. The shipboard environment itself is also cause for concern. Recent Navy shipboard and laboratory testing of a material extrusion system attributes motion and a high humidity environment as experienced by an underway ship to part geometric variability and increased internal porosity in the raw material.

A successful innovation effort will include a manufacturing methodology that is not adversely affected by the shipboard environment (motion and humidity) and produces ready-to-use final component parts that pass NAVSEA FST requirements. Final products could include: (1) a material that can pass FST requirements and be used in existing AM systems, (2) an individual printer or retrofit designed for current printers that ensures dimensional quality of parts during build while under motion, and (3) a material storage and processing methodology for non-metallic materials that ensures material quality throughout the build regardless of the surrounding environment.

The ability to rapidly manufacture parts at sea will increase the Navy's ability to replace failed components in a timely fashion, reduce long lead times on replacement parts, mitigate issues with part obsolescence, and eliminate spare part inventory issues.

PHASE I: The company will develop an Shipboard Additive Manufacturing (AM)/3D Printing methodology that meets the requirements as outlined in the topic description. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Material testing and analytical modeling will establish feasibility. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II statement of work (SOW), the company will develop a Shipboard Additive Manufacturing/3D Printing prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the AM methodology. System performance will be demonstrated through prototype evaluation and testing over the required range of shipboard motion parameters and environmental conditions. Evaluation results will be used to refine the prototype into an initial design that will be delivered to the Navy. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the Shipboard Additive Manufacturing/3D Printing technology for Navy use. The company will develop an AM methodology for evaluation to determine its effectiveness in an operational environment onboard a LPD 17 Class ship. The company will support the Navy for test and validation to certify and qualify the system for Navy use underway. The demonstration on a surface vessel while underway is for motion mitigation. A developed AM closed loop feedback system will assist in ensuring dimensional part quality in applications other than under motion and will thereby benefit other industries (medical, industrial, and scientific communities). Environmentally controlled material storage will also increase the number of areas that AM can be utilized beyond shipboard.

REFERENCES:
1. B. Stucker, University of Louisville, “Additive Manufacturing Technologies: Technology Introduction and Business Implications”. Frontiers of Engineering 2011: Reports on Leading-Edge Engineering from the 2011 Symposium/ADDITIVE MANUFACTURING.

2. J.-P. Kruth, M.C. Leu, T. Nakagawa, “Progress in Additive Manufacturing and Rapid Prototyping”, CIRP Annals - Manufacturing Technology, Volume 47, Issue 2, 1998, Pages 525-540, ISSN 0007-8506, http://dx.doi.org/10.1016/S0007-8506(07)63240-5.

3. Sharon L. N. Ford, (2014), “Additive Manufacturing Technology: Potential Implications for U.S. Manufacturing Competitiveness” September 2014. Retrieved from: http://www.usitc.gov/journals/Vol_VI_Article4_Additive_Manufacturing_Technology.pdf

4. ASTM E162 – 15, “Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source”, Retrieved from: http://www.astm.org/Standards/E162.htm

5. ASTM E662 – 15, “Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials”, Retrieved from: http://www.astm.org/Standards/E662.htm

6. NAVSEA DESIGN DATA SHEETS, DDS-078-1, (2004) “Composite Materials, Surface Ships, Topside Structural and Other Topside Applications - Fire Performance Requirements”, Copies of these documents are available from Commander, Naval Sea Systems Command, ATT

KEYWORDS: Additive Manufacturing; printing parts at sea; 3D printing; rapid prototyping; material development; FST requirements

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

N161-039 TITLE: Extremely Small, High Performance Intelligence, Surveillance, and Reconnaissance (ISR) Payloads for Expendable Undersea Platforms

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: FNC - SIRFSUP (FNT-FY15-04); NAVSEA PMS 435 (Submarine Electromagnetic System)

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 5.4.c.(8) of the solicitation. 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 extremely small, high performance Intelligence, Surveillance, and Reconnaissance (ISR) payload for expendable undersea platforms.

DESCRIPTION: Undersea platforms are used in many applications where the covert, extended persistence is required. These expendable modules can be buoys launched from the three inch launcher, sensors left behind from unmanned undersea vehicles, or submarine launched unmanned aerial vehicles (UAVs) requiring small ISR payloads. All of these need to convert electromagnetic energy into actionable intelligence (ref. 3). There are currently NO small ISR or EW payloads that are capable of being deployed out of something as small as a submarines 3 inch launcher.

There is a need and associated requirements within the Navy and other Department of Defense (DOD) agencies to detect, geo-locate, and discriminate emitters of interest in littoral and open ocean environments (ref. 1). Larger intelligence data demand and fewer manned intelligence platforms make it difficult to meet all intelligence requirements. Additionally, scenario characteristics such as geometry, obscuration, clutter, multi-path, signal detection, and signal type may limit the performance of large standoff intelligence gathering systems (ref. 2).

This SBIR topic seeks to develop various sized Radio Frequency (RF) system payloads (< 1U, 1U and 3U form factors) and associated signal processing for various size expendable platforms that will perform detection, processing, and discrimination of multiple emitters in dense environments. System solutions should include both tethered and untethered concepts.

Signals of interest cover a wide range from High Frequency (HF) through Ka-band (approximately 1 megahertz (MHz) through 40 gigahertz (GHz)). This range covers communication systems as well as radar. Recognizing that one system will not fit all applications simultaneously, there is a desire to develop common hardware solutions that can have different profiles loaded based on the focused missions.

Size, weight, and power (SWAP) considerations often limit a system's applications. For this topic, various classes of expendable platforms will be taken into consideration. These classes include extremely small SWAP (less than inch cubed, less than one half pound, 10's of milliwatts of power), small SWAP (inches-cubed volume, sub-one pound weight, watts of power), medium SWAP (inches-cubed volume, one to ten pound weight, 10's of watts of power), and large- SWAP (5-10 inches cubed volume, 10's of pounds, 10's of watts of power). The system shall be modular and would include an antenna, receiver and transmitter hardware, processing hardware, downlink and communication hardware, and an associated ground station. System designs should consider extensions to multi-platform system concepts where the same hardware may be repeated across several sensors forming an integrated and netted sensor network.

Algorithm development shall include all required processing for the given system for detection, processing, localization, and discrimination of multiple signals. Single sensor and multi-sensor techniques will be considered. Algorithms must consider and process advanced emissions such as 4th and 5th generation (4G and newer) mobile phones and Low Probability of Intercept (LPI) radar waveforms such as pulse compression, spread spectrum codes, and low peak power high duty cycle (LPPHDC) (ref. 3). Algorithms must consider operating conditions such as multi-path, obscuration (to some sensors in a multi-sensor system), geometry, synchronization and timing between platforms, and processing and memory constraints on the payload. Processing is expected to take place both on-board the expendable platforms (non-tethered) as well as on the host platform (tethered). Commercially available datalink bandwidths must be considered and will aid in determining the processing trade between on-board and off-board.

Finally, the system developed should co-exist with already available data format options of the host platforms. This allows for RF detection and location followed by optical validation.

This topic will allow the Navy to make tethered and untethered expendable high performance ISR payloads for undersea platforms, and submarines will be able to significantly expand their instantaneous ISR horizon. For unmanned platforms and other deployable buoys to perform an ISR mission, this becomes a force multiplier for submarines in the future.

This topic increases mission performance by allowing unmanned and deployed ISR sensors to become force multipliers for a submarine in the future. These capabilities will allow submarines to significantly expand their ISR horizon. This also allows the submarine, in real time, to geo-locate emitters by using these extended reach sensors to act as separate nodes on a distributed network reaching back to the submarine.

PHASE I: The company will design and demonstrate through simulation or limited testing the concept of and feasibility to develop a tethered and untethered modular, reconfigurable ISR sensor package as described in the Description. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II (SOW), the company will develop a tethered and untethered modular, reconfigurable ISR sensor package prototype system for the concept developed in Phase I. The company will further develop and refine detection, localization, processing, and discrimination algorithms for the detection of many signals in an emitter rich environment. Performance of bench level lab experiments will be used to demonstrate performance. This capability will be demonstrated in a 1U and 3U form factor as a minimum. A prototype system will be delivered at the end of the Phase II. Companies participating in Phase II will be required to prepare a plan to transition the technology to the Navy under Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the ISR payload system to a AN/BLQ-10B (V) Program of Record (PoR) through NAVSEA PEOSUBS PMS435 Submarine Electromagnetic Systems program office. The company will finalize design and fabricate production engineering development models (EDMs), according to the Phase III SOW, to determine the systems effectiveness in an operationally relevant environment. The company will support the Navy for test and validation, in accordance Submarine Electromagnetic Systems program office specifications, to certify and qualify the system for Navy use and for transition into operational platform. Following testing and validation, the end design is expected to transition to the PoR. Technology has application by local civilian emergency organizations desiring the ability to geo-locate hand held radio and phone emissions from stranded hikers.

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1. Wiley, Richard G., ELINT: The Interception and Analysis of Radar Signals, London, UK, Artech House, 1993; http://www.artechhouse.com/uploads/public/documents/chapters/Wiley_925_CH04.pdf

2. Volakis, John, Antenna engineering Handbook, Fourth Edition, New York, NY, McGraw-Hill, 2007 (Chapter 47, Kellog, Robert; Mack, Eldon; Crews, Cathy, Direction finding Antennas & Systems); http://accessengineeringlibrary.com/browse/antenna-engineering-handbook-fourth-edition

3. Milojevic, D.J.; Popovic, B.M.; Improved algorithm for the deinterleaving of radar pulses, Radar and Signal Processing, IEE Proceedings F, Volume 139, Issue 1, Feb. 1992 Page(s):98 – 104

KEYWORDS: Unmanned Air Vehicles; Geo-location; Emitter location and identification; multi-sensor geo-location; single sensor geo-location; Unmanned Undersea Vehicles

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

N161-040 TITLE: Advanced Materials for Carbon Dioxide (CO2) Capture

TECHNOLOGY AREA(S): Materials/Processes

ACQUISITION PROGRAM: PMS397—Advanced CO_2 Removal Unit (ACRU) 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 5.4.c.(8) of the solicitation. 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 advanced materials for their potential use as a submarine CO_2 removal system.

DESCRIPTION: Current submarine Carbon Dioxide (CO_2) removal technologies include both liquid and solid amine-based systems. The materials use amine chemistry to capture CO_2 at room temperature and the material is regenerated using heat and vacuum to remove the captured CO_2 and restore the material back to the chemical state where it can repeat the process of capturing additional CO_2. Legacy hardware, using the liquid based system, is prone to scaling and other complications from the use of a liquid (Ref. 1). Additionally, the material has a short lifetime, requiring replacement underway, and hazmat wastes are complicated to handle. The use of solid CO_2 capture sorbent technologies improves the maintainability of the system and improves the quality of life for the sailor. Both systems, however, are relatively energy intensive and only harness a portion of the full theoretical CO_2 capture capacity of the sorbent. Space and volume constraints dictate the need to maximize the amount of CO_2 capacity for a minimum of volume, and an advanced system that could offer the full CO_2 removal capacity of a material would be advantageous to the Navy.

A new and innovative solid material capable of higher CO_2 loading per unit mass of sorbent could offer space and volume savings to the submarine, using less power and reduce the load on the ship's chilled water system. For example, Metal Organic Framework (MOF) materials have shown to offer a unique CO_2 capture mechanism that can potentially maximize the full working capacity of the material with only a small change in pressure (Ref. 2 and 3). Current technologies operate within a range of cyclic capacities, between approximately 3-5% by weight, and preliminary research has demonstrated that MOF materials may be able to achieve weight capacities of up to 13%. Additionally, existing solid CO_2 removal technologies are sensitive to moisture level in the air stream. MOF have shown to be stable under a wide range of operating parameters, which could provide increased reliability to the submarine. All other materials that may have similar characteristics should be considered.

The Navy is looking for an advanced CO_2 capture system capable of harnessing the full cyclic capacity of the material that will improve the CO_2 scrubbing performance of the submarine and offer additional capabilities of longer durations or increased crew sizes. The product would offer additional CO_2 removal capacity within the same footprint and volume of legacy systems. Alternatively, a higher capacity material would offer space and weight savings by providing the same CO_2 removal capacity in a smaller footprint. In either case, a new system would be considered more energy efficient by requiring less energy to accomplish the same capability. A new system would be more affordable by requiring significantly less material to capture typical submarine levels of CO_2. Additionally, a new system may reduce total operating costs, both by reducing the draw on ships' power and chilled water systems and/or maximizing the amount of time between required sorbent replacement.

Any material under consideration for CO_2 capture would need to work within the typical submarine operating environment and must be robust. Materials must be stable under a range of humidity conditions, typically between 30-60% relative humidity, and maintain a background level of 0.5% CO_2. A granular product in the 200-1000 micron range is preferable for this application. Materials must offer a high cyclic stability over extended durations in a typical environment—0.5% CO_2 in a balance of air.

PHASE I: The company will develop a concept for a material appropriate for CO_2 capture meeting the requirements described in the above description. The company will demonstrate the feasibility of the concept through modeling or analytical methods in meeting Navy needs and will establish that the material can be reasonably developed into a useful system for the Navy. The Phase I Option, if awarded, should include initial material layout and capabilities description of how to incorporate the material in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a functionalized form of the material and test it on a lab scale under the appropriate conditions to simulate a submarine environment. The material will be evaluated to determine its capability in meeting the performance goals defined in Phase II SOW and the Navy requirements for CO2 removal materials. CO2 removal material system performance will be demonstrated through material evaluation and analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to finalize and deliver a sample of prototype material that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the CO2 removal system into Navy use on the Ohio Replacement Submarines and potentially backfit onto prior classes of submarines. The company will finalize and fabricate the CO2 removal material system to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for transition into operational Navy use. Following performance testing and validation, the system is expected to produce results outperforming the current CO2 capacity in regards to meeting the Navy's requirements for CO2 removal materials which offer more space and volume savings for the submarine while using less power and load on the ship's chilled water system. CO2 capture materials have many commercial applications, the most common being "green" technologies and stripping CO2 from power plant stack gasses. These applications operate under a higher CO2 background level, but the technologies operate under the same basic principles and technology developed under this SBIR would directly apply to commercial applications.

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1. Mason, John T. "LOS ANGELES CLASS and OHIO CLASS Carbon Dioxide Removal System – System Health Report," 30 May 2007.

2. Demessence, Aude, D'Allesandro, Deanna M., Foo, Maw Lin, Long, Jeffery R., "Strong CO2 Binding in a Water-Stable, Triazolate-Bridged Metal-Organic Framework Functionalized with Ethylenediamine." J. Am. Chem. Soc., 2009, 131 (25) pp 8784-8786. http://pubs.acs.org/doi/full/10.1021/ja903411w

3. Sumida, Kenji, and others, "Carbon Dioxide Capture in Metal-Organic Frameworks", Chem. Reviews, 2012, 112 (2), pp 724-781; http://pubs.acs.org/doi/pdfplus/10.1021/cr2003272

KEYWORDS: CO2 capture; CO2 removal materials; submarine CO2 removal; Metal Organic Framework; Navy removal of CO2 using liquid materials; submarine air system reliability.

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

N161-041 TITLE: Guided Missile Submarine SSGN Seawater System Antifouling

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS392, Strategic and Fast Attack Submarine Program Office

OBJECTIVE: Develop a system that will inhibit biological fouling of seawater system piping and components that will result in the reduction of total ownership cost from existing submarine fouling removal procedures.

DESCRIPTION: Current seawater system antifouling methods employed on LOS ANGELES/SEAWOLF Class and VIRGINIA Class submarines (Electrolytic Chlorine Generators (ECGs)) have proven to be effective at minimizing fouling, but have also proven to be costly (equipment acquisition and refurbishment costs in excess of $1M) and pose a significant problem for the supply system (long lead times for difficult to obtain (e.g. electrodes) or obsolete (e.g. power supplies) system components). As such, the Navy is interested in the development of a new system that provides the benefits of previous systems without the hindrances.

Fouling of Guided Missile Submarine (SSGN) condensers and heat exchangers, caused by ocean based organisms (barnacles, tube worms, zebra mussels) living in and restricting fluid flow, significantly impacts the operational capabilities (Ao) of the SSGNs and requires significant cost, schedule, and ship's force/shipyard efforts to resolve. As discussed above, there are means of preventing fouling installed on other classes of submarine, but 1) no growth prevention system exists on SSGN's; and 2) those existing systems on other classes come with a high initial purchase cost and high refurbishment costs.

The Navy desires a method or system for its OHIO Class submarine which will inhibit biological fouling of seawater systems, has inherent capability to tie into existing seawater system piping , and: 1) meets the high integrity standards (SUBSAFE Requirements Manual NAVSEA 0924-062-0110) of submarine sea water systems, 2) minimizes integration/redesign of existing system configuration, 3) meets the environmental standards for various areas of operation, 4) demonstrates current or new concepts that can be innovatively designed to fit into the submarine environment , and 5) demonstrates cost savings compared to the costs of cleaning the clogged seawater systems (estimated at $210,500 / 526.25 man-days per hydro lancing).

PHASE I: The company will develop a concept and demonstrate anti-fouling method feasibility by presenting theoretical means of inhibiting or removing growth. The company will provide a proposed system delivery method or integration plan (such as how the system would connect into a seawater system) and associated basic calculations for the system or method requirements (required system flow rates, power requirements, chemical consumption rates, and others as applicable). The company will present the expected innovation for proposed system or method if commercial technology is to be converted for submarine use, and anticipated cost savings based on the costs of currently employed cleaning methods (hydrolancing). The Phase I Option, if awarded should include the initial layout design and capabilities description for the system to be developed in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop and deliver a prototype Seawater Antifouling system for evaluation. The prototype will be evaluated to determine its capability to inhibit (no growth visible during tube inspection) growth (for example, seaweed, barnacles, tube worms, zebra mussels) defined in the Phase II SOW and developed system demands (such as power requirements, component, and constituent spatial requirements). The method or system must demonstrate its ability to inhibit growth, thereby reducing or eliminating the need for the Navy to invest manpower and resources in seawater system cleaning. The method or system will need to be evaluated for ease of required maintenance (for example chemical addition or electrical component replacement, and environmental impact such as required local environmental testing for submarine home ports (Sea Urchin Fertilization Test Method)).

PHASE III DUAL USE APPLICATIONS: The company will support the Navy in transitioning the anti-fouling inhibiting system to Navy use. The company will finalize the design and fabricate anti-fouling systems according to the Phase III SOW. The anti-fouling systems will be installed per programmed Ship Alteration (ShipAlt) on OHIO class SSGNs. The company will support the Navy for test and validation in accordance with environmental and operational requirements to certify and qualify the system for Navy use. The anti-fouling system could have private sector commercial potential for any ocean-going vessel susceptible to biological fouling. For military applications, the anti-fouling system could have further military employment potential for both surface and additional submarine platforms.

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1. Anish. "4 Types of Anti-fouling Systems Used on Board Ships to Prevent Marine Growth." Marine Insight. 05/31/2012; http://www.marineinsight.com/tech/4-types-of-anti-fouling-systems-used-on-board-ships-to-prevent-marine-growth/

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KEYWORDS: Antifouling; biofouling; sea water system blockage; marine growth prevention; chemical dosing; electro-chlorination

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

N161-042 TITLE: Theater Multi-Mission Planner

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 5, Undersea Warfare 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 5.4.c.(8) of the solicitation. 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 theater level multi-mission planner that can assess tradeoffs in mission performance versus risk.

DESCRIPTION: The Navy has a need for a Tactical Decision Aid (TDA) or software component for Theater Anti-Submarine Warfare (ASW) level multi-mission planning capability that can provide Warfighters the tools needed to develop multi-warfare missions and provide decision makers quantitative information needed to assess multi-mission performance and associated risk management. This technology will provide an automated mission planning capability with algorithm(s) that optimize area allocations based on multiple mission objectives and constraints, asset capability and availability, opposing force capabilities, and environmental factors. This technology will also provide a quantitative measurement of effectiveness for expected mission performance versus risk.

Theater ASW Commanders (TASWC) are tasked to plan, coordinate and direct multiple warfare missions in dynamic and complex regions (Ref. 1and 2). This can be a challenging multi-mission planning problem due to the amount of time and requisite knowledge required to develop the critical factors, Courses of Action (COAs), Enemy Courses of Action (ECOA), and associated alternatives for decision makers to assess each mission's performance and balance that with quantifiable risk management metrics. "Critical factors are those attributes considered crucial for the accomplishment of the objective. These factors that in effect describe the environment (in relationship to the objective) should be identified and classified as either sufficient (critical strength) or insufficient (critical weakness)" (Ref. 1).

Theater planners respond to operational needs of the Sea Combatant Commander by providing available resources. To fulfill mission objectives, warfare commanders have to balance available resources and assets with real world operations tempo and Combatant Command (COCOM) tasking. Timely development of plans that can account for performance and vulnerability for simultaneous execution of: ASW; Intelligence, Surveillance, and Reconnaissance (ISR); Surface Warfare (SUW); and other maritime missions are impractical using today's mission planning tools and methods. Today, automated multi-mission planning tools do not exist and as such skilled operators are obligated to perform this task manually. (Ref. 4) This manual process is very time consuming and it has the potential to draw operators away from other necessary tasks and risks reducing observations of important information. The Navy seeks to automate this planning process to reduce the time it takes to develop and analyze plans and provide the decision makers with quantitative metrics to assess resource allocation and risk. This is a complex problem and is more likely to reduce the time in a percentage range 300-400% from a current manual process.

Innovative solutions that provide an automated mission planning capability for the Undersea Warfare Decision Support System (USW-DSS) AN/UYQ-100 at sea for the Sea Combatant Commander (SCC) and the Theater ASW Watch Floor Battle Watch Captain are sought. The prototype/software will be a Tactical Development Aid (TDA) that is compliant with Navy doctrine, tested in the lab during the Phase II effort and evaluated by Subject Matter Experts (SMEs) for effectiveness. Certification and schedule will be in parallel with transition system certification. As an innovative, new capability, the solution will seek to optimize multiple warfare mission platforms consisting of ASW, Mine-Warfare, Strike-Group ASW, Theater ASW, and Water Space Management to provide a quantitative prediction of effectiveness that compares Navy assigned mission effectiveness thresholds (area clearance, vulnerability) and Navy assigned risk thresholds, for expected mission performance versus risk. The risk threshold metrics could include vulnerability, counter-detection, and impact to mission. Other risk metrics may also be considered.

PHASE I: The company will develop a concept for an innovative Tactical Decision Aid that meets the requirements listed in the description. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be developed into a useful product for the Navy through testing, and analytical modeling. The company will provide testing facilities and personnel during Phase I. The Phase I deliverable should include the initial key technical milestones and capabilities description to build the Tactical Decision Aid in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a Tactical Decision Aid prototype for evaluation. This could be either standalone or integrated with existing capabilities depending on what is proposed by the company. The prototype will be evaluated in a land based USW-DSS test environment to determine its capability in meeting the performance goals defined in the Phase II statement of work and the Navy requirements for an innovative Tactical Decision Aid, as described in Navy doctrine NDP.05 Navy Planning. Since an automated capability for this topic does not currently exist, the system performance will be demonstrated through prototype evaluation or analytical methods that aid the warfighter on how best to utilize available war fighting resources. Evaluation results will be used to refine the Tactical Decision Aid prototype into an initial design that will meet Navy requirements. The Navy will provide secure facilities and test environments. Test and evaluation periods will be determined based on the prototype development schedule and program of record test events; when practical Fleet input may be utilized for in-depth evaluation. The company will deliver a prototype Tactical Decision Aid software application to the Navy at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: In Phase III the company will be expected to support the Navy in transitioning the Tactical Decision Aid for Navy use. The company will finalize its design on an innovative Tactical Decision Aid for evaluation to determine its effectiveness in an operationally relevant environment. Following its completed design at a TRL 8, the company will support the Navy for operational test and validation to certify and qualify the system for Navy use. The Tactical Decision Aid will be implemented into a current USW-DSS build under development for use on the Theater ASW watch floor, i.e. CTF-34 and the Aircraft Carrier Strike Group Sea Combatant Commander Zulu Module. Product test, integration, and validation will be conducted during the program of record development cycle where appropriate. The company will participate in associated Integrated Product Teams (IPTs) such as, but not limited to, development, architecture, test, and integration. The company may be expected to engage with the Configuration Control Board. Commercial applications for mission planning that include risk assessment capabilities vary from simplistic to very complex. Utility companies, commercial transportation companies, and emergency response organizations could all benefit from this capability. Disaster preparedness is a specific area that could successfully employ this capability where environmental and logistical information constraints and likelihoods, disaster response optimization, and predetermined risk factors are weighed against one another to develop the best options for an organization's response.

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KEYWORDS: Theater Anti-Submarine Warfare Commanders; theater ASW; multi-mission warfare planning; automated mission planning; risk management of Naval operations; COAs

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

N161-043 TITLE: Automated Verification and Validation for Distributed Testing

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: PEO IWS 5, Undersea Warfare 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 5.4.c.(8) of the solicitation. 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 testing framework for automated Verification and Validation to support distributed system testing between the AN/SQQ-89 Undersea Warfare Combat System and Aegis Weapons System (AWS).

DESCRIPTION: The Navy needs to implement Automated Verification and Validation (V&V) to support distributed testing between AN/SQQ-89 Undersea Warfare Combat System, Aegis Weapons System (AWS), and other Combat System (C/S) elements. Current capabilities do not support distributed testing with stand-alone or wrap-around simulation and stimulation (SIM/STIM) tools. This topic will increase V&V coverage and reduce the 18-month average lag time between software baseline freeze and combat systems certification to 12 months. The primary bottleneck in Navy element and C/S certification is availability of subject matter expert (SME) manpower to investigate tough cognitive issues encountered during V&V. The reason for the manpower bottleneck is that a significant amount of SME labor is expended in sites planning of stand-alone SIM/STIM tools and repetitive regression testing. Several case studies (Ref. 1, 2, and 3) suggest automated V&V tools would significantly eliminate the manpower bottleneck for testing real time complex systems. The use of automated V&V tools will reduce manpower to the minimal amount required to set-up and maintain testing. An innovative technology will reduce life cycle costs through improved V&V coverage and improved SME availability for tough cognitive troubleshooting issues during developmental test and evaluation. Automated V&V will reduce post-fielding operations and support costs by reducing the number of software and hardware defects delivered with the end product. Automated V&V also allows more efficient use of manpower by reducing SME time expended in both sites planning and repetitive testing.

The needed technology will create an innovative and automated external interface testing (EIT) framework for automated V&V including diagnostics, data recording, analysis tools, and automated reporting. The new tool will apply to the following interfaces: track management (including fire control and track reporting), sensor interfaces (including radar), and future capabilities. It is imperative that this Automated V&V system be compatible with existing Aegis baselines (e.g., 5.3.9, 6.3 with and without ALIS, and 7.2) and have the ability to adapt as C/S elements are modernized.

This topic will reduce the 18-month lag time from software freeze to actual fielding, and simultaneously increase V&V coverage with significantly less resources than traditional methods. The Navy would greatly benefit from being able to collect Objective Quality Evidence (OQE) for element and C/S certification using a distributed engineering test bed with automated V&V tools. The desire is to enhance performance of increasingly complex Navy combat systems by ensuring stability, robustness, and survivability prior to fielding.

The goal of this topic will be use of automated V&V technology for distributed engineering test and verification. Automated testing must at a minimum be applicable to the following C/S states and modes: tactical (real-time), test (built-in self-diagnostics), and training (synthetic SIM and STIM). Additionally, the distributed combat system test bed must faithfully replicate the shipboard configuration needed for logical testing of C/S elements and provide the capability for network sensitivity analysis to evaluate the stability, robustness, and survivability of the entire combat system prior to certification. Finally, a complete solution will include the ability to provide objective quality evidence (OQE) for Element certification, C/S certification, and eventually Warfare System certification that culminates with testimony to readiness for at-sea testing, as required in the C5ISR Modernization Policy (COMUSFLTFORCOM/COMPACFLT 4720.3b) (Ref. 4).

PHASE I: In Phase I, companies will develop a conceptual framework for automated external interface testing (EIT) of SQQ-89 for tactical, test, and training states and modes of the combat system. Feasibility will be demonstrated with a prototype test tool design capable of external interface testing between SQQ-89 and Aegis Weapon System via an existing Distributed Research and Engineering Network data link infrastructure. The Phase I Option, if awarded would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will build an automated V&V test tool prototype to include network diagnostic tools, data recording, and automated analysis and reporting. The Phase II developed prototype will be used to conduct an automated V&V demonstration with SQQ-89 and Aegis weapon system over an existing data link infrastructure between developer sites. A prototype V&V test tool will be delivered at the end of Phase II. The company will develop a Phase III plan for transition.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology in Phase III, with the addition of a testing framework to collect OQE for SQQ-89 element and Aegis C/S certifications using a distributed engineering test bed. Phase III transition is intended to fill a critical gap in Research Development Test & Evaluation (RDT&E) across the entire surface ship distributed engineering plant, which spans both industry development and Navy certification sites (connected by data link). This automated testing platform could be used in commercial application, such as testing large quantities of a product or automated testing on software integration. It is applicable to any highly complex, highly survivable system or systems with real-time operation requirement (Commercial and Government).

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KEYWORDS: Automated V&V; Combat Systems certification; V&V Coverage; V&V Throughput; Objective Quality Evidence (OQE); External Interface Testing (EIT)

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

N161-044 TITLE: OHIO Class External Hull Antifouling

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS392, Strategic and Fast Attack Submarine Program Office

OBJECTIVE: Develop a rapidly installable and removable system that will minimize, inhibit, or remove marine biological fouling on the external surface area of the boat (hull and control surfaces).

DESCRIPTION: Biological fouling of a submarine's hull greatly reduces the propulsion plant efficiency by increasing the hull's hydrodynamic resistance and leads to obstruction of internal seawater systems. Remediation of biofouling requires significant diver labor with hull cleaning tools, which increases cost of maintenance from both the manpower and radiological perspectives and reduces Operational Availability (Ao). Currently employed antifouling coatings on OHIO Class submarines do inhibit growth; however, the antifouling coatings are not effective under the stagnant conditions experienced by submarines while in port. Development of a cost-effective, submarine antifouling method or system that inhibits or removes biofouling during in-port periods will mitigate the biofouling concern and free up valuable maintenance resources thus supporting the Navy's need of improved Operational Availability (Ao) and reducing life-cycle maintenance costs. Current systems in use, i.e., diver tools or UUV hull cleaners, are focused on removing fouling that has already occurred; the goal of this project is to prevent the need to utilize these systems and the repeated expenditure associated to these cleaning events.

The Navy desires a temporarily installed system or method that will mitigate and/or control biological fouling on the external surfaces of the ship during in-port periods. This system or method must be capable of being rapidly installed and removed to support submarine arrivals and departures and require only minimal personnel demands to operate during maintenance periods. The goals of this system or method are to: 1) not alter the hydrodynamic flow of the hull while at sea (change the hull form); 2) not impact the high integrity standards of submarine sea water systems or hull integrity (no changes to existing SUBSAFE boundaries (Requirements Manual NAVSEA 0924-062-0110) or systems); 3) minimize integration or redesign of existing system configuration; 4) coincide with current standing environmental requirements ; and 5) demonstrate a Return on Investment ROI in under 4 years (based on the cost and manpower savings for eliminating the need for hull cleaning on submarines).

PHASE I: The company will define and develop a concept for inhibiting or removing sea growth that meets the requirements as stated in the Description section above. The company will demonstrate the feasibility of the concept through analysis of how existing or available systems (for example, ultrasonic systems or other coating systems) could be improved upon for Navy use, or via theoretical means in the form of equations or biological interactions. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop and deliver an external hull antifouling method or system prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II SOW and in the reduction or removal of sea growth on a representative submarine hull. It is recommended that system performance will be demonstrated through installation and/or application of the method or system on an inactivated submarine hull at Puget Sound Naval Shipyard to address system interaction with boats that have varying hull coating types to determine acceptability for use in ports that service all types of Naval submarines. The method or system must demonstrate its ability to remove or inhibit growth, thereby reducing or eliminating the need for the Navy to invest manpower and resources in hull cleaning. The external hull antifouling method or system will be evaluated for ease of required maintenance (preservation requirements, chemical addition, and electrical component replacement) and environmental impact.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the antifouling system or method's integration to Navy use on the OHIO Class submarine. The company will finalize the design and fabricate production units according to the Phase III SOW. The final products will be installed, demonstrated, and tested in accordance with developed operating procedures. The company will support the Navy for test and validation in accordance with environmental and operational requirements to certify and qualify the system for Navy use. The antifouling method or system described in the SBIR topic could have private sector commercial potential, as the innovation or improvements developed for the Navy could potentially be employed for any ocean-going vessel susceptible to biological fouling. For military applications, the antifouling system could have further military employment potential for both surface and additional submarine platforms.

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KEYWORDS: Marine antifouling; biological fouling; marine biofouling; marine growth prevention systems; anti-fouling coatings; factors impacting hydrodynamic flow

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

N161-045 TITLE: Coastal Battlefield Reconnaissance and Analysis (COBRA) Hardware In The Loop and Software Sensor Simulator

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS495, Mine Warfare Program Office, Coastal Battlefield Reconnaissance and

OBJECTIVE: Develop a Hardware in the Loop (HIL) test-bed for current and future Multi-Spectral Imaging (MSI), Simultaneous Multi-Spectral Imaging (SMSI), and future Coastal Battlefield Reconnaissance and Analysis (COBRA) Block II sensors.

DESCRIPTION: The mission of COBRA is to conduct unmanned aerial tactical reconnaissance in the littoral battlespace for detection and localization of minefields and obstacles in the surf zone and beach zone prior to an amphibious assault. The COBRA Block I system is in Low Rate Initial Production (LRIP) and is designed for daytime detection of surface laid mine-lines and obstacles in the beach zone with limited capability in the surf zone (Ref. 1). The COBRA Block II program, currently beginning development, extends the minefield and mine line detection into the Surf Zone while adding nighttime capability. The COBRA program is interested in technologies that would facilitate quicker selection of sensors and a consistent platform for comparing sensors for both Block I and Block II systems.

To achieve the detection goal, COBRA Block I utilizes a passive, multi-spectral sensor system which operates in 6 bands from near UV to near infrared. The sensor is capable of providing 4 frames per second (4 Hz) for the 6 bands with a 16M camera (4896x3264) yielding a Ground Sample Distance (GSD) of 2.4" which translates into 6.1 Gigabits per second (Gbps) of data. The sensor is capable of daytime surface-laid mine line and obstacle detection in the beach zone with off-board processing. As new sensor advancements and technologies become available for both current and future blocks, the COBRA system does not have an efficient means to test new hardware but must rely on extensive developmental data collection (flight tests) to determine the effectiveness of one complex sensor over another. Historically, data collections for unmanned air vehicles (UAVs) require approximately 6 months to plan, coordinate, execute, and analyze. In addition, inadequate comparisons of sensors exist due to the six-month lag and the development of other components on the project. As a result, some sensor configurations are not compared with the same common tool set and developmental costs are high.

This topic is seeking an innovative method and system to provide real-time comparisons of the performance of new Multi-Spectral Imaging (MSI), Simultaneous Multi-Spectral Imaging (SMSI), and other future COBRA Block II sensors against a consistent baseline to reduce time and cost by comparing sensors (both same generation sensors and current generation vs future generation) without the need to collect extensive imagery data. Based on an estimate of $500,000 per data collection, savings of up to $10,000,000 will be realized for each COBRA sensor. In addition, the time associated with data collection can be reduced from 6 months to a few weeks.

Two common ways to develop sensors are through physical trial and error tests or through simulation. Ignoring the previously identified time lag and the lack of common platform, due to the delicate and expensive nature of UAVs coupled with the risks of damage to property during testing, trial and error is not a workable solution (Ref. 2). While simulation is a powerful tool, it cannot capture all real-world variables such as machine noise, actuator lag, and other factors encountered during testing. HIL simulation will merge the power of simulation with the actual physical components of the system being tested (Ref. 3). Developing a common sensor test-bed would allow all sensors to be compared against the same tool set, reduce the risk of damage to the system, but most importantly reduce the cost and time of data collection. The proposed platform should leverage existing scene generation models within COBRA.

The complete toolset can be validated through comparison to real data collections. Technical risk for the software models is low as substantial existing imagery for the MSI camera exists and will be used to validate detection of minefields and obstacles. Technical risk for the HIL is low as commercial components such as optical collimators are available and should support the camera specifications. A government approved acceptance test procedure (ATP) will be developed, used for final testing, and will be used for success metrics to include Signal to Noise Ratio (SNR) and Contrast Transfer Function (CTF) measured across the Field of View (FOV). In addition, the HIL can be used to test automatic gain control and other high level system behaviors. Real imagery allows comparison of receiver response to high and low intensity scenes within a frame as well as between frames which just isn't possible when only test patterns are used. In addition, image quality can be quantified based on National Imagery Interpretability Rating Scales (NIIRS) approach and methodology.

The proposed HIL system will be required to conform to the Navy's Open Architecture (OA) initiative. Modular design of hardware and software components will enable openness to the Navy and other contractors. The HIL platform should be designed to support the current COBRA Block I MSI camera, the forthcoming Block I replacement camera (SMSI), and future Block II sensors. The HIL platform will allow objective comparison of multiple cameras on the same test-bed.

COBRA HIL and Software Sensor Simulator platform addresses the Navy needs such as land-based mine detection from a Fire Scout Vertical Takeoff and Landing Tactical Unmanned Aerial Vehicle (VTUAV). Additionally, the COBRA Machine Learning development effort will reduce the non-recurring engineering costs for the COBRA program while improving the overall performance and capability of the COBRA System.

PHASE I: The company will develop a concept for a COBRA HIL and Software Simulator System that meet the requirements outlined in the description. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Material testing and analytical modeling will establish feasibility. The Phase I Option, if awarded, should include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a HIL Development, Software Model, and Product Integration prototype for evaluation and delivery. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II SOW and the Navy requirements for the COBRA HIL and Software Simulator System. System performance will be validated at the contractor's location with government oversight. Validation will be the comparison of the HIL simulation vs. flight test data previously collected for daytime detection of surface laid mine-lines and obstacles in the beach zone. Evaluation results will be used to refine the prototype into an initial design that will be delivered to the Navy and meets Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the technology for Navy use. The HIL test-bed developed according to the Phase II SOW will be tested and certified to determine its effectiveness in the COBRA program. The HIL test-bed will transition to COBRA but will be a Depotlevel asset. The company will support the Navy for test and validation to certify and qualify the system for Navy use. In addition to successfully transitioning HIL and Software Sensor Simulator into the COBRA program, the technology is adaptable directly to many commercial activities that have significant potential in the private sector. HIL applications include commercial photography, agriculture, and medical imaging. Attention will be given to these dual use applications as the program progresses to address potential commercial spin off opportunities.

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KEYWORDS: Multi-Spectral Imaging (MSI);Simultaneous Multi-Spectral Imaging (SMSI); Hardware In the Loop (HIL) test-bed; optical collimators; control algorithms for unmanned air vehicles UAV; vision-based control

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

N161-046 TITLE: Ceramic-Metal Joining for Hypersonic Vehicle and Missile Components

TECHNOLOGY AREA(S): Weapons

ACQUISITION PROGRAM: ONR FNC SHD-FY15-07 (Hypervelocity Projectile)

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 5.4.c.(8) of the solicitation. 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 for joining ceramic components to metal airframe components that will withstand the aerothermal heating of high-speed air vehicles.

DESCRIPTION: Development of high-speed munitions, such as the Hypervelocity Projectile (HVP), has many technical challenges due to the aerothermal heating and stresses that munition components are subjected to during flight. The HVP munition control surfaces expect to face very high aerothermal stresses which require a combination of materials to address these issues. The joining of these materials is vital to munition performance as its integrity during launch and lengthy flight times must be maintained. In addition to control surface applications, joining technologies will also be applicable to missile components (such as radomes) with performance parameters that will be extended (for example speed and time of flight) with future missile development programs. In a high-speed air vehicle environment, aerothermal heating subjects vehicle components to high temperatures that affect their structural integrity. Several of the components of a high-speed air vehicle are affected.

Fins, for example, experience severe heating on the leading edges, but the temperature drops significantly a short distance back from the edge. The majority of the fin may experience temperatures that are more moderate. An attractive design approach would be to use higher temperature materials like ceramics on the leading edge and common aerospace materials such as titanium alloys for the bulk of the fin, since only the leading edge portion may exceed allowable temperatures for metals. This approach requires an attachment technology to affix ceramic leading edge inserts onto metal components such as fins. These inserts must be attached in a manner that will survive the temperatures and stresses resulting from flight. Ceramic missile radomes, which are sometimes mounted to the metal airframe with polymer adhesively bonded composite rings, begin to fail as vehicle flight speeds and times increase. The thermal capabilities of polymer adhesives are exceeded which then cause the joints to fail. The Navy needs a technology that adheres ceramic to metal and withstand the high temperatures and stresses incurred while a high velocity airframe component is in flight.

This effort requires combined knowledge of hypersonic vehicle design, aerothermal heating concepts, mechanical engineering (modeling of stresses), and materials science including ceramics, metals, and joining. The successful approach will involve innovative design in addition to appropriate materials science concepts. The principle transition for this topic is control surfaces or fins on hypersonic vehicles such as advanced missiles or the rail gun projectile (Ref. 3). These control surfaces can be relatively small, with dimensions of just a few centimeters and a sharp leading edge radius of approximately 1 mm or less. The thickness of the control surface may only be a centimeter or less, as well. Since weight is always a concern for air vehicles, lower density and high temperature capability technologies are crucial. Flight speeds range from Mach 5 to 8, and flight times range from a few seconds to several minutes. Launch is typically at sea level. The missile body diameters may range from five inches to over one foot.

With these conditions, the temperature of the leading edge is too high for metals to function properly (Ref. 1). Past efforts involving ceramic leading edges have concentrated on much larger structures on the scale of manned vehicles like the space shuttle, with significantly more blunt leading edges. In contrast, for high-speed air vehicle applications, oxide ceramics and silicon nitride are of primary interest, and would be attached to common aerospace metals such as titanium alloys. Many materials have been investigated, including ceramic matrix composites and carbon-carbon composites, but for these sharp edges, the most promising class of materials has been the Ultra High Temperature Ceramics (UHTCs). This group includes materials such as silicon carbide and zirconium diboride. Johnson (Ref. 2) discusses the advantages of these materials for leading edges.

Technologies and processes are sought to allow successful attachment of appropriate ceramic leading edge inserts to high temperature metal structures such as the fins. The means of attachment may include mechanical designs, brazing, diffusion bonding, or combinations of these. The attachment design must mitigate or accommodate the stresses resulting from the temperature gradient and withstand mechanical loads as well. For example, a control surface on a missile launched at Mach 5 may experience temperatures as high as 2000°C at the leading edge, and 200°C at the root. This temperature differential will result in significant stresses, which will be combined with stresses from aerodynamic pressure as control surfaces articulate. A suite of tests provided by the company will be used to characterize the technology through the required service conditions including temperature, oxidation, and stresses. The technology developed in this topic will enable higher performance projectiles and missiles to operate at higher speeds and for longer flight times.

There is also an element of cost reduction potential concerning materials costs in manufacturing. Fins composed entirely of ceramics can be very expensive. A solution using ceramic inserts with metal structures, for example, could reduce total munition acquisition cost. This would manifest itself even more in a projectile application (vs. missile), where higher quantities are envisioned for procurement.

Development of high-speed munitions, such as the Hypervelocity Projectile (HVP), has many technical challenges due to the aerothermal heating and stresses munition components are subjected to during flight. The HVP is being developed for both the Navy MK 45 MOD 4 gun system and the Electromagnetic Rail Gun (EMRG) application. In both of these applications, munition control surfaces are expected to face very high aerothermal stresses, requiring a combination of materials to address these issues. The joining of these materials is vital to the munition performance as its integrity during launch and lengthy flight times that must be maintained.

PHASE I: The small business will investigate feasibility of their concept for joining ceramic components to metal airframe components by conducting bench-scale experiments joining model materials of interest. The concept will be substantiated by using standard materials science investigative methods (optical and electron microscopy, x-ray diffraction, microhardness), and the thermostructural capabilities of the joints will be measured. Modeling should be employed to estimate thermal shock response and testing shall be used to validate modeling to prove feasibility. The

Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results in Phase I and the Phase II Statement of Work (SOW), the company will scale-up the attachment methods to produce a notional model component full scale or sub-section prototype. Additionally, radome sub-sections may be prepared. The prototype components should be subjected to extensive characterization through testing and analyzing with the goal of demonstrating that the attachment method can function under the required service conditions including temperature, oxidation, and stresses. The suite of tests that demonstrate the characterization of the technology will be identified by the small business during this phase and must be approved by the EMRG program office. These tests may include high temperature mechanical tests, thermal shock tests, oxidation tests, non-destructive testing, and microstructural examinations. The company will prepare a plan to transition the technology to the Navy during Phase III for a specific application to be identified with Navy input during execution of Phase II. Information in this phase may possibly be classified depending on level of success and tie-in with program.

PHASE III DUAL USE APPLICATIONS: The HVP is being developed for both the Navy MK 45 MOD 4 gun system and the Electromagnetic Rail Gun (EMRG) application. Transfer of this technology to Navy use will involve manufacture of components such as fins including the ceramic inserts able to meet performance parameters of the EMRG HVP. The contractor will support the manufacturing of the components employing the technology developed under this topic, and will assist in the qualification testing defined by the Navy program. This testing will be similar to that described in Phase II, but more extensive. It is likely that work in Phase III will be classified. There are many commercial uses for ceramic-metal joining, including medical components, vacuum feed troughs, cutting tools, and electronic components. The potential for application of the developed technology into these areas will depend on a comparison with existing technologies in use (typically brazing) including performance and cost.

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KEYWORDS: Ceramic-metal joining; hypersonic vehicle design; ultra-high temperature ceramics; control surfaces at hypervelocity; hypersonic vehicle fins; ceramic missile radomes

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

N161-047 TITLE: Lithium Battery Early Warning Fault Indication System

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS394, Advanced Undersea Systems Program Office

OBJECTIVE: Develop an innovative early warning battery fault indication system with low energy input and a target volume of 125 cm^3 for sensors and electronics.

DESCRIPTION: A fault in current Navy used lithium (primary and secondary) batteries can occur for various reasons such as overcharge, impact, manufacturing issues, or latent defect. When a fault occurs, the battery can release toxic and flammable gases which can start and feed a fire or cause significant equipment damage and present catastrophic hazards to personnel safety. Testing has shown that early signals of a battery issue can occur internally. If detected early, the system can provide valuable warnings of single or multiple cell issues before they evolve into bigger and more hazardous issues. The early signals will indicate the presence of smoke and particulates, light, heat and sound emission, pressure increase, and an increase in Volatile Organic Contaminants (VOC) over a known baseline level for the application (the free floodable volume of a sealed pressure vessel or Unmanned Underwater Vehicle (UUV)) (Ref. 1 through 4).

The early warning signals would provide operators time to complete required preventive and corrective actions to ensure personnel and platform safety. The UUVs as identified in References 1 through 3 have no early warning system integrated into its battery design or battery enclosure with these characteristics. A single cell fault or failure may go undetected until it has propagated out of control and causes visual indications of a battery event external to battery enclosure. At that point, it is too late and does not allow sufficient time to stop propagation effectively and satisfactorily protect personnel, equipment and the platform from toxicity and flammability and explosion hazards, causing irreparable damage.

The battery fault early warning system shall be comprised of sensing device(s) that can identify smoke and particulate, light, heat and sound emissions, pressure and VOC variations or other clearly identifiable precursors for incremental and sudden battery failure. When detected, the device will cause an alarm to be seen and heard from a remote wired or wireless alarm panel. The battery fault early warning system shall not cause modification to the battery design. Use of existing battery enclosure penetrations will be required (such as underwater pressure feedthroughs). The system components shall be packaged with all remote sensors communicating to a single unit, which will provide alarm indication. System shall have the capability to interface with vehicle controller using standard communication protocols (i.e., Ethernet, etc.). The sensing device(s) shall be compact and adaptable to a circuit card or embeddable assembly within an enclosure and require a low amount of power to operate. The threshold space, weight, and power requirement is 400 cm3, 1kg, 25 watts and the objective is 200 cm3, 550 grams, 5 watts. Operation may be self-powered or externally powered via an adaptor to the external feedthroughs. The device shall be configured such that it can monitor and detect a single cell event inside the battery enclosure (Ref. 1 through 4 is an example of a “target application battery enclosure” - REMUS 600 development). In order to minimize false alarms, the system shall rely on double fault detection.

The smoke and particulate sensor could be an optical sensor or could borrow from commercial electronic nose “sniffer” technology (such as photo-ionization detectors or mass-spectrometer-on-a-chip systems). However, to be compliant with existing Navy safety standards and minimize approval requirements, sensors utilizing radiation sources shall not be utilized. The VOC sensor shall not use oxygen dependent detector as that could itself cause a battery event. The detector assembly shall not be a source of flammable gas ignition with respect to explosive atmosphere conditions. The system shall not trigger on any single low-level event. The system shall trigger on any single high-level event and will implement data fusion to support a combination of several low-level events as indicators of possible developing issues. The ability for each sensor to accurately detect what it is designed to detect shall be demonstrated and tested by the developer and an independent Navy lab with a Navy approved test plan. The VOC sensor shall be accurate to detect and report concentrations of organic vapors from 5 to 20000 parts per million (PPM) within +/- 1 ppm.

The fault sensing technology shall take advantage of Commercial-Off-the-Shelf technology as applicable. The system shall be ruggedized in order to withstand worst-case environments inside the battery enclosure (thermal flux, pressure, corrosives) for the period before a battery event becomes catastrophic and affects the surrounding area outside of the battery enclosure. The detector must be capable of functioning and meeting Grade A characterization after exposure to MIL-S-901D shock impacts. The system shall be able to provide both audible (> 80 dB) and visual indications on a wired or wireless remote indicator panel. The panel does not have to be another company designed device and could instead be a cell phone or computer software application. If wireless technology is used, it shall not affect the battery operation, shall not provide electromagnetic interference (EMI), and shall be tested to meet MIL-STD-461 requirements. If a software application is used, it shall meet the requirements of MIL-STD-882E and Joint Software Systems Safety Engineering Handbook for design and testing of Navy safety critical software. Sufficient redundancy shall be present in the system so that if the power is lost, other power options are available, or if a sensor fails, the system can still function to monitor for a single battery cell fault. System maintenance shall be limited to routine calibration and/or replacement as needed.

The final system shall provide operators with real-time audio and visual feedback of cell and battery faults that may lead to a battery casualty and failure, with the release of heat, toxic products, and local high-pressures or flammable gases (thermal runaway of either primary or rechargeable chemistries posing hazards to personnel and local environments). The use of sensor fusion from multiple detectors examining characteristic precursors and emissions will increase the pre-event detection with a decrease in false negative alerts. This system will reduce maintenance cost by 20% and provide safety to prevent catastrophic failure.

PHASE I: During Phase I, the company must provide a concept to solve the Navy's problem of being able to sense lithium battery fault indications from within a battery module and send an alarm indication of their presence to a wired or wireless remote monitoring panel. The company must demonstrate the feasibility of the Lithium Battery Early Warning Fault Indication System concept by testing and showing that each sensor can accurately detect what it was designed to detect when exposed to repeated simulated ambient battery environmental conditions. The Phase I Option, if awarded should include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a prototype of the Lithium Battery Early Warning Fault Indication System unit and demonstrate that it can fit in the target size and power envelope as identified in the description above. The company will integrate the sensing technology from Phase I into a real battery design prototype, which will be furnished by the Government. The battery will undergo repeated normal charge and discharge cycles. The sensors will be tested either on or once removed from the battery module. The testing will demonstrate that each sensor can still accurately detect what it is designed to detect when exposed to repeated real battery charge or discharge environmental conditions. False positives and false negative results shall be tracked over the entire testing period. Phase II test data shall show that alarm visual and audible indications, which correspond to the detected presence of smoke/particulate, light, heat and sound emission, and VOC and pressure increases were provided on a remote indicating panel (cell phone, computer or separate panel). Use of Government safety certified battery test facilities are available to the company. Successful exit from Phase II will include a transition plan for entry into the Acquisition Program to be executed as part of Phase III.

PHASE III DUAL USE APPLICATIONS: The company will support the Navy in transitioning the Lithium Battery Early Warning Fault Indication System technology to Advanced Undersea Systems use. The company will provide on-site technical assistance and assist in the development of logistical technical data. This data is used to install and operationally test the company's technology solution. A standard operational test shall validate that after the battery is installed that the system is on-line and can accurately detect battery faults. A production strategy shall be developed by the company to show that Navy's production needs can be met. This technology is used in commercial industry to monitor security indications, for example smoke/fire detector, breach of entry signals from cameras, or sensors that all tie back to a hard panel and remote alarm panel via cell phone or computer technology to alert the user.

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KEYWORDS: Lithium battery; lithium battery fault detection; early warning system; battery fault detector, battery fault detection unit; visual feedback of cell and battery faults

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

N161-048 TITLE: Miniaturized Electric Actuation System

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS394, Advanced Undersea 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 5.4.c.(8) of the solicitation. 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 seawater submergible miniaturized Electric Actuation System (EAS) with power densities comparable to an equivalent size hydraulic actuation system.

DESCRIPTION: The Navy is seeking to develop a miniaturized Electric Actuation System (EAS) to meet the demands of operating in a seawater environment while preserving the power densities available in comparably sized hydraulic actuators.

Ongoing and future development of Unmanned Underwater Vehicles (UUV) which interface with manned submersibles highlights a need to develop innovative ways of providing mechanical actuation of linkages, valves, and interlocks while facilitating packaging within the constraints of attack submarine (SSN) ocean interface. This is accomplished by utilizing actuators as system components (Ref. 1). By minimizing the host ship impacts, the threshold for integration of UUVs with manned submersibles can be significantly lowered. The current practice of using hydraulic systems to provide mechanical actuation force imposes an expensive and maintenance intensive solution. Modification of fielded systems has proven to be an expensive and time-consuming effort (Ref. 2) and may limit widespread integration of UUVs with SSNs. The current methodology for high power density mechanical actuation via hydraulic power results in significant operational and maintenance costs associated with cleanliness of the hydraulic system and maintenance of the fluid power components (control valves, actuators, pumps). By removing the specialized hydraulic plant (generally powered by electricity) and replacing with an EAS, it is envisioned that cost savings could be realized.

The EAS should be of a scale and power density comparable to a 3 inch and smaller hydraulic piston operating at a nominal value of 2,500 pounds per square inch (psi). Stroke should be up to 3 inches but not less than 1 inch.

Current EAS methodologies that meet the above criteria with pure electric, electro-mechanical, electro-hydraulic, Piezo-ceramic, or Paraffin schema are acceptable. The EAS must be capable of withstanding submergence pressures on the order of magnitude of 1,000 psi, and experience wet and dry actuation at temperatures ranging from 20 degrees Fahrenheit to 150 degrees Fahrenheit . The ability to provide a continuous force output for prolonged periods, up to 1 month, is also required.

The development of underwater EAS has focused on replacement of large hydraulic actuators with high load capacity. Development of sub-scale electric actuators, which provide the high power densities and resistance to the marine environment, will help to facilitate the integration of UUVs and SSNs in launch and recovery systems such as the Universal Launch and Recovery Module (ULRM).

PHASE I: In Phase I, the company must provide an EAS concept that demonstrates the power density and actuation length along with how that EAS is suitable for submerged environmental requirements listed in the description. Suitability for submerged environment may be demonstrated parametrically, or with conceptual analysis. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: In Phase II, the company will develop a prototype EAS(s) for testing and evaluation based on the results of Phase I and the Phase II Statement of Work (SOW). The EAS prototype will be evaluated against operationally relevant qualification requirements to determine if the technology has the potential to meet Navy performance goals described in the Phase II SOW. The performance requirements to be articulated in the Phase II SOW would include hydrostatic operations and power verification along with other shipboard qualifications as necessary. A prototype EAS will be delivered to the Navy at the end of Phase II. The company participating in Phase II will be required to prepare a plan to transition the technology to the Navy under Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the EAS technology to Navy use. The EAS must be compatible with existing UUV/manned submersible integration efforts and incorporated, where feasible, into the Tactical ULRM design. The EAS technology would provide mechanical actuation of system critical functions safely allowing the operational deployment of UUVs alongside manned submersibles. The EAS will be validated, tested, qualified, and certified for Navy use in accordance with the host ship qualification requirements and host ship supplied services. The development of high energy density undersea capable EAS could be utilized in the deep-sea resource industry and deep ocean academic investigation.

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2. GAO Report to Congressional Committees. "Increased Focus on Requirements and Oversight Needed to improve DOD's Acquisition Environment and Weapons System Quality," February 2008.

KEYWORDS: Electric actuator; Universal Launch and Recovery Module (ULRM); Large Diameter Unmanned Underwater Vehicle (LDUUV); Unmanned Underwater Vehicle; electro-mechanical; electro-hydraulic

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

N161-049 TITLE: Joint Tactical Radio System (JTRS) Compliant Anti-Jam Waveform for Littoral Combat Ship (LCS) Unmanned Vehicle Beyond Line of Sight

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS420, LCS Mission Packages

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 5.4.c.(8) of the solicitation. 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 affordable, innovative Joint Tactical Radio System (JTRS) compliant waveform to satisfy competing LCS unmanned vehicle Beyond Line of Sight (BLOS) communication requirements for high data rate, multiple nodes, and anti-jam.

DESCRIPTION: The Littoral Combat Ship (LCS) deploys multiple Unmanned Vehicles (UVs) in support of the interchangeable mission packages. The Multiple Vehicle Communications System (MVCS) provides LCS mission packages with the capability to simultaneously communicate with multiple Unmanned Surface Vehicles (USVs) and surfaced Unmanned Underwater Vehicles (UUVs) by providing a common data link and network communication services.

The MVCS is designed as an open architecture communications system that can be adapted to support any radio. The MVCS currently uses the AN/PRC-117F radio for Beyond Line of Sight (BLOS) communications with USV's. The LCS Capability Development Document (CDD) has requirements that future spirals of the external communications equipment will be JTRS compliant and must operate in a jamming environment. Currently, there is no JTRS compliant waveform which meets the MVCS BLOS data rate and anti-jamming requirements.

This topic is seeking an innovative JTRS compliant waveform that can meet the BLOS communication requirements for high data rate, multiple nodes, and anti-jam for the LCS MVCS.

The threshold BLOS data rate requirement is 452 kbps from each Unmanned Vehicle to the LCS seaframe and 9.6 kbps from the LCS sea frame to each Unmanned Vehicle. The threshold number of BLOS unmanned vehicles is 2. The BLOS range is achieved using surface wave propagation. The operating frequency band is 18 to 35 MHz's. The maximum bandwidth is 250 kHz. The threshold BLOS anti-jamming requirement is that the LCS sea frame and unmanned vehicles communicate in a 20 dB Jammer/ Signal (J/S) power density environment, as measured at the antenna plane of reference, and with the jamming signal being a Continuous Wave (CW) tone, swept CW tone, narrowband noise, wideband noise, clone signal, and pulsed jamming located at any point in the operating bandwidth. Various radio jamming types such as CW tone, swept CW tone, noise, clone signal, and pulsed jamming can break the communications link to the unmanned vehicle by causing packet loss or preventing the receiver from being able to acquire or process any signals. To counter these types of threats, an anti-jamming waveform, adaptive filtering, and fast frequency hopping can be implemented. The current state of art employs these techniques on narrowband radios but not on wideband radios capable of meeting the MVCS data rate requirements.

JTRS compliant waveforms will be implemented around open standards architecture, referred to as the Software Communications Architecture (SCA). This core SCA will reduce technology refresh insertion time and lower Total Ownership Costs (TOC) while allowing multiple packaging and channel configurations to match evolving warfighter requirements. Once the JTRS compliant waveform is developed it will be made available through the Joint Tactical Network Center for use on any JTRS compliant radio as an affordable solution for others with requirements similar to LCS.

JTRS compliance, for the purpose of this SIBR, relates to the use of the Software Communications Architecture (SCA) to develop a software waveform (Ref. 3). This architecture establishes an implementation-independent framework with baseline requirements for the development of software for software defined radios. The architectural framework was created to maximize portability and configurability of the software (including changing waveforms), and component interoperability (Ref. 2). Waveforms developed within this architecture can generally be realized on JTRS radios with minimal hardware modifications (Ref. 1 and 4). These waveforms are then made available through the Joint Tactical Network Center (JTNC) for use by others with similar communications requirements.

An Anti-jamming capability will provide countermeasures to hostile jammers that can render unmanned vehicles useless due to loss of communication and control. Currently the MVCS BLOS communications do not have an anti-jamming capability, so its mission capability is limited in a jamming environment. Its capability will be increased when it meets the requirement that the LCS sea frame and unmanned vehicles communicate in a threshold 20 dB Jammer/Signal (J/S) power density environment.

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. The Phase II effort will likely require secure access and NAVSEA will support the contractor for personnel and facility certification for secure access.

PHASE I: The selected company will develop a concept for a JTRS compliant BLOS waveform that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The Phase I Option would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I and the Phase II statement of work (SOW), the small business will develop a prototype JTRS compliant waveform for use on a Software Definable Radio (SDR) according to the Phase II SOW for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II SOW and the Navy requirements for a JTRS compliant BLOS waveform. System performance will be demonstrated through prototype evaluation in operationally relevant environment. Evaluation results will be used to refine the prototype into a final design that will meet Navy requirements. The prototype will be delivered to the Navy at the end of Phase II. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the JTRS compliant waveform technology for Navy use. The company will assist the Navy with operational testing of a JTRS compliant waveform, used on a SDR according to the Phase III development plan, to determine its effectiveness through the Mission Package Integration Program for LCS in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use. The private sector has a need for highly reliable wireless networks. Anti-jamming technology for wide bandwidth wireless networks has applications in police, civil defense, search and rescue, and industrial use wherever critical communications which can be intentionally or inadvertently interfered. One of the biggest risks in using wireless networks in the commercial arena is that everybody shares the same spectrum. The state of Georgia estimates that the Port of Savannah adds approximately $400,000 of economic value every hour it operates. The risk of interference with wireless networks shutting down the port, whether intentional or unintentional, poses a very costly risk to critical national infrastructure. In applications such as this, the additional cost incurred by adding an anti-jam waveform can be easily justified. JTRS requires the waveform be implemented in software so that it can operate on any JTRS compliant software defined radio. Therefore, the waveform could be widely used in both military and commercial applications.

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KEYWORDS: Joint Tactical Radio System (JTRS); Joint Tactical Network Center (JTNC); anti-jam waveform; wide band networking anti-jam waveform; Software Definable Radio (SDR); Software Communications Architecture (SCA)

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

N161-050 TITLE: Undersea Domain Multi-level Security Data Miner

TECHNOLOGY AREA(S): Human Systems

ACQUISITION PROGRAM: PEO IWS 5, Undersea Warfare 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 5.4.c.(8) of the solicitation. 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 intuitive multi-level security data-mining algorithm to access historical trends and collected data that meets user security requirements through a unified operator interface for mission planning development and conclusions.

DESCRIPTION: The Navy continues to focus on big data analysis, data mining, and information access. System operators are required to generate various reports tailored for multiple Fleet users. Creating reports requires intensive efforts in research, collection of data, generation of uniquely formatted reports, and reformatting the information to create new reports. Although much of the data is the same information, adequate preparation by mission operators is accomplished by accessing the various data sources to create mission plans. They also access the data imbedded in the system while at sea.

Current mission preparation requires operators to spend numerous hours searching Secret Internet Protocol Router Network (SIPRNET) websites, various publications, using different classification levels for access. Current information is stored in different formats, as reference material, for the operators to page through; this includes hardcopy three-ringed binders, electronically on websites, and other systems. This information is not stored, indexed, or tagged in a manner that enables operators to rapidly query and search historical reports to conduct trend or data analytics or provide training opportunities for junior personnel. Systems such as submarine sonar systems do not currently permit operators to visualize historical trends and information in a consolidated, intuitive manner. A technology capable of providing a single point of access for all required data at multiple security levels (e.g., Secret and Top Secret) and that provides an intuitive user interface for generating accurate reports will improve efficiency, potentially lower costs by a factor of 7:1 through reductions in report generation, data collection, and mission planning. This will enable refocusing efforts of the work force to other tasks.

The technology sought must rapidly access and parse data types across different sources at different security levels to produce a dedicated and intuitive user interface. The data that will be accessed includes acoustic, operational, intelligence, lessons learned, required reports, and environmental data. Once accessed, the newly mined information will be stored in a single data server for future access over the network (cloud) (Ref. 4). This technology must enable users across the fleet to access the data they need, in the format they define. The user interface will support all levels of security (e.g., Unclassified up to TS-SCI). The fused data can be available in interactive overlays. Examples are current and historical environmental data; current, projected, and historic Automatic Identification System (AIS) data; historic reconstructed contact tracks; and areas of uncertainty (AOU's). The fused data can be available in information layers from operator analysis, comments, and station peculiarities associated with a geographic area. All connected systems will operate independently of the display type and resolution. Tagging of data collected for easy search will be enable correlation and classification prior to uploading it to the cloud. The technology will enable data from previous missions reconstructed files to be easily recalled and overlaid with current data to show history of deployments for contacts of interest and activity levels. It will also provide the ability to show history of these deployments. During the development, the Fleet users will coordinate and work with the company developers in a series of user interface design efforts. These user interface design efforts couple the operators with the developers ensuring a better understanding of technology capabilities and limitations for the operators and result in an optimal user interface for the fleet operators.

There are four key components to be included in the concept. 1) A data management structure at all classification levels that restrict operator access to information they are allowed to view (Ref. 1 and 4). 2) A data-mining algorithm that can query, tag, access and sort large amounts of information across numerous data types and formats (Ref. 2 and 3). 3) An intuitive user interface enabling searching and displaying information such as historical geographic target tracks and environmental information or message traffic. 4) Ability for automatic parsing and auto completion of reports in various formats without the need to enter the same information multiple times. The resulting innovative concept will greatly reduce operator workload and improve situational awareness in areas of mission planning and report generation.

The data mining algorithm will eliminate the need to manually collect various data types and makes usable data available to everyone with appropriate access privileges, reducing Life Cycle costs and increasing performance for mission preparation. Additionally, it increases mission capabilities because it will take less time to locate critical data needed to plan missions and evaluate success post-mission. The data mining algorithm will allow the computer to search for vital information while the operator is able to interpret the data provided instead of using valuable time in the search process.

PHASE I: The company will develop a concept for an intuitive multi-level security data mining algorithm that meets the requirements as stated in the description section above. The company will demonstrate the feasibility of their concept in meeting Navy needs and will establish that the concept can be feasibly produced by sample testing, modeling and simulation and or analysis. The Phase I Option, if awarded would include the initial layout and capabilities description to build the data mining algorithm unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop a prototype intuitive multi-level security data mining algorithm and conduct a series of user design sprints with fleet operators in developing the user interface for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II SOW and the current information assurance (IA) specifications for classification security. System performance would ideally be demonstrated through installation and prototype testing at a facility that already includes a range of security postures, from unclassified to TS-SCI. A multi-level security data mining algorithm prototype software will be delivered at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the intuitive multi-level security data mining algorithm during the appropriate Advanced Software Build (ASB) Advanced Capabilities Build (ACB) Advanced Processing Build (APB) software transition path referred to as the AxB process. The company will finalize the software design and algorithm prototype, according to the Phase III SOW, for AxB Step testing evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation in accordance with the appropriate AxB Peer review working group and the Test and Evaluation Working Group. The technology will have private sector commercial potential for any secure system such as banking and medical information requiring access and analysis of historical information, reports, and trend analysis.

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KEYWORDS: Data mining algorithm; multi-level computer security; AxB process; SIPRNET; Data Management Structure; Network Cloud

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

N161-051 TITLE: Modular Expendable Electronic Warfare (EW) Decoy Buoy for Undersea Platforms

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PMS 435, Submarine Electromagnetic Systems; SIRFSUP (FNT-FY15-04).

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 5.4.c.(8) of the solicitation. 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 low cost, expendable Electronic Warfare (EW) decoy buoy that can be launched out of a submarine 3-inch launcher.

DESCRIPTION: The submarine force requires a low cost expendable EW decoy buoy which is not currently available. Submarines operate in littoral and open ocean environments; and it is imperative that submarines remain covert during these missions. This topic will give the submarine the ability to evade detection when at periscope depth by providing a deceptive signature to lure away potential adversaries.

Today's submarine force has become increasingly exposed to more sophisticated and capable radar environments. The chance of becoming detected during missions is becoming more likely. The submarine force has limited options on how to operate in contested regions and has no mechanism to help elude detection. By developing a low cost, expendable EW decoy buoy for undersea platforms, submarines will significantly improve their survivability in dense, hostile environments by providing a deceptive signature to lure away potential adversaries (ref. 1).

In the future (through this topic), the submarine force will possess a deceptive decoy that can be deployed to degrade or deceive increasingly capable radar systems (ref. 3 and 4). This buoy will have the ability to be programmed by the AN/BLQ-10B (V) via an interface (the submarine EW suite), and will need the ability to be launched out of the submarines 3-inch launcher or ejector. This payload needs to be reconfigurable to allow for tailoring to the operational environment (ref. 4 and 5).

The configurable modules need to account for an energy module (a battery module), a technique generation module (a digital radio frequency (RF) memory card), and an antenna/RF conditioning module (this is the interface between the technique generator module and the RF energy in the air) (ref. 2). These modules must survive depths greater than 800 feet. The system must be reconfigurable and operate over a frequency range of 1 gigahertz (GHz) to 40 GHz. The decoy must be able to operate for greater than 2 hours and must not require direct connection to the host submarine to operate. To make the modules affordable and expendable the goal is to have them cost less than $7,000 each. There is currently no capability in the submarine community that meets this need.

The Phase II and Phase III efforts 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 required, data of the same level of complexity as secured data will be provided to support Phase I work.

PHASE I: The company will develop a concept design for a low cost, expendable EW decoy buoy and demonstrate the feasibility of the concept through simulation or limited testing. The modular, reconfigurable EW decoy buoy will need to meet the requirements in the description section and can be launched out of a submarine 3-inch signal ejector. The Phase I Option, if awarded will require an initial layout and capabilities description to build a prototype in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop an EW decoy buoy prototype. The company will further develop and refine RF processing and technique generation, perform bench level lab experiments to demonstrate performance of this capability in a representative 3-inch form factor as a minimum. The EW decoy buoy prototype will be delivered at the end of the Phase II. Companies participating in Phase II will be required to prepare a plan to transition the technology to the Navy under Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the EW decoy buoy to a capable undersea platform program of record (POR) through the Submarine Electromagnetic Systems program office (NAVSEA PEOSUBS PMS435 – AN/BLQ-10B (V)). Entering Phase III we expect the project to be at TRL 7 and at the end of PHASE III the product will be expected to be at TRL 9. The company will finalize design and fabricate the EW decoy buoy, according to the Phase III SOW, to determine the systems effectiveness in an operationally relevant environment. The company will support the Navy for test and validation, in accordance Submarine Electromagnetic Systems program office specifications (see the AN/BLQ-10B (V) performance Specification (S) and the Submarine ES CDD (S) – these will be made available to the PHASE II participants once all DD254's are in place), to certify and qualify the system for Navy use and for transition to an operational platform. Following testing and validation, the end design is expected to transition to the PoR. The option of expendable RF buoys should prove useful in many applications. The more specific EW decoy payloads have applicability to homeland defense, law enforcement, and private-security systems.

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KEYWORDS: Decoy; expendable buoy; submarine 3 inch signal ejector; EW; submarine missions; deceptive electronic signature

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

N161-052 TITLE: Advanced Heat Spreader Technology for Gallium Nitride (GaN) Monolithic Microwave Integrated Circuits (MMICs)

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Air and Missile Defense Radar (AMDR)

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 5.4.c.(8) of the solicitation. 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, low-cost Monolithic Microwave Integrated Circuits (MMICs) heat spreader technology for high-power density GaN microwave power amplifiers.

DESCRIPTION: Future Navy radar and electronic warfare (EW) systems will be based on transmit and receive (T/R) module architectures where dozens (perhaps hundreds) of T/R modules are packed tightly behind the array face. Typically, each individual module contains multiple MMIC high-power amplifiers (HPAs), with GaN on silicon carbide (SiC) being the current state-of-the-art. The future trend is toward increasing levels of power density within the T/R module. This is a natural consequence of the constant need to increase radar and EW transmitted power in order to keep pace with emerging threats. However, the trend toward increasing power density results from the desire for higher levels of integration in order to reduce size and weight.

The performance and reliability of GaN transistors are fundamentally tied to operating temperature, and amplifiers of higher efficiency naturally generate less waste heat. The efficiency of GaN HPAs has increased remarkably over the past twenty years. However, the potential for further increases in efficiency is limited and efficiency alone cannot be the predominant enabler of the higher power densities required by future systems. Consequently, the operating temperature of the HPA MMIC (specifically the transistor gate region) will be the limiting factor in system design and thermal management will be an integral issue in HPA MMIC design for T/R module applications (Ref. 1).

A number of previous efforts have addressed T/R module packaging and thermal management at the macro scale - that is, the problem of removing heat from the overall MMIC structure to the T/R module housing, and finally to structural support members which incorporate liquid cooling. However, for radar systems requiring long pulse operation (at pulse widths of 5 ms or greater) or EW systems that require high duty cycle operation (typically exceeding 10%), the dissipation of heat at the location of the transistors themselves becomes the limiting factor in thermal management. At the MMIC level, various solutions have been investigated with the simple substitution of highly conductive materials, such as diamond, being the most straightforward (Ref. 2). However, even highly conductive layers have not yielded the performance required and are compromised by the thermal conductivity of the epoxy or solder used to bond to the MMIC (Ref. 3 and 4). Consequently, an advanced heat spreader technology (materials, design, and bonding method) that offers a significant improvement in heat dissipation at the MMIC level (at the MMIC-bond interface) is desired. An order of magnitude improvement in heat conduction represents the ideal goal.

Significant restrictions, arising from performance, reliability, sustainability, and affordability considerations, complicate the requirements for new heat spreader technology. First among these is that the proposed technology must be compatible with existing GaN on SiC MMIC technology and existing HPA designs. This enables transition of the technology to near-future Navy systems such as the Air and Missile Defense Radar (AMDR) in the form of technology updates without requiring fundamental system architecture changes while also benefiting future designs. Another requirement is that the heat spreader technology should not depend on an external supply of liquid cooling to the T/R module as this represents a minority of system architectures. Reliability is a paramount concern and proposed technologies must have reliable life expectancies exceeding the GaN MMICs they support (a minimum T/R module service life of 15 years can be assumed). Finally, affordability is a prime concern. Proposed technologies must be compatible with automated assembly processes and the intrinsic materials must have a path toward manufacturability in production volumes. Ideally, the material cost of the heat spreader technology, will increase the overall MMIC assembly cost by no more than 10%.

This topic serves to enable higher transmitted power from future versions of AMDR without requiring a major system change. Increased transmit power improves fundamental radar performance parameters such as detection range. If this can be done without increasing the radar size and without changing the radar architecture, the increased performance can be had at a fraction of the cost. By addressing the fundamental thermal management problem that limits HPA MMIC performance, increased power can be obtained from essentially the same T/R module design. The technology sought by this topic is widely applicable and the same arguments are equally true for future EW systems such as the Surface Electronic Warfare Improvement Program (SEWIP).

PHASE I: The company will develop a concept for advanced heat spreader technology at the GaN HPA MMIC level that meets the requirements stated in the topic description. The company will demonstrate the feasibility of their concept in meeting Navy needs and will establish that the concept can be feasibly produced by sample testing, modeling, simulation, and analysis. The company will address technical risk reduction and provide performance goals and key technical milestones. Phase I Option, if awarded, would include the initial layout and capabilities description to develop the advanced heat spreader material with the associated bonding process in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), the company will develop a prototype heat spreader technology and the associated processes for bonding GaN HPA MMICs to the heat spreader. The prototype material with associated bonding process will be evaluated to determine its capability in meeting the performance goals defined in Phase II SOW and the Navy requirements for thermal management of HPA GaN MMICs in T/R modules. Performance will be demonstrated through the company's laboratory testing of prototypes under simulated operational conditions. Performance must be verified over the required range of parameters including numerous thermal cycles. However, prototype testing may be augmented by modeling and analytical methods. Evaluation results will be used to refine the prototype into an initial design to meet state-of-the- art performance in a

T/R module application for a military grade system and that will meet Navy requirements. The company will deliver the prototype at the end of the Phase II. The company will prepare a Phase III development plan to transition the technology for commercial use to supply Navy needs.

PHASE III DUAL USE APPLICATIONS: The company will be expected to produce its heat spreader technology and support the processes required for its successful transition into Navy use in programs such as AMDR. The company will develop and fully document the processes required to deploy the technology for use by industry according to the Phase III development plan. The technology will be evaluated to determine its effectiveness in full-rate production of T/R Modules based on GaN MMIC HPAs. The US domestic radio frequency (RF) semiconductor business supplies commercial as well as military markets and advances in semiconductor and MMIC technology, though first implemented in military systems, eventually transition to commercial product lines. Since this topic seeks to develop a product for MMIC thermal management and not a specific military application, the potential for commercial application is unfettered. The potential commercial market is essentially unlimited should the technology prove cost competitive.

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KEYWORDS: Heat spreader for MMICs; thermal management in radar systems; T/R module; GaN MMIC; GaN HPA; GaN on SiC

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

N161-053 TITLE: Modular Tethered Antennas for Undersea Platforms

TECHNOLOGY AREA(S): Battlespace, Electronics, Sensors

ACQUISITION PROGRAM: The FNC is SIRFSUP (FNT-FY15-04). NAVSEA PEOSUBS PMS 435 (Submarine Electro

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 5.4.c.(8) of the solicitation. 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 modular, reconfigurable, tethered antenna lift body for undersea platforms that will support two-way Radio Frequency (RF) communication, imaging sensors, broadband Intelligence, Surveillance and Reconnaissance (ISR) antennas, and Global Positioning System (GPS) reception.

DESCRIPTION: Undersea platforms (Unmanned Undersea Vehicles (UUV), submarines, buoys) are used in many applications where the covert, extended persistence of an emitter is required. These platforms generally navigate via an inertial navigation unit that is fixed to GPS prior to diving or acoustically via transponders in fixed locations. The underwater regime limits these platforms ability to communicate or perform collection while at depth. The current state of the art options available are low data rate acoustics, or latent RF communications as the platform periodically comes back to the surface. Neither of these allow for persistent ISR from undersea platforms. The ability to perform electromagnetic ISR functions and communicate rapidly while still submerged would be very beneficial to many applications and the Scalable Integrated RF for Undersea Platforms (SIRFSUP) Future Naval Capability (FNC) application in particular. As an example, a UUV would have to intercept a Signal of Interest under the guidance of a remote detection system and report the incident back to a parent authority. A tethered antenna that will support two-way RF communication and GPS reception would greatly enhance the identification (ID) and localization capabilities of such a system (ref. 2). The floating wires and communication buoys utilized by submarines provide potential inspiration. The intent of the tethered structure is to perform both the ISR function and the report back / communication function and support tremendous depth excursions. The current state of the art allows for the report back / communications in a relatively shallow depth excursion and does not support the broadband RF components to support ISR missions.

The tethered lift body must be modular and easily reconfigurable carrying payloads, antennas, or sensors less than 10 pounds in weight on a tether of less than 500 feet (ref. 1). This modular capability must survive in depths less than 2,000 feet. It is expected that this capability (when in production) will have a cost less than $25,000 US dollars.

By developing tethered modular antenna sections, undersea platforms will be able to more covertly accomplish their missions and allow an ability to communicate back while minimizing surface exposure time. For UUV's and other deployable buoys to perform an ISR mission, reconfigurable antenna modules tailored to the missions at hand, will be required.

This topic increases mission performance by allowing unmanned deployable undersea platforms to become force multipliers for a submarine in the future. These capabilities will allow the unmanned platform to stay below the surface (allowing for more covert operations) but still allow for the offloading of critical data elements when required, thus decreasing mission time and surface exposure. In an acoustic mission, this keeps the acoustic sensors at the proper layer depth but still allows for off-loading of critical information. In an ISR role, this allows the platform to stay deep (minimizing surface exposure) but still allows the platform to get the appropriate receive sensors to the surface.

The Phase II and Phase III effort will 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 required, data of the same level of complexity as secured data will be provided to support Phase I work.

PHASE I: The company will develop a concept for a tethered, modular, reconfigurable antenna that meets requirements as stated in the Description above. The company will demonstrate the feasibility of the concept through modeling and analysis and show that the concept will increase the overall performance of the antenna. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Based on the results of Phase I effort and the Phase II Statement of Work (SOW), the company will develop a prototype to demonstrate the submerged tethered, modular, reconfigurable antenna performance through employment of an actual UUV or a realistic surrogate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II SOW for the tethered lift body. The company will be required to develop a clear and concise transition schedule or plan showing how to get from prototype stage to Engineering Development Model for the Program of Record (POR) acquisition office. The prototype will be delivered to the Navy at the end of the Phase II. Companies participating in Phase II will be required to prepare a plan to transition the technology to the Navy under Phase III.

PHASE III DUAL USE APPLICATIONS: The company will be expected to support the Navy in transitioning the tethered antenna lift body system to Navy use in the Undersea Platforms Program Office. The company will finalize the design and fabricate two engineering development models (EDMs) of the tethered antenna lift body system, in accordance with the Phase III SOW, to evaluate and determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation in accordance with AN/BLQ-10B (V) POR to certify and qualify the system for Navy use and for transition into an operational environment. Following testing and validation, the end design is expected to produce results outperforming the current lift system technology. SECRET clearance may be required for Phase III. The lift system described in this topic could have private sector commercial potential that could be utilized by commercial unmanned platforms for communications with their parent and hosting platforms. Some possible areas for utilization are oil exploration, ocean floor mapping, and whale monitoring among others.

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1. M. Kono, "Winding and packing of optical fiber for deployment from remotely controlled underwater vehicles", Proceedings of the winter annual meeting of the American Society of Mechanical Engineers, November 1981.

2. High-Strength, Long-Length Optical Fiber for Submarine Communications at Speed and Depth, Navy SBIR 2008.1 - Topic N08-095. http://www.navysbir.com/n08_1/N081-095.htm .

KEYWORDS: Autonomous Underwater Vehicle (AUV); Unmanned Underwater/Undersea Vehicle (UUV); communications; underwater antennas; tethered platforms; Global Positioning System (GPS)

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

N161-054 TITLE: Maritime Electromagnetic Maneuver Warfare (EMW) Environmental Sensing

TECHNOLOGY AREA(S): Battlespace, Sensors

ACQUISITION PROGRAM: EM Warfare Battlespace Management, Real Time Spectrum Operations, Future Me

OBJECTIVE: To enable Navy ships to measure the full set of environmental variables at multiple heights remotely from a single fixed position on the exterior decks or mast; to include pressure, temperature, horizontal wind speed and direction, visibility, and absolute humidity at multiple levels without using in situ sensors or expendables.

DESCRIPTION: The Surface Navy has interest in high fidelity prediction of electro-magnetic (EM) and electro-optical (EO) propagation from surface ships to support prediction of radar, electronic warfare, laser, and communications systems performance. Winds, density, visibility, icing, and turbulence measurements are also needed for marine aviation to 5,000 meters. Higher fidelity observation and prediction is desired for new platforms such as ship-launched remotely piloted aircraft. Currently, the fidelity of numerical prediction programs is limited in part by the fidelity of the locally observed environmental conditions used as input. This project desires to investigate technologies that would enable high fidelity measurement of environmental profiles in the vicinity of a surface ship at multiple levels from a fixed position on the superstructure.

Current systems measure at a single point at their location or use expensive, bulky, and expendable in situ sensors like rawinsondes or unmanned aerial vehicles (UAVs). Current commercial off-the shelf (COTS) products that profile such as Light Detection and Ranging (lidars), radiometers, and acoustic sensors do not individually retrieve all needed values nor do they have sufficient spatial resolution or accuracy. Vertical range should be from the ocean surface below deck level to well above the top of the atmospheric boundary layer to at least 1,500 meters. Vertical resolution should be fine enough to detect gradients in refractivity relevant to anomalous radio and radar propagation, approximately 1-5% of the total boundary layer height per measurement level. The system should be designed such that it is affordable and maintainable in a maritime environment, fits within surface Navy power and size constraints, and to the extent possible is self-calibrating. Successful execution of this SBIR would support a proof-of-concept demonstration of an at-sea capability.

Technologies of potential interest could include but are not limited to Doppler lidar and lidar spectroscopy, ceilometers, passive radiometry, acoustic sounders, and direct measurement of state variables in an integrated design to produce best possible absolute accuracy and precision. Bulk similarity approaches for more limited direct retrievals such as evaporative duct estimates from sea surface (skin or inlet) temperature, near surface air temperature, relative humidity or wet bulb temperature, mean sea level pressure, and cup-and-vane or sonic anemometer wind speed and direction could be considered only as part of a more general solution to the total vertical profile. Reductions in ship's force manning require that the system is automated and requires minimal and straight forward maintenance and manual calibration to the maximum extent possible. In addition, rapid changes in ambient conditions due to natural changes or ship movement require a relatively rapid measuring capability of no more than 30 minute intervals. Accuracy roughly equivalent to a calibrated commercial rawinsonde, but without the use of expendable in-situ sensing approach is desired. Small UAVs are not considered a feasible approach for this particular topic due to the difficulty of certifying them for shipboard use and maintaining crew proficiency.

PHASE I: Define, develop and determine feasibility for the Maritime EMW Environmental Sensing component modules in a realistic environment, a concept for the determination of 3-dimensional environmental state variables that can meet the vertical resolution, timeliness and accuracy requirements discussed in the Description.
Required Phase I deliverables include a report which defines the concept and provides relevant details that shall include hardware designs, and relevant lab measurements validating the feasibility in terms of size, weight, power, and accuracy of the components for the prototype design.

PHASE II: Refine, develop, demonstrate and validate the hardware and software designed in the Phase I effort into a prototype system. Deliverables from the Phase II effort shall include the Maritime EMW Environmental Sensing prototype hardware and software, and a report that documents the performance of the prototype. The small business will produce a prototype package that works in a shipboard maritime environment. Phase II will develop, demonstrate and validate the solution the prototype solution.

Required Phase II deliverables will include:
- Design architecture, algorithms and data analytics
- Test plan
- Software executables and source code
- Demonstration of hardware solution effectiveness and relevance in a relevant environment
- If SWAP-C goals are not met, a clear path to Size, Weight, Power, and Cost reductions for follow-on efforts
- Phase II Final report

PHASE III DUAL USE APPLICATIONS: Refine the prototype system into a product that can be used on a surface Navy combatant with appropriate user interfaces and documentation. The small business will assist in transitioning the Maritime EMW Environmental Sensing system to its shipboard platform for full operational testing and evaluation. At the end of the Phase III effort the system should be at a Technology Readiness Level of 7. When appropriate, focus on scaling up manufacturing capabilities and commercialization plans. Marine weather observing and forecasting, commercial shipping and navigation, environmental monitoring of remote and minimally attended locations.

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KEYWORDS: Marine weather observing, maritime boundary layer meteorology, environmental remote sensing, refractivity, LIDAR, microwave radiometry, electromagnetic ducting

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

N161-055 TITLE: Imaging through Fog

TECHNOLOGY AREA(S): Information Systems, Sensors

ACQUISITION PROGRAM: Combined Electrooptic Surveillance and Response System (CESARS), FY16-02 FN

OBJECTIVE: Develop and demonstrate a passive Electro-Optical (EO)/Infrared (IR) - EO-IR - imaging system that employs coordinated, jointly optimized, acquisition and processing of multi-modal (spectral, temporal, polarization, quantum etc.) data to enhance the operational range by 10X compared to a single-mode imaging system in the presence of obscurant.

DESCRIPTION: The US Fleet Forces are often present in congested waterways throughout the world for a variety of humanitarian and military purposes. To maintain situational awareness (SA) and to support target detection, tracking, and identification, electro-optical (EO) and infrared (IR) sensors could be employed for their superior resolution and image-forming mode of operation, in contrast to radar. However, the short wavelengths associated with EO-IR make imaging far more susceptible to performance degradation from scattering by ubiquitous water-based aerosols, which typically generate a large, non-information carrying, background radiation that overwhelms the ballistic signals that do carry information about the scene. Imaging through dense fog is the intrinsic hard problem, as a strongly scattering medium fills the entire working volume. Imaging through cloud layers [1] or haze [2] or fog [3] can be improved by exploiting prior information in processing, but the deleterious effect of the scattering medium on the signal-to-background ratio remains the key limitation, which depends on the image acquisition mode as well as the optical properties of the water-based aerosols.

While active imaging techniques, which typically employ structured laser-light illumination and/or temporal gating, have been employed somewhat successfully to enhance image acquisition, passive imaging provides fewer degrees of freedom to manipulate. Changes in atmospheric conditions, ambient illumination conditions, and orientation-dependent scene reflection/emission characteristics further conspire to complicate passive-imaging enhancement. However, by employing, for example, a judicious choice of spectral band(s), polarization diversity, high-speed multi-frame acquisition, or other mode of acquisition together with advanced processing techniques, significant improvements can potentially be achieved, especially for a specific class of obscurants. For example, select spectral bands may provide enhanced transmission, while ballistic photons may possess different average polarization states compared to scattered photons. Processing techniques can optimally exploit these enhancements to extract additional scene information. Although the gain in image quality associated with a single degree of freedom may be modest, an overall improvement obtained by combining multiple, optimized degrees of freedom, may be more substantial. Therefore, a multi modal hardware solution combined with coordinated processing techniques may enable an imaging system to be realized that provides a substantial overall operational improvement.

This topic seeks to develop a passive EO-IR imaging system that employs jointly optimized multi-modal image acquisition and processing to increase operational range by 10X over baseline range (to be selected by performer) that corresponds to traditional single-mode image acquisition in the presence of obscurant. Solutions can exploit all or any portion of the electromagnetic spectrum ranging from the UV to the far IR, including the conventional bands referred to as electro-optic (EO), near-infrared (NIR), short-wave IR (SWIR), mid-wave IR (MWIR), and long-wave IR (LWIR), but excluding mm-wave bands. System designs that employ either innovative sensors or Commercial-off-the-shelf (COTS) components are both of interest, along with data fusion techniques and advanced algorithms. While systems having low size, weight, and power (e.g., < 1 cu. ft., <30 lbs., and <300 W) are of interest, larger systems will also be considered. The overall objective is to achieve a 10X enhancement to substantially improve situational awareness, target detection, tracking, and ID tasks in presence of strongly scattering medium.

PHASE I: Determine feasibility, design and simulate a multi-modal EO-IR system with jointly optimized sensing and processing to achieve a 10X improvement in operational range compared to single-mode operation in the presence of obscurant. Identify key risk elements to achieving the 10X improvement objective and perform suitable simulations and/or experiments to mitigate these risk factors. Prepare a publication-quality technical document detailing the system design and performance characteristics, which should include an analysis of the proposed system relative to the current state-of-the art.

PHASE II: Construct and demonstrate the multi-modal EO-IR system with associated processing designed in Phase I. Specifically, conduct quantitative measurements and analysis to verify the purported 10X improvement in operational range. The experimental validation can be performed in a laboratory simulated environment that is realistic representation of a shipboard environment. Prepare a document based on results from Phase II that follows the standards of a publication in refereed journal.

PHASE III DUAL USE APPLICATIONS: Extend the technology to a full system prototype by optimizing the hardware and processing demonstrated in Phase II. Refine the design to minimize size, weight and power consumption while introducing mechanical robustness against shock and vibration. Detailed specifications will be provided by the Navy during Phase III. Provide support in transitioning the technology and qualifying its use for the Navy. The small business will provide user's manuals and training materials to the Navy. This technology will have applications in all services of the military, in law enforcement, civilian, and commercial sectors. Anywhere enhanced long-range imagery is needed constitutes a relevant application of this technology. Applications might include unmanned aerial surveillance (UAS) systems, precision agriculture, oil and gas pipeline inspection, disaster relief, or search and rescue. Drug interdiction in the maritime environment via unmanned or manned surface or aerial vehicles is another example application.

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1. Sermsak Jaruwatanadilok, Akira Ishimaru, and Yasuo Kuga, "Optical Imaging Through Clouds and Fog," IEEE Trans. On Geoscience and Remote Sensing, vol. 41, no. 8, August 2003, pp. 1834-1843

2. Kaiming He, Jian Sun, Xiaoou Tang, "Single Image Haze Removal Using Dark Channel Prior," in Proc. Of Int'l. Conf. on Computer Vision and Pattern Recognition 2009.

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KEYWORDS: High dynamic range imaging, fog, electro-optical, infrared, polarization, multi-spectral, sensor fusion, autonomous, real-time, advanced processing, intelligence, surveillance, reconnaissance, situational awareness.

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

N161-056 TITLE: Intuitive, High Confidence Human-Machine Interface Symbology for Carrier Landing

TECHNOLOGY AREA(S): Air Platform, Human Systems

ACQUISITION PROGRAM: INP LA-CNR: Sea-based Automated Landing Recovery System (SALRS)

OBJECTIVE: Develop and demonstrate Head-Up/Helmet-Mounted Display symbology for pilots to perform tactical jet landings on an aircraft carrier in highly degraded visibility and deck motion conditions, using advanced flight control augmentation and precision ship-relative navigation.

DESCRIPTION: Carrier tactical aircraft such as F/A-18E/F/G and F-35C have highly augmented flight control systems for carrier landing which enable reduced workload. They also have precision ship-relative navigation capabilities in operation as well as some in development. However, pilot displays remain antiquated, using 3 different approach navigation symbol sets, some dating to the 50's and 60's (az-el bars). In order to exploit their automated capabilities in all conditions, advanced, intuitive head-up display (HUD) symbology is needed that provides continuous situational awareness and flight guidance information to the pilot. Ideally this symbology would provide sufficient guidance and confidence to fly all the way to touchdown without outside visual cues. The display must be easily interpretable, matching display dynamics with aircraft dynamics and flight control, and provide high confidence situational awareness, including ship deck motion and landing area dimensions. It must also be compatible with existing HUD displays which are used throughout the flight envelope, to avoid any disorienting or difficult to learn transformations when transitioning from mission operations to landing approach.

PHASE I: Develop a conceptual design for a head-up display a pilot can use to fly a tactical jet aircraft to a carrier landing without use of outside visual cues. Demonstrate a preliminary version of the display in a piloted simulation. The simulation should be representative of an F/A-18E/F type aircraft and a US Navy aircraft carrier with a moving flight deck. Assume that a precision guidance system is available so that the aircraft knows precisely where it is relative to the ship, and what the carrier flight deck motion is. The aircraft should fly a standard Case III (straight-in) approach to landing. Show feasibility of flying precision approaches and landings in conditions of reduced and zero visibility, with low pilot workload.

PHASE II: Continue development of the HUD display based upon Phase I effort. Demonstrate capability in a high fidelity piloted flight simulation, using an aircraft closely representative of the F/A-18E/F, and a U.S. aircraft carrier. Include conditions up to sea state 6 and zero visibility. Conduct an experiment using Navy pilots and the F/A-18E/F flight simulator at the NAS Patuxent River Manned Flight Simulator facility, or a similar facility. Show that landings can be conducted using the advanced HUD display in zero visibility that are equal to or better than those conducted using current displays in good visibility. Metrics for this performance comparison are: accuracy in maintaining glideslope and lineup, accuracy on touchdown, and reduction in scatter on sink rate at touchdown. Show also that pilots who are otherwise qualified to fly the aircraft can learn to use the display to conduct landings with minimal additional training.

PHASE III DUAL USE APPLICATIONS: Integrate the HUD display into a test aircraft representative of an F/A-18 at NAS Patuxent River, or a similar facility. Conduct flight tests during shore based simulated carrier landings. Assist the Navy with transitioning the HUD display into its intended platform(s). Commercial aircraft continue to develop capabilities to land in reduced visibility conditions. This HUD symbology could also be applied to passenger and freight carrying commercial air carriers.

REFERENCES:
1. NAVAIR 01-F14AAD-1 NATOPS Flight Manual Navy Model F-14D Aircraft, 1 February 1997, figure 2-94 "HUD Added Symbology"

2. Merrick, V., Farris, G, Vanags, A., NASA Technical Memorandum 102216, January 1990, "A Head Up Display for Application to V/STOL Aircraft Approach and Landing"

KEYWORDS: aircraft; carrier; landing; display; symbology; degraded visual environment

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

N161-057 TITLE: Short-Wave Polarimetric Imager

TECHNOLOGY AREA(S): Sensors

ACQUISITION PROGRAM: No specific program currently.

OBJECTIVE: Develop and demonstrate a short wave infrared (SWIR) band polarimetric imager consisting of an uncooled indium gallium arsenide (InGaAs) focal plane array with an aligned, pixel pitch-matched micro-grid polarizer (Bayer-type) array. The SWIR InGaAs polarizer camera should be compact, rugged and with sufficient frame rate to enable on-the-move operation.

DESCRIPTION: Multispectral and polarimetric sensors have been used for material imaging (LeMaster, et al; 2013) and target detection (Hubbard, et al; 2008) for improved contrast and lower false-alarm rates with detection and identification. Visual to Near-IR (VNIR) polarization has been successfully used for littoral minefield detection, while polarimetry has been investigated for buried and surface mine detection (Ackenhusen, 2001). A pixel pitch-matched SWIR polarization camera would be an improvement over conventional SWIR polarimetric imaging methods, such as spinning filter wheels or multiple sensor approaches, which are not optimal for on-the-move operation and which often suffer from variable image registration issues that lead to changing polarization artifacts. The Bayer-type array has fixed artifacts that can be undone by standard color interpolation techniques. The polarizer grid approach requires a precision alignment of a micro-grid polarizer in both pitch and angle to the sensor focal plane array. Each “super pixel” of the polarizer array should consist of four sub pixels that produce different pixel polarization states (comprising a representative subset of the Stokes parameters). When a distant object is imaged onto a super pixel, the complete linear polarization state of the incoming light can be measured.

The goals of this project are to develop and demonstrate an uncooled InGaAs camera for actively imaging polarization spectral response between 0.9 µm to 1.7 µm. The SWIR InGaAs micro-grid polarizer camera should be compact (approximate volume of 6 cubic inches) and rugged (functional shock and vibration) and must be usable at ambient temperatures -20 °C and above. The pixel pitch-matched polarizer grid should be attached to a state of the art focal plane array, preferably greater than 640 x 512 pixels, with state of the art noise reduction technology and dynamic range for an uncooled camera. The desired digital output is 12 bits with a minimum 30 frame per second (fps) frame rate. The desired voltage requirements are 8-16 volts DC with a desired power of <5W. Minimization of life cycle costs should be a design consideration.

PHASE I: The company will demonstrate technical feasibility of the concept in meeting Navy needs for an on-the-move polarimetric imaging capability in the short wave infrared. The company will prove the concept of a pixel-matched polarimetric camera in the laboratory by completing and reporting on the following tasks:

- Overall design for pixel pitch matched micro-grid for identified focal plane array
- Identification, development, and/or fabrication of micro-grids consistent with overall design
- Demonstration that the micro-grid meets the design requirement for the focal plane array, e.g., in spatial and polarimetric uniformity, with best possible extinction ratio for the individual elements (goal of 100:1)

PHASE II: Based on the results of Phase I effort, the small business will develop a Phase II prototype camera for evaluation. Expected activities are for the company to:

- Build and demonstrate the pixel pitch matched micro-grid onto an uncooled InGaAs focal plane array of required camera specifications (i.e, rugged, shock/vibration, temperature) with state-of-the-art noise and dynamic range capability. Demonstrate the polarimetric response within the defined spectral range using suitable calibration targets
- Iterate to improve design and performance
- Deliver prototype pixel pitch matched uncooled InGaAs camera of required specifications to the Navy for further evaluation

Naval Surface Warfare Center Panama City Division (NSWC PCD) will consult and provide applicable background information to the camera developer to support development of the prototype. NSWC PCD will collaborate with the awardee in determining the performance of the pixel- pitch matched uncooled InGaAs camera.

PHASE III DUAL USE APPLICATIONS: The small business will apply the knowledge gained in Phase II to build three copies of a prototype camera, suitably packaged for integration with a USMC land platform of the Navy’s choosing. The company will work with the Navy to characterize the camera's performance, integrate the camera on the designated USMC platform, and support field tests to verify the camera operation for various field applications. Market research and analysis shall identify the most promising technology areas and the company shall develop manufacturing plans to facilitate a smooth transition to the Navy. Ultimately, the goal is for the awardee to market such detectors to the infrared sensor community for applications of measurements of natural and man-made materials beyond the capabilities of unaided human vision.

REFERENCES:
1. U.S. patent 3971065, Bryce E. Bayer, "Color imaging array", issued 1976-07-20.

2. LeMaster, D.A., et al. SWIR active polarization imaging for material identification. (2013). Polarization Science and Remote Sensing, Proc. Of SPIE, Vol. 8873.

3. Hubbard, W., et al. Multispectral-Polarimetric Sensing for Detection of Difficult Targets. (2008, Electro-Optical and Infrared Systems: Technology and Applications V, Proc. Of SPIE, Vol 7113.

4. Ackenhusen, J.G. Infrared/Hyperspectral Methods (Paper II): Appendix D. Alternatives for Landmine Detection. 2001.

KEYWORDS: SWIR Camera; polarization; pixel-pitch matched; polarimetric imager

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

N161-058 TITLE: Computer-Aided Cryptographic Algorithm Design and Exploration Workbench

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Design and develop an integrated workbench and tools for computer-aided design and exploration for cryptographic algorithms.

DESCRIPTION: Cryptography has been one of the foundational building blocks for privacy and security in the cyber environment. Researchers in the field of cryptography are continuously exploring and developing new algorithms, classes/types, and capabilities; recent advancements in cryptography include fully homomorphic encryption (FHE) and attribute-based encryption. However, algorithmic exploration in cryptography remains a laborious mathematical exercise. In addition, verifying the correctness and security of a cryptographic algorithm is equally laborious, manual, and error prone. For instance, several publications in cryptography have had to be retracted due to unforeseen errors in the formalizations of security proofs.

The complexity and brittleness of the security properties of cryptographic algorithms make it especially difficult to develop an automated generator and verifier for new algorithms. However, recent developments in academic research have demonstrated the power of automation in cryptographic design [1,2] and in verifying the security of cryptographic proofs [3]. Currently, the tools developed for these works exist as academic prototypes and may not have been developed to interoperate with other tools. Relatively immature, these tools often require significant formal programming knowledge to operate successfully, and hence are not easily accessible to mainstream cryptographers (users).

An easy-to-use cryptographic design and verification workbench can significantly reduce the amount of effort required and the error potential associated with cryptographic design exploration and verification. Such a toolset could serve as an integrated design environment capable of performing the full process of automated cryptographic algorithm design, from algorithmic exploration to proving security properties under many different attack scenarios (e.g., chosen ciphertext and/or plaintext attacks, etc.). This cryptographic workbench should integrate various theorem provers with a mechanized verification process, build special automated exploration tools for cryptographic algorithm design, and must be able to accommodate the integration of future tools. This workbench will also serve as a platform for fostering the integration and collaboration of researchers and developers of cryptographic automation tools.

The tools and workbench developed in this SBIR topic would lower the barrier for cryptographic algorithm design and exploration, hence accelerating the discovery of various new types of cryptographic algorithms and protocols. The workbench should allow cryptographers to explore a wider range of the design space and construction for cryptographic algorithms, far beyond what can be achieved with manual exploration, without requiring its users to be experts in formal programming. Besides reducing the design effort and potential for error, computer-aided cryptography may allow for the discovery of a large number of secure algorithms of certain types and properties. The availability of a large collection of similarly secure algorithms would allow for further filtering of algorithms according to properties orthogonal to security, such as computational requirements, implementation complexity, and power requirements, depending on the particular needs of an application.

PHASE I: Identify an initial set of tools suitable for computer-aided cryptographic design, design any missing elements in the tool chain, and devise methods which allow tools to interoperate. Design an extensible workbench to integrate the tools into an environment capable of performing the full process of automated cryptographic algorithm design. Develop an initial proof-of concept prototype for the workbench.

PHASE II: Based upon the Phase I effort, develop and enhance the integrated workbench and tools for computer-aided design and exploration for cryptographic algorithms prototype into a fully functioning workbench. Demonstrate and evaluate the efficacy of the tool for exploring selected types of cryptographic algorithms and corresponding design goals, for example by showing that the workbench can successfully be used to design and develop a new cryptographic algorithm or be used to verify the security properties of an existing cryptographic algorithm.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of Phase II, the performer will provide support in transitioning the cryptographic workbench to the Navy for its intended use. The performer will develop a plan for integrating the product into the Navy’s information system security framework. Usually as a result of the requirements of the operating environment, non-standard cryptographic algorithms have been employed in a variety of commercial devices and applications, e.g., RFID, embedded sensors, business and financial transactions, data warehousing, etc. Such custom cryptographic algorithms are often sub-par in the quality of security they provide. As such, the ability to automatically design, develop, and verify a secure (high-quality) cryptographic algorithm which fits particular design requirements will have strong commercial demand, and will improve the security of commercial devices and applications. The availability of the cryptographic workbench will also accelerate the discovery of various novel cryptographic capabilities such as homomorphic encryption and attribute-based-encryption at research institutes and universities around the world.

REFERENCES:
1. Joseph A. Akinyele, Matthew Green, and Susan Hohenberger. Using smt solvers to automate design tasks for encryption and signature schemes. In Proceedings of the 2013 ACM Conference on Computer and Communications Security, CCS '13, pages 399-410, New Yo

2. Joseph A. Akinyele, Matthew Green, Susan Hohenberger, and Matthew W. Pagano. Machine- generated algorithms, proofs and software for the batch verification of digital signature schemes. In Proceedings of the 2012 ACM Conference on Computer and Communications Security, CCS '12, pages 474-487, New York, NY, USA, 2012. ACM.

3. Gilles Barthe, Benjamin Gregoire, Sylvain Heraud, and SantiagoZanella Beguelin. Computer-aided security proofs for the working cryptographer. In Phillip Rogaway, editor, Advances in Cryptology CRYPTO 2011, volume 6841 of Lecture Notes in Computer Scien

4. Daniel Bleichenbacher. Chosen ciphertext attacks against protocols based on the rsa encryption standard pkcs #1. In CRYPTO, pages 1-12, 1998.

5. Johannes Blomer and Gennadij Liske. Direct chosen-ciphertext secure attribute-based key encapsulations without random oracles. Cryptology ePrint Archive, Report 2013/646, 2013. http://eprint.iacr.org/.

KEYWORDS: cryptography; algorithmic design; automation; security proofs; cyber; encryption

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

N161-059 TITLE: Very High Powered, Low Frequency Underwater Projectors

TECHNOLOGY AREA(S): Materials/Processes, Sensors

ACQUISITION PROGRAM: PEO IWS 5A, Littoral Combat Ship Variable Depth Sonar Advanced 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 5.4.c.(8) of the solicitation. 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: To develop, fabricate, and demonstrate a low frequency, very high-powered underwater transducer that exploits the enhanced properties of PMN-PT textured ceramic.

DESCRIPTION: Traditionally low frequency underwater projectors are of the flextensional or flexural designation to permit low frequency operation in a small volume. These devices are normally excited by piezoelectric ceramic commonly identified as PZT. For these devices the power output is field limited as opposed to stress limited. The advent of PMN-PT textured ceramic promises a power output boost that permits at least 10 dB more source level over conventional PZT. This increase in field limit allows the transducer designer to better match the stress and field limits of the particular design. The intended end product use of these projectors is an array that needs to generate very high acoustic power in a compact device that exhibits broad bandwidth and high effective coupling. A notional design would be a transducer that is football sized that can achieve a source level of 207 dB with a useable bandwidth encompassing 600 to 1200 Hz. The ability of the mechanism to transmit in an omnidirectional mode and in a directional mode would be an advantage for operational use. Variations on the established classifications of flextensional transducer types would be preferred.

PHASE I: Identify a device that can be developed to meet the notional need while being compact (a useful design target might be 25-30 cm in the longest dimension, less than 4.5 l volume and less than 40 kg in mass) and optimized to exploit the properties of PMN-PT textured piezoceramic. Undertake 2 or 3 notional paper design variations to assess the strength of the approach including a variation that can be excited in a directional mode. Select an omnidirectional and directional design to pursue in Phase II and analyze all aspects of the design and perform a cost analysis for production.

PHASE II: Complete the Very High Powered, Low Frequency Underwater Projectors designs selected in Phase I and fabricate a prototype for each omnidirectional and directional design selected. Undertake a complete electroacoustic analysis of each prototype including high power in-water testing, continuous duty high power operation, and a design review package. Verify the computer model of the transducer design with measured data to assess the viability of the model and its ability to modify performance parameters maintaining tractability. If necessary make adjustments to the designs and fabricate revised prototypes and repeat the testing and model verification regime. Compare the final test and model results with the notional performance goals.

PHASE III DUAL USE APPLICATIONS: Continue to extensively test the prototype fabricated in Phase II and test for severe environmental conditions of depth, power output, and duty cycle. Fabricate, assemble and test a partial array to assess array performance. Working with the Navy POC match the achieved performance with current Navy needs and transition this technology for its intended purpose. The development of this technology will have application to the oceanographic community and oil exploration industry.

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KEYWORDS: Underwater sensors, underwater acoustic transmitters, underwater transducers and sensors, ASW, Textured Piezoceramic, sonar projectors, active piezoelectric materials

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

N161-060 TITLE: Measuring and Assessing Maneuver Squad Leader Adaptability

TECHNOLOGY AREA(S): Human Systems

ACQUISITION PROGRAM: FNC: Accelerating Development of Small Unit Decision Makers; PoR: MCTIMS

OBJECTIVE: To develop an automated measure of adaptability, including the three enabling cognitive constructs of cognitive flexibility, change detection, and anomaly detection, to support U.S. Marine Corps efforts to quantify the small unit decision-making (SUDM) ability of maneuver squad leaders.

DESCRIPTION: The U.S. Marine Corps implemented the SUDM initiative in 2008 to enhance the training and education provided to maneuver small unit leaders who must operate in a decentralized manner and make challenging decisions in complex, ill-structured environments. To support this initiative, the Office of Naval Research (ONR) has sought to enable the development of decision training and assessment tools by pursuing research to model SUDM.

Research to date has examined SUDM as a multidimensional construct consisting of several hypothesized enabling competencies and Cognitive And Relational Skills (CARS) [2,3]. In all, five competencies and ten CARS have been identified and associated with nine Key Performance Areas (KPA) required of maneuver squad leaders. An initial SUDM Assessment Battery has targeted the assessment of each of these competencies and CARS. To date, the SUDM Assessment Battery addresses 11 of the hypothesized enabling constructs including attentional control, sensemaking, perspective taking, analytical reasoning, self-regulation, and others. The four constructs yet to be adequately measured are adaptability, cognitive flexibility, change detection, and anomaly detection. Adaptability is defined as a competency; cognitive flexibility, change detection, and anomaly detection are supporting CARS that underlie adaptability.

Off-the-shelf measures of these four unaddressed constructs have proven inadequate as battery instruments for a number of reasons including inadequate construct validity as it relates to the infantry small unit domain, unacceptable criterion validity, inability to administer without a researcher or on a large scale, and prohibitive licensing costs. The capability sought is an automated, performance-based measure(s) of adaptability and the three CARS for integration into the SUDM Assessment Battery - cognitive flexibility, change detection, and anomaly detection. The performance-based measure(s) must reflect the operational definitions of the constructs as defined by the Maneuver Squad Leader Mastery Model [4], require no more than 30 minutes to complete, and support large-scale administration to infantry E3s-E5s and LTs at The Basic School or Infantry Officer Course (IOC) without the need for a human observer. Ideally, the measure will consist of a performance task assessing the individual's skill level in support of adapting within a context relevant to squad level infantry operations. Validation of the instrument must demonstrate its ability to predict decision-making performance, discriminate levels of experience or another acceptable criterion measure, and catalog outcome scores according to the five stages of squad leader development as described in the Maneuver Squad Leader Mastery Model. The administration, scoring, and reporting functions of the measure must be automated and transitioned to the Marine Corps Training Information Management System (MCTIMS) for implementation by the USMC.

PHASE I: Develop a concept and initial prototypes / mockups of techniques and technologies that are able to measure the adaptability competency and supporting CARS of cognitive flexibility, change detection, and anomaly detection as they relate to infantry squad leader decision making. Required Phase I deliverables will include a final report, Phase II plans, proposed assessment instrument(s) / metrics, and prototypes / mockups. The final report will include evidence-based rationale for the measurement and scoring concept, conceptual integration of the proposed measure with the Mastery Model, and Phase II plans. Phase II plans should include key components, technological milestones, and integration with the SUDM Assessment Battery. Mockups and/or prototypes are also required at the end of Phase I base to demonstrate a proof of concept. Phase I Option, if awarded, should include the processing and submission of all required human subjects use protocols, if required. Due to long review times involved, human subject research is strongly discouraged during Phase I base, but may be appropriate for the option.

PHASE II: Required Phase II deliverables will include the construction, demonstration, validation, and application of the adaptability measure proposed as a result of the Phase I effort. Usability and other required testing will be performed on the instrument to insure the effectiveness of the technology for the user audience. All appropriate data collection and psychometric analyses will be performed to insure sufficiency of the instrument and its relationship to the SUDM Assessment Battery, and to establish scoring parameters for the target audience. A final report will document the development and testing of the instrument.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, the contractor will be expected to provide support in transitioning the technology for Marine Corps use as part of the automated SUDM Assessment Battery within the Squad Leader Development Program (SLDP). The contractor will support the Marine Corps with certifying and qualifying the technology for Marine Corps use. Other commercial sectors (e.g., sports), federal agencies (e.g., DHS), or state/local agencies (e.g., police) may be interested in the use of the adaptability measure and could serve as another avenue for transition of the technology.

REFERENCES:
1. Headquarters Marine Corps, Plans Policies & Operations. (2015). Squad Leader Development Program (SLDP). Quantico, VA. http://www.hqmc.marines.mil/ppo/UnitHome/SLDP.aspx

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KEYWORDS: Small Unit Decision Making, Decision Making, Adaptability, Cognitive Flexibility, Change Detection, Anomaly Detection

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

N161-061 TITLE: Non-aqueous Environmentally Benign Surface Preparation for Aluminum Pre-treatment Processes

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

ACQUISITION PROGRAM: 1. Commander, Fleet Readiness Centers (COMFRC) - Target Site FRC SouthWest, 2. FY17 Advanced Topcoat

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 5.4.c.(8) of the solicitation. 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 method, process, or technology to replace aqueous hazardous materials used for surface preparation of aluminum alloys prior to application of chemical conversion coating or anodization as a corrosion protective coating and pre-paint adhesion promoter.

DESCRIPTION: Aluminum aircraft components that require repair or re-work at NAVAIR's Fleet Readiness Centers (FRCs) are subjected to multiple aqueous immersion tank processing steps for preparation of metallic surfaces prior to application of corrosion protective coatings. These chemical processing tanks require thousands of gallons of hazardous materials to clean, etch, and de-oxidize aluminum alloys prior to application of chemical conversion coating or anodize coating. Each process step requires a water rinse prior to the next step to neutralize the reaction, clean the surface, and prevent drag-out contamination of the subsequent process tank. The rinse water is then contaminated and considered a hazardous material that must be disposed of properly. The large amount of hazardous chemicals and contaminated rinse water generated from the aluminum surface preparation process are cost prohibitive, an environmental risk, and hazardous to human health. These aqueous processes also include process variations that occur due to upstream chemical variation. These chemical variations are a product of processing multiple aluminum alloys in the same aqueous solution that is altered with each production run/batch until the process tank is changed out. Current approach requires significant component processing time, process variation, and hazardous material disposal costs.

This innovative environmentally benign method, process, or technology will replace aqueous hazardous materials without increasing processing time or compromising corrosion protection performance, while reducing hazardous material costs. The innovation should reduce or eliminate traditional hazardous chemicals required for aluminum components processing including mildly alkaline cleaners, acid or alkaline chemical etchant, various deoxidizer and disputer acids, alternative Methyl Ethyl Ketone (MEK) approved organic wipe solvents, biflouride pickling/cleaning, and contaminated rinse water from rinsing in-between each process step. Requirements include that the new method, process, or technology will be compatible with currently used chemical conversion coating material, Ion Vapor Deposition (IVD) Aluminum process, and the three types of anodization.

PHASE I: Develop a new aluminum surface preparation process replacing hazardous materials prior to application of chemical conversion coating or anodization as a corrosion protective coating. Demonstrate the feasibility of the new process through bench top surface preparation. Surface preparation will be inspected using portable goniometry instead of the traditional water-break test to gain quantitative water contact angle data for analysis of surface wettability. The surface adhesion of the protective coating to the aluminum alloy must pass a Dry and Wet Tape Adhesion Test, and have acceptable performance in Salt Fog Corrosion Resistance Testing.

PHASE II: Fully develop an aluminum surface preparation process that can be operated manually or automatically on aircraft components without a significant increase in processing time or costs when compared to the current immersion tank surface preparation process. Operational parameters will be optimized with aluminum coupon testing and analysis. Testing and analysis in this phase will include metallurgical, mechanical, corrosion resistance, and surface characterization of the new surface preparation process on various commonly used aircraft aluminum alloys (i.e., 2024, 7050, and 7075 alloys). Process development and evaluation will also include using scrapped components to demonstrate and validate (DEM/VAL) the new aluminum surface preparation process to establish and refine practical applications as an alternative to the immersion tank based surface preparation process currently used.

PHASE III DUAL USE APPLICATIONS: Perform full scale corrosion resistance testing of new aluminum surface preparation process on a selected aircraft component. Transition and implement the developed surface preparation process for Navy use as an alternative to the current aqueous immersion tank surface preparation process. The small business will work with the Navy, DoD, and industry to transition through the appropriate qualification process. Commercial transportation industries including: shipping, aerospace, and automotive would benefit significantly from an environmentally benign aluminum surface preparation process for application of corrosion resistant coatings because a high percentage of transportation components are made of aluminum or are going to be made out of aluminum because of the abundance of the material, its strength to weight ratio, and its relative corrosion resistance.

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1. ASTM D3359 Measuring Adhesion by Tape Test. Retrieved from http://everyspec.com/

2. NAVAIR 01-1A-509 Aircraft Cleaning and Corrosion Control Manual. Retrieved from http://everyspec.com/

3. MIL-PRF-23377 Solvent-borne, Epoxy primer. Retrieved from http://everyspec.com/

4. MIL-PRF-85582 Water-borne, Epoxy primer. Retrieved from http://everyspec.com/

5. MIL-PRF-85285 Polyurethane Paint Coating. Retrieved from http://everyspec.com/

6. MIL-DTL-81706 Aluminum Chemical Conversion Coating. Retrieved from http://everyspec.com/

7. AMS-M-3171 Magnesium Chemical Conversion Coating. Retrieved from http://everyspec.com/

8. ASTM B117 Salt Spray/Fog Test. Retrieved from http://everyspec.com/

KEYWORDS: Aluminum alloys; hazardous materials; hazardous waste; aluminum surface preparation; corrosion protective coatings

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

N161-062 TITLE: Low Size, Weight, Power and Cost (SWaP-C) Cryogenic Heat Exchangers based on Highly Anisotropic Materials

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Space Platforms

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 5.4.c.(8) of the solicitation. 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 low SWaP-C Cryogenic Heat Exchangers based on Highly Anisotropic Materials by harvesting advances in anisotropic materials science to enable reduced volume, weight, and manufacturing cost for low temperature heat exchangers to enable cryogenic technologies to be deployed on SWaP-C sensitive platforms, e.g. UAV and satellites.

DESCRIPTION: The required high electrical power efficiency for the closed cycle cryocoolers needed to deploy 4 degree kelvin (K) superconducting radiofrequency (RF) receivers, 3K optical absorption energy sensors, and future <1K quantum computers on power sensitive platforms depends on saturating the heat capacity of the exhaust gas with energy from the warmer just compressed gas. Thus the heat exchangers (called recuperators and regenerators for DC and AC flow systems respectively) must efficiently conductively transfer heat perpendicular to the gas flow, while simultaneously not conducting it along the gas flow. Materials with highly anisotropic and large thermal conduction are needed to minimize weight/volume. Affordability requires development of simple, safe manufacturing techniques with etched or machined, hermetically sealed gas flow channels.

The current state of the art in recuperators consists of stacks of silicon wafers corrosively etched into the flow channels and maximal heat exchange surface area. Silicon is isotropic thermally, thermal insulating layers must be inserted between each pair of wafers, and the wafers must be relatively thick and heavy in order for etch processing and assembly breakage to be acceptable. Thus Si recuperators tend to be heavy and large to achieve adequate thermal performance and consequentially expensive to launch.

Regenerators generally consist of layers of porous materials, often stacked grids or packed powders, which may be (effectively) sintered to ensure they will not settle under the impact of vibration (launch!) and gravity. Flow channel optimization is currently quite immaturely understood or not independently controlled.

Proposers are expected to focus on solutions appropriate to the temperature range well below 20K where current cooler technology is weakest and proposals extendable to below 1K will be rated especially favorably. Solutions that allow a common manufacturing technique to be applied in a sequence of different temperature range layers will be preferred over techniques requiring different manufacturing/assembly techniques for different thermal zones. Only proposals appropriate for fully closed cycle coolers will be viewed as responsive.

PHASE I: The original proposals should define a specific set of materials and construction method(s) to be explored during the phase 1 base award. Determine feasibility for the development of low SWaP-C Cryogenic Heat Exchangers based on Highly Anisotropic Materials. Demonstrate feasibility through experimental tests to define critical parameters not already available in the research literature, not just numerical simulations. By the end of the Phase I effort, predictions of the ultimate performance of the heat exchanger should be possible Phase II awards will be determined on the technical approach and performance capabilities of the heat exchanger as demonstrated in the Phase I feasibility tests documented in the final report. The initial Phase II proposal should also discuss the remaining technical risk items and include a plan to reduce them in Phase II. The Phase I option period should further refine any remaining materials selection issues, e.g. by addressing desirable chemical alterations for adjacent thermal zones, or experimentation with alternative sample production techniques.

PHASE II: Phase II should fully develop and demonstrate an improved performance heat exchanger prototype. For a recuperator, the metric might quantify how perfectly the input and exhaust gas matches in temperature at each point along the flow axis, times the weight * volume product for a 20 to 4K gradient to be spanned. During the Phase II base period, subassemblies and fabrication techniques should be separately demonstrated and iterated for performance. Any necessary materials growth/fabrication issues should be resolved adequately to allow the effort to proceed. Phase II should culminate in the construction and test of a complete heat exchanger sufficient to allow potential users to evaluate the utility of the technology. Note that the production of vibration by the coolant flow must be minimized.

PHASE III DUAL USE APPLICATIONS: During Phase III, the prototype heat exchanger developed during the Phase II effort would be reiterated and integrated into a full 4K cooler (or colder) cryo-cooler demonstration unit that will be evaluated independently as a cooler in a government lab and then incorporated in a trial 4K sensor system unit. Collaboration of the heat exchanger vendor with a cooler company is highly desirable by this stage since to be commercially successful the heat exchanger must be merged into complete coolers and those merged into systems with sensors/processors requiring cryogenic cooling. This may be ESM systems on military platforms, earth observing space satellites like WindSat, medical instrumentation, or earth based quantum computers used in data centers. The specific product developed here will have utility primarily as an enabler of the utility of the materials science/physics driven phenomena observable only at/ below 4K. This includes many known quantum phenomena and most of the methods of quantum computing, long held as the ultimate replacement for Si computers now that Moore's law is ending. 4K conventional computing is also being pursued by the US government for use as major servers due to their projected superior energy efficiency. Given the improved low noise floor that cryogenics provides naturally, improved medical sensors, such as more accurate brain mapping systems, are also likely. However, the methods of using layered materials to produce heat exchangers developed here will have general utility at higher temperatures where the need for refrigeration is large on commercial scales, from flash freezers and LN2 temperature baths for tire recycling to above room temperature cooling of telecom power amplifiers, motors and turbines.

REFERENCES:

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2. Advanced Low Temperature Thermoelectric Materials for Cryogenic Power Generation Project, NASA, 2015, retrieved from https://data.nasa.gov/dataset/Advanced-Low-Temperature-Thermoelectric-Materials-/iqd9-8a9w/about

3. A High-Performance Thermoelectric Material for Low-Temperature Applications; retrieved from http://chemgroups.northwestern.edu/kanatzidis/Reprints/CsBi4Te6_science.pdf

4. An Ultra-Compact Laminar-Flow Cryogenic Heat Exchanger, retrieved from dotynmr.com/download/pubs/1992_ACE_Doty_UCLFHE.pdf

5. Cryoginics ’98 IIR International Conference Prague, Czech Republic, May 12 – 15, 1998, retrieved from www.isibrno.cz/cryogenics98/

6. Thermal analysis of cyclic cryogenic regenerators, International Journal of Heat and Mass Transfer, Vol 17, p 37-49 (2974).

7. Regenerator Materials – regenerator plot chart, retrieved from cryogenics.nist.gov/MPropsMAY/RegeneratorMaterials/RegenPlot.htm

8. Cryocooler, retrieved from https://en.wikipedia.org/wiki/Cryocooler

KEYWORDS: heat exchangers; recuperators; regenerators; anisotropic materials; layered materials; cryocoolers

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

N161-063 TITLE: High Energy, High Repetition Rate, non-chirped pulse amplification (CPA), Ultra Short Pulsed Laser (USPL) Systems

TECHNOLOGY AREA(S): Materials/Processes, Sensors, Weapons

ACQUISITION PROGRAM: ONR Code 35: Solid State Laser (SSL) Tech Maturation and High Energy Laser

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OBJECTIVE: Develop robust, high pulse energy (10mJ-100mJ), high repetition rate (>1 kHz repetition rate), ultra-short pulse (<1 ps) laser amplifier system operating at a near-infrared (NIR) or mid-wavelength infrared (MWIR) wavelength that employs a non-chirped pulse amplification architecture.

DESCRIPTION: High peak-power (gigawatt – terawatt class) lasers with kHz-class repetition rates have applicability for a variety of defense and commercial applications. Among other things, Ultra Short Pulsed Lasers (USPLs) are attractive due to their ability to produce laser radiation that can ablate matter without depositing large quantities of heat. Provided that the average laser power is low enough that accumulated heat is negligible, efficient material removal without heat affected zones can be achieved with relatively modest pulse energies (microjoules/pulse). However, if long range propagation is involved or, in the case of a manufacturing facility where pulse energy splitting is used to feed multiple machining heads, multi-mJ laser systems are necessary. At these pulse energies, more exotic effects such as Kerr self-focusing and non-linear optical frequency conversion processes (higher harmonic generation, X-ray generation, etc.) could also be leveraged for potential applications. For these processes to be relevant, pulse lengths less than 500 fs are typically required.

Existing laser systems that can achieve this level of performance (multi-mJ pulse energy, kHz repetition rate, sub-picosecond pulse length) rely on chirped pulse amplification architectures (CPA). This type of architecture begins with a very low energy (pico- to – micro-joules), ultrashort (10's – 100's of femtoseconds) pulse, which is then significantly temporally stretched (100's of picoseconds to several nanoseconds), amplified to higher pulse energies (micro- to milli-joules), and then recompressed to ultrashort durations. This technique is well known and forms the basis of most, if not all, high peak power USPL systems. Unfortunately, these types of systems have significant limitations, especially as it applies to the stretching and compressing stages of the laser system. Ongoing research and development efforts exist that seek to improve the performance of these components.

On the other hand, non-CPA based amplification techniques have been theorized, modeled in the scientific literature, and in some cases demonstrated in laboratory settings. However, these techniques have yet to be pursued to any significant extent, particularly in a manner that emphasizes the full systems engineering approach needed to transition to practical applications. Non-CPA based techniques are intriguing and represent a fundamental shift away from the traditional USPL system architecture. A non-CPA bases USPL system could revolutionize the entire industry and enable laser products that are amenable to installation in a military platform.

PHASE I: Phase I activities should focus on fully developing the design, architecture, and composition of the proposed conceptual laser and amplifier system as well as providing sufficient evidence to support the feasibility of the proposed concept.

Evidence of feasibility may include results from theoretical models, but should preferably include experimental results or initial laboratory demonstrations of key technological elements. Theoretical models used to illustrate and support feasibility should be directly relevant to the key technological issues of the proposed concept.

The proposed conceptual design should show how the proposers will produce a prototype non-CPA based, compact, USPL system that can generate pulses with greater than 10 mJ per pulse, greater than 1 kHz repetition rate, and less than 500 fs pulse duration at a NIR wavelength (1.0, 1.5, or 2.0 microns). Notional system, subsystem, and component functional and technical specifications should be identified and any critical interface requirements between the subsystems should also be defined and explained. The prototype design should provide compelling evidence that the final product will be compact and robust in adverse environments.

PHASE II: Phase II activities will further define the design developed in Phase I and then execute the prototype system fabrication, construction, and integration activities that lead to the completion of a USPL prototype system that achieves the specifications identified in Phase I to be delivered to the Navy for evaluation.

Detailed design activities should include maturation and finalization of the full system, subsystem, and component specifications such that procurement of hardware can be accomplished and the prototype system can be assembled, tested, demonstrated, and delivered at the conclusion of Phase II.

As described in the plan for Phase II that was developed in Phase I, the Phase II activities should include regular design reviews with the government program manager and development milestones which provide evidence of progress towards the technical specifications of the critical subsystems and components necessary to complete the construction of a prototype system meeting the program goals.

In addition to producing a deliverable hardware prototype, a final technical data package that includes design drawings and descriptions, subsystem and component specifications, interface descriptions and definitions, and operating instructions for the prototype will be produced and delivered.

PHASE III DUAL USE APPLICATIONS: Phase III activities will include the development and execution of a plan to manufacture a production-level USPL system based on the Phase II prototype and assist in the engineering, integration, and testing of the production level system into existing or future Naval combatant vessels, systems, test vehicles, or test ranges. The contractor will pursue commercialization of the various technologies and components developed in Phase II for potential commercial uses. The technology being developed in this topic is likely to find synergy within the scientific, nanotechnology manufacturing, and homeland defense communities.

REFERENCES:
1. J-C. Diels and W. Rudolph, Ultrashort Laser Pulse Phenomena, Academic Press (1996).

2. W. Koechner, Solid-State Laser Engineering, 5th ed, Springer Press, 1999.

3. J. Tümmler, R. Jung et al., Opt. Lett. 34, 1378 (2009).

4. D. Mueller, S. Erhard, and A. Giesen, in Advanced Solid-State Lasers, C. Marshall, ed., Vol. 50 of OSA Trends in Optics and Photonics (Optical Society of America, 2001), paper MF2.

5. C. Stolzenburg and A. Giesen, in Advanced Solid-State Photonics, OSA Technical Digest Series (CD) (Optical Society of America, 2007), paper MA6.

6. Mitrofanov, A. V., et al. "Mid-infrared laser filaments in the atmosphere." Scientific reports 5 (2015).

KEYWORDS: USPL; lasers; ultra-short pulsed lasers; laser development; chirped pulse amplification; CPA

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

N161-064 TITLE: Development of a Portable Platelet Apheresis Machine

TECHNOLOGY AREA(S): Biomedical

ACQUISITION PROGRAM: MARCORSYSCOM; PM-CSS PdM - Combat Support Equipment, Biomedical Engineering

OBJECTIVE: Development of a single-person carry, ruggedized, battery operated, automatic platelet apheresis device to provide fresh, leukocyte-reduced, platelets in the field.

DESCRIPTION: Platelets are a blood component essential to hemorrhage control. The majority of preventable deaths on the battlefield are secondary to hemorrhage. Survivability is inversely related to the speed of receiving blood/blood components following catastrophic wounding. Transfusion of whole blood is not realistic in the expeditionary environment due to whole blood storage requirements and removal of substantial intravascular volume causes the donor to be temporarily “out of the fight”. To overcome this, naval medical facilities have components of whole blood except platelets which have a very short shelf life.

Currently manufactured platelet apheresis devices exist in transfusion centers but are not designed for expeditionary use (being large, heavy, bulky and have external components susceptible to breakage) with the process taking 60-120 minutes to be complete. Determination of lab values (blood type, human leukocyte antigens s, donor sepsis, platelet count, etc.) occurs as separate steps.

A solution is the development of a portable, automated, platelet apheresis machine (apheresis removes platelets while returning all other blood cells and plasma to the donor). Field apheresis will allow platelets to be collected from a single donor on site so they are available to the severely injured.

Required Features:
• The device must be able to receive and maintain the donor’s personal info for tracking, and be able to print all stored data.
• Automated laboratory assays to determine blood type, platelet number and serum calcium levels; results displayed on electronic screen.

• Simple operation. For example, after obtaining and presenting the data, the device prompts the administrator with the question “Do you want to proceed with apheresis?” With the push of the “yes” button, platelet collection begins.

Performance of the device must be equivalent to currently FDA approved devices. It must be lightweight, ruggedized, have an effective platelet separation and leukoreduction processes, have automated features (blood pressure cuff, saline infusion, process cycles, etc), reduced need for citrate (an anticoagulant typically used in the blood collection process), simple operation and set up. The device needs to be able to determine hematocrit and platelet count prior to initiation of apheresis cycle and be able to optimize device settings based results and entered patient data (sex, height, weight). Must be FDA approved on completion.

PHASE I: Determine technical feasibility of an approach and develop the concept technology for a portable platelet apheresis device. Device must be a closed-system (to maintain sterility) able to sequester and concentrate platelets while returning all other blood components to the donor. Device must also specifically reduce, to the greatest extent possible, immunogenic leukocytes (leukoreduced). Device should also perform laboratory assays as part of the process: determine blood type, donor’s platelet count and calcium levels. Deliverable would be a design schematic and analysis of potential technical and regulatory issues.

PHASE II: Select the best approach from Phase I to develop and demonstrate a prototype device (End of Phase II deliverable). The prototype will be used to establish, through experiments and prototype fabrication, performance parameters of the device. Phase II milestones:
• Initial Planning Meeting/Design Review
• Demonstration of personal data input/output
• Demonstration of laboratory assays, data acquisition, output on electronic display (graphical user interface or GUI), storage and print ability
• Demonstration of closed processing system incorporating leuko-reduction and platelet sequestration & concentration
• Demonstration of packaging system

PHASE III DUAL USE APPLICATIONS: Phase III work is oriented towards commercialization with planned transition to the Rapid Innovation Fund program to complete hardware design and manufacture and development of required documents to enter into Food and Drug Administration (FDA) approval path. The ramp-up to manufacturing and the commercialization plan will also be developed during this phase of development. Developing countries or rural areas in developed countries where access to blood products is limited due to distance or lack of capabilities to store and maintain perishable blood products. May also have appeal to NGO’s involved in disaster relief efforts where existing blood supplies are rapidly depleted or conditions for storage of blood products do not exist.

REFERENCES:
1. Transfusion Medicine and Hemostasis. Shaz BH, Hillyer CD, Roshal M and Abrams CS, 2nd Edition, Elsevier, 2013.

2. McLeod BC: Apheresis, Principles and Practice. 3rd Edition, AABB Press, 2010.

3. Apheresis: Basic Principles, Practical Considerations and Clinical Applications, retrieved from http://pathology.ucla.edu/workfiles/Education/Transfusion%20Medicine/13-5-Apheresis-Basic-Principles-Practical-Considerations-and-Clinical-Applications-part

KEYWORDS: Platelets, Apheresis, Leuko-reduced, Portable, hemorrhage control, blood components; massive transfusion

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

N161-065 TITLE: Ocean Sensing Lab on a Chip

TECHNOLOGY AREA(S): Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Submarine Corrosion Control Technologies Future Naval Capabilities (FNC) 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 5.4.c.(8) of the solicitation. 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 ruggedized Lab on a Chip (LoC) that can be integrated into a shipboard corrosion control system to measure ocean water chemistry.

DESCRIPTION: The Office of Naval Research seeks proposals to perform in-situ monitoring of oceanographic chemical parameters employing ruggedized, hull-mounted (external) sensor systems. Underwater hull corrosion protection is performed by the Impressed Current Cathodic Protection (ICCP), an advanced control system which balances the distribution of electrical energy required to provide corrosion protection to the hull, propeller, and significant hull appendages. This control system responds to the electrochemical polarization demand of these surfaces, and employs feedback voltage from seawater silver/silver-chloride seawater reference electrodes, measured against the voltage of the ship’s hull. Evolution of electrochemical cathodic surface polarization, as well as environmental instability of reference electrodes, is a direct product of seawater chemistry in the hydrodynamic boundary layer on the hull.
Precision of measured oceanographic chemical parameters sought for this application include: temperature (± 0.1°C), pH (±0.01 units), conductivity (± 1.0mS/m), dissolved oxygen (±0.01mg/l), chloride (±0.1mg/l), bromide (±0.01mg/l), sodium (±0.1mg/l), calcium (±0.1mg/l), sulfate (±0.1mg/l) and sulfide (±0.1mg/l). A sampling rate of at least one oceanographic chemical assessment every minute will be required during operation. Ranges of chemical parameters measured must satisfy global oceanographic and littoral estuarine chemistry ranges for navigable waterways.

Recent advances in LoC technologies have reported field sampling of relevant oceanographic chemical parameters of interest described above[1]. LoC sensing technology has successfully demonstrated the measurement accuracy of many of the above parameters of interest in controlled laboratory environments with small form factors [Collaborative for Oceanographic Chemical Analysis], however they have not been demonstrated in ocean environments with complex backgrounds (all the parameters varying) and environmental fouling over extended periods of time. This topic seeks to integrate the sensors of interest onto a single miniaturized LoC that would work in real-world ocean environments (e.g. with biofouling, under pressure, and having all the parameters varying at once) and meet the Navy's goal of a 20 year lifetime. The ICCP reference electrodes are contained in packages measuring 10.0 cm (width) X 7.5 cm (length) X 5.0 cm (depth). A proposed LoC sensor must integrate into this package without impacting the reference electrode performance. Furthermore, the LoC sensor should be installable shipboard at a reasonable production cost, and be ruggedized for shock according to MIL-STD-901 (Shock, Grade B) and vibration according to MIL-STD-167-1A.

PHASE I: Determine feasibility for the development of a ruggedized Lab on a Chip that can be integrated into a shipboard corrosion control system to measure ocean water chemistry. Feasibility can be demonstrated through simultaneous sensing of the key oceanographic chemical parameters, pertinent to corrosion control, on an integrated circuit package in a laboratory environment.

PHASE II: Based on Phase I effort, develop a prototype Lab on a Chip and integrate the sensor package into a shipboard ICCP reference electrode holder, and demonstrate sensor operation for a minimum of six months in a natural seawater environment.

PHASE III DUAL USE APPLICATIONS: Integrate the final design sensor package into shipboard ICCP architecture, install the sensor aboard ship at multiple reference electrode locations and demonstrate operation of the sensor package aboard ship for a minimum of two years. Support the Navy with certifying and qualifying the system for Navy use. When appropriate focus on scaling up manufacturing capabilities and commercialization plans. The developed technology will find application in commercial ship hull corrosion protection where previously impressed current corrosion protection has been impractical due to the ongoing maintenance and calibration requirements of such systems.

REFERENCES:
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KEYWORDS: Oceanographic chemical analysis, corrosion control, cathodic protection, impressed current cathodic protection, lab on a chip, water chemistry

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

N161-066 TITLE: Medium Voltage Silicon Carbide Power Components

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

ACQUISITION PROGRAM: PEO Ships: PMS 320 Electric Ships Office

OBJECTIVE: Develop medium voltage (6500V, >100A) silicon carbide (SiC) metal oxide semiconductor field-effect transistor (MOSFET) dual half-bridge power switching module. The module will implement an anti-parallel diode utilizing the SiC MOSFET internal body diode to enable high-power density, multi-megawatt power electronic converters for propulsion motor drives and shipboard power distribution.

DESCRIPTION: Future all-electric warships will have a greater demand for improved electrical power density, conversion, and system reliability. Over the last decade, significant advances have been made with medium voltage silicon carbide (SiC) devices. However, few commercial modules are available above 3300V, and the technology remains cost prohibitive. This topic addresses the development of medium voltage, high current power electronic switching modules that can be applied to 1 MW/m3, propulsion motor drives and shipboard power distribution system elements to meet the needs of these greater demands. These modules must provide a cost structure of less than $45/A with medium voltage SiC devices without compromising performance. Future Navy ships will require high power converters for applications such as electromagnetic rail gun, Air and Missile Defense Radar (AMDR), and propulsion on comparable displacement, future DDG-51 ship platforms.

The 6500 V silicon carbide dual half-bridge power MOSFET module should have the characteristics of 1) high-speed switching with low capacitances and inductances, 2) high blocking voltage with low on-resistance, 3) easy to parallel and simple to drive, 4) avalanche ruggedness, and 5) high reliability .
The proposed SiC MOSFET dual half-bridge power module will meet the following thresholds:
• Drain-source blocking voltage greater than 6500 volts with drain-source leakage less than 10 microamperes
• On-resistance less than 40 milliohms at 20 V gate voltage and 150 °C junction temperature
• Continuous drain current greater than 100 amperes for 20 V gate voltage and 150 °C junction temperature
• Gate-to-source charge less than 100 nanocoulombs
• Gate Threshold Voltage greater than 2.0 V at 150 °C junction temperature
• Gate-to-source leakage current less than 600 nanoamperes at gate-source voltage of 20 V
• Short-circuit withstand time of greater than 10 microseconds
• Avalanche energy for a single pulse greater than 4 joules
• Rise time less than 100 nanoseconds (ns) and fall time less than 100 ns
• Module isolation voltage greater than 10,000 volts

• Cost structure less than $45/A

PHASE I: Determine feasibility and establish a plan for the design and development of 6500V, 100A silicon carbide dual half-bridge power module. The module will be designed for low inductance, low thermal resistance, and high reliability. The SiC MOSFET power module should be designed to utilize the internal body diode within the SiC MOSFET power switch process as the anti-parallel diode without an additional diode in the module. Demonstrate by design module inductance level, module thermal resistance, module thermal cycling capability, module current level, number of die per module, and estimating module production costs for various lot sizes. Final report should convince that the proposed product can be properly designed to meet the previously described desired and required features can and be achieved if Phase II is awarded. The small business will provide a Phase II development plan addressing technical risk reduction.

PHASE II: Develop and demonstrate a 6500V, 100A silicon carbide dual half-bridge power module with low inductance, low capacitance, low thermal resistance and high stability. The SiC MOSFET power switch module should be designed to utilize the internal body diode within the SiC MOSFET power switch as the anti-parallel diode (without an external separate anti-parallel diode). Demonstrate that the on-resistance of the 6500, 100 A SiC MOSFET power switch module is stable with operation time and does not suffer from blocking voltage degradation or on-resistance drift due to stacking fault growth during forward bias of the internal body diode. Demonstrate stable operation of gate threshold voltage (HTGB at 150 °C with VGS = -25V for 1000 hours), stable blocking voltage (HTRB at 150 °C for 80 percent of blocking voltage for 1000 hours), and stable forward voltage (less than +/- 20 percent change when operated at 150 °C junction temperature for 300 hours). Characterize the 6500 V, 100 A SiC MOSFET power switch module turn-on and turn-off losses up to 150 °C. Develop a reliability test plan to meet threshold metrics.

PHASE III DUAL USE APPLICATIONS: Phase III shall address the commercialization of the product developed as a prototype in Phase II. The small business is expected to work with suitable industrial partners for this transition to military programs and civilian applications. The expected final state of this 6500V, 100A module will match the requirements given in Phase II and will be suitable for transition into a multi-megawatt Power Control Module for interface from ship bus to radar interface. The medium voltage silicon carbide components 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: Silicon Carbide, Power Electronics, Wide Bandgap Semiconductor, Power Module, Medium Voltage, Power MOSFET

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

N161-067 TITLE: Novel Materials and Components for New Liquid Monopropellant Propulsion Systems

TECHNOLOGY AREA(S): Materials/Processes, Weapons

ACQUISITION PROGRAM: Ballistic Missile Defense System (BMDS) - Standard Missile 3 (SM-3) ACAT 1

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 5.4.c.(8) of the solicitation. 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 materials and systems for new ionic liquid monopropellants capable of providing improved safety with full propulsive capabilities. Focus on the design and demonstration of an electrically controlled ionic liquid monopropellant motor comprising the igniter, vessel, valves, and controls is sought.

DESCRIPTION: Hypergolic propulsion systems are the state-of-the-art technology for extreme control of propellant thrust for Divert and Attitude Control System (DACS); however, their use aboard Navy ships and submarines is severely restricted due to their high reactivity, toxicity, and corrosivity. DACS utilizing solid propellants (Solid DACS (SDACS) or Throttleable Divert Attitude Control System (TDACS)) were developed to circumvent the problems surrounding the use of the hypergolic fuels but impose limitations on the performance of the resulting motor. The capability to significantly reduce the size of these small thrusters without the use of highly volatile hypergolic propellant systems can lead to increased payload capacity and simplification of the propulsion system. A propulsion system utilizing an environmentally benign, low vapor pressure, low toxicity ionic propellant along with the necessary system components that utilize the electrochemical nature of these propellants to control their reaction while maintaining or exceeding the performance of the hypergolic systems can be realized and should allow for the reduction and simplification of current DACS systems. This effort will involve the design and construction of an ionic propellant propulsion system that will leverage electrodes and electrical control of the propulsion phenomena while addressing the stability, corrosion and deleterious electrode reactions that can lead to poor system reliability. A systematic effort to evaluate and develop rational "design rules" for the electrodes and other system components should be undertaken using a hydroxylammonium nitrate (HAN)-based propellant as the baseline ionic propellant composition. The focus of the effort will be on the electrode materials selection, system geometry and the safety of propellant. The propellant selection and propulsion system component design should focus on the requirements for a TDACS used on SM-3 Block II.

PHASE I: Perform an analysis and identify notional system geometries, select promising novel materials for the electrodes, and identify material properties that can impact stability, corrosion and deleterious electrode reactions. Using the baseline HAN monopropellant system, perform theoretical calculations that demonstrate the feasibility of the proposed materials and system. Recommend an electrode material and design for further evaluation and scale-up.

PHASE II: Based on Phase I effort, develop and scale-up an ionic propellant system that utilizes electrodes and electrical control of the propulsion phenomena. Develop "design rules" that can be used to evaluate electrode performance in an electrically controlled motor system utilizing a HAN monopropellant. Conduct performance and safety evaluations and ensure that the system maintains the performance of SM-3 Block II TDACS and that the design is capable of meeting the requirements for safety and suitability for service use outlined in STANAG 4170 and JOTP-001.

PHASE III DUAL USE APPLICATIONS: Based on Phase II effort, fabricate a full-scale motor based on the Phase II design and deliver to a Navy test facility for testing to determine its performance and safety. The small business will support the Navy with certifying and qualifying the design for Navy use. When appropriate the small business will focus on scaling up manufacturing capabilities and commercialization plans. At the completion of this phase, the propulsion system will be ready for transition into a new electrically controlled Divert and Attitude Control System (DACS) for use in a missile system such as SM-3. The capability to significantly reduce the size of small engines and thrusters on commercial spacecraft and satellites without the use of highly volatile hypergolic propellant systems can lead to increased payload capacity and simplification of the propulsion system which can lead to their use in devices such as the Draco thrusters in SpaceX Dragon spacecraft.

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KEYWORDS: Ionic; monopropellant; solid; propulsion; electrical ignition; AF-M315E, Ammonium Dinitramide; ADN; LMP-103S; hydroxyl ammonium nitrate; HAN

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

N161-068 TITLE: Low Probability of Detection Acoustic Communication

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

ACQUISITION PROGRAM: Forward Deployed Energy and Communication Outposts (FDECO) INP

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 5.4.c.(8) of the solicitation. 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: To develop an acoustic modem system employing stealthy techniques for sending information through ocean acoustic channels at modest to moderate bit rates (100s of bits per second) over ranges of 1 to 10 km.

DESCRIPTION: The application of Unmanned Undersea Vehicle (UUVs) to a wide variety of scientific and military tasks is currently a common practice, but communication to and between the UUVs typically relies currently on commercial modems that employ fairly high source levels and readily recognizable frequency and phase shift coding systems. Conceptual applications of UUV systems include missions where the probability of success for the concept relies on the assumption of a stealthy posture. Communication modes that are difficult to detect will support requirements for such UUV systems. Two potential basic approaches (note that small business effort is not limited to these approaches) to this problem are: 1) to attempt to remain undetected through reduced signal-to-noise ratio (SNR) signals, or 2) to camouflage the communications such they will not be identified or associated with the system that is employing them.

PHASE I: Develop initial concept design for an acoustic modem system and perform an analysis of the expected performance of the modem including the details of the carrier, modulation, and information coding strategy that will support bit rates in excess of 100 bps over ranges from 1 to 10 km. Feasibility for the acoustic modem system may be determined through analysis which should include a Low Probability of Detection and Low Probability of Intercept (LPD/LPI) performance characterization with estimates of detection probability as a function of range and other considerations.

PHASE II: Develop a prototype acoustic modem system and demonstrate capacity and other performance metrics using actual transmissions of acoustic data. Analysis should include both communication capacity and LPD/LPI performance characterization as a function of range and other considerations. Develop a production design, including size, weight, power, and costs estimates, as well as complete system performance predictions and evaluations to include capacity estimates under a variety of environmental conditions and ranges. SECRET clearance may be required for Phase II.

PHASE III DUAL USE APPLICATIONS: Develop and deliver a functioning point to point communication system for use on the ONR Forward Deployed Energy and Communication Outposts. Verify predicted performance metrics for signal acquisition, synchronization, and bit error rate, as well as detection probability as a function of range. SECRET clearance may be required for Phase III. LPD performance is unlikely to be a priority for users of UUVs in marine construction and oil/gas production, but higher SNR variants of the modems and coding schemes might provide notably robust performance in challenging environments.

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KEYWORDS: Acoustic communication, modem, underwater networks, UUV, Low Probability of Intercept, Submarine Communication

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

N161-069 TITLE: Effective Crack Arrestors for On-Board Fatigue Crack Repair of Aluminum Ship Structures

TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: Naval Sea Systems Command - Surface Warfare (NAVSEA 21)

OBJECTIVE: Develop and implement an effective method to incorporate crack growth stopping features which can be performed by ships force. Develop a repair selection toolkit for design and performance evaluation of repaired aluminum ship structures that can be utilized by ships force for emergent cracking issues.

DESCRIPTION: New high speed aluminum vessels have been recently constructed and are now in operation by the US Navy. The structure has been designed to preclude crack initiation during the operational life of the ship, however past experience with welded aluminum structures has demonstrated plate cracking will occur and will grow. Research in ship structures has shown that not only will aluminum cracks grow, they will grow three to four times faster than cracks in steel plate at the same fatigue stress level [Sielski, 2007]. The reason for faster growth rate is the lower fracture toughness of aluminum, compared with steel. Unlike steel structures, there has been very little R&D on crack-arrest of welded aluminum ship structures.

The current state of the art for marine aluminum plate cracking repair includes standard grind out and welding, simple drill stopping of the crack tips, interference bolt to apply compressive stress to the hole edge, welded insert, welded doubler plates, and composite patched plate. Composite patches have demonstrated fatigue life benefits [Noland et. al. 2013], however the current Navy method cannot be applied by ship’s force. The interference bolt method provides an increase in fatigue life, however it requires careful drilling and reaming of the hole so that an evenly distributed stress can be applied to the hole’s edge [Callinan et. al. 1998]. Effectiveness of simple compression bolts for aluminum structure has not been well documented and other options involve welding, which increases the risk of new cracking due to welding defects, workmanship, and general sensitivity to heat input and cooling.
The aerospace industry continues to investigate methods to predict and arrest crack growth in thin aluminum plate. Marine industry aluminum plating is typically thicker and does not behave in a simple 2D plane stress manor. Bonded reinforcement and cold working have both been studied for their effects on crack growth behavior. Jones and Dunn’s (2009) research on crack growth near cold worked holes demonstrated the need to account for the through thickness stress profile created during processing and evolution under fatigue; traditional 2D plane stress analysis could not capture the complex stress profile and required 3D analysis methods. A combined experimental and 3D numerical study is essential to develop innovative crack-arrest methods and features such as special fasteners or bonded reinforcement.

PHASE I: Develop concept(s) for crack arresting methods for welded aluminum ship-type components and demonstrate performance and production feasibility at lab scale under low cycle tension-tension fatigue loading conditions. Coordination with government to determine stress levels and loading rates will be required. The Phase I performance demonstration can be accomplished using ship scale flat plate (10-mm thickness) under uniaxial loading conditions. The test specimen should be similar to the one developed by Kosai et al (1996) and allow for both uniaxial and biaxial load conditions. The flat cruciform specimen was an alternative method for simulating pressurized fuselage crack kinking in the presence of tear strips. Demonstrating crack growth rate and directional behavior under uni-axial loading conditions and in the presence of crack arresting technology facilitates the down select of promising lab scale crack arresting methods for further development under Phase II.

PHASE II: The goal of Phase II is to refine the top performing methods to arrest crack growth developed in Phase I. The low cycle fatigue testing and analysis efforts should be expanded to capture higher stress levels and increased stress state complexity with constant and random amplitude fatigue spectrum loading. Coordination with government engineers will be required to determine stress state. Specimen loading should represent the combination of crack tip fracture energy typical of a standard welded aluminum detail flaw. The loading scenario should be developed through detailed numerical analysis with test response behavior used to confirm the predictions. Numerical capabilities should facilitate the estimation of a fatigue lifetime limit and demonstrate the ability of the technology to arrest crack growth or significantly decrease the crack growth rate and increase the load cycles to failure of the repaired plate. The Phase II Option, if awarded, should demonstrate crack arresting capabilities for full scale structural components under fatigue loading. This demonstration can be accomplished using a fixture and specimen similar to the large ductile tearing fixture.

PHASE III DUAL USE APPLICATIONS: Coordinate with NAVSEA 21 to design, simulate, and demonstrate crack arresting capabilities for existing damage that resulted from fatigue loading. This will be a shipboard demonstration on a Navy ship with aluminum structure, or other appropriate welded aluminum structure, such as high speed ferry, passenger train, or tractor trailer. Analytical and design tools should be packaged, demonstrated, and transitioned to develop effective crack arresting technology that can aid in cost effectively managing life cycle performance and maintenance costs. Effective crack arresting technology for aluminum would be applicable across commercial maritime industry where life cycle management drives business operating costs and profits. Lightweight aluminum structures also exist in the energy and land transportation industries. Aluminum structures from tractor trailers, shipping containers, passenger trains, to high speed ferries can benefit from development of this technology.

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KEYWORDS: Crack Arrest; Aluminum; Fracture; Fatigue; Marine Structure; Ship Structure; Compression Bolt; Cold Working; Composite Patch

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

N161-070 TITLE: Retrofitting Code into Binary Executables and Firmware to Add New Functionality for Embedded Systems

TECHNOLOGY AREA(S): Information Systems

ACQUISITION PROGRAM: FNT-FY17-04 Resilient Hull/Infrastructure Mechanical & Electrical Security

OBJECTIVE: Investigate, design, and develop an automated or semi-automated tool for inserting new instructions and functionality into existing (compiled) binary executables and firmware for embedded systems.

DESCRIPTION: Effectively securing the growing array of embedded devices in use on military platforms is a critical challenge. Aside from their ubiquity, embedded devices increasingly handle larger amounts of privacy-sensitive information as the movement towards the “Internet of Things” (IoT) continues. Furthermore, embedded devices play a central role in critical infrastructure and control key mechanical systems in the industrial, energy, and transportation sectors. In such applications, errors and vulnerabilities in the software running on these devices can have devastating impacts due to their ability to cause failures in the physical world.

A key challenge toward securing embedded devices is that it is difficult to modify their behavior for defensive security purposes: the devices commonly execute proprietary firmware where source code and documentation are unavailable. Given the long lifespans of these components, it is often the case that the original vendor is unavailable or unmotivated (due to lack of cost-effectiveness) to provide updates with new and improved security functionality. An automated or semi-automated tool to allow users to retrofit their own set of instructions into the operation of the firmware would enable security improvements for such legacy devices.

Retrofitting new functionality onto legacy binary code is a challenging task, but not insurmountable [1-3]. With embedded firmware, the lack of OS and library abstractions in conjunction with a variety of poorly documented firmware image formats, some of which must be unpacked [4], renders existing static or dynamic binary analyses extremely challenging to apply. Such methods typically require basic facts about the system under analysis, including how to interact with hardware, how to load the image into memory, where to begin execution, and where untrusted input can be received and processed by the firmware [5].

This SBIR topic encourages the development of a methodology and tool or toolset for reducing the workload in retrofitting binary executables with the ultimate goal of enhancing the security defenses of an embedded system. The resultant tool or toolset should operate statically on a binary image, not operate dynamically in a manner that requires modifying the loader or interface. The tool should accept a binary image as input, integrate the new functionality, and should output an enhanced binary image that has been retrofitted with the new code.

The methodology should encompass all technical aspects of the effort, including but not limited to analysis of binary code formats, binary reverse engineering, binary rewriting, and insertion of new functionality/code into an existing binary. When retrofitting new code, care must be taken to apply the modifications safely and in a manner that impacts the overall system in a predictable fashion. Also very few, if any, assumptions should be made about the information supplied by the original vendor (e.g. debug symbols).

PHASE I: Develop a methodology and toolset for retrofitting new functionality into legacy binary code. Identify, design, implement, and integrate the tools required for the methodology. Develop a limited proof-of-concept for the methodology to prove the feasibility of your approach.

PHASE II: Based on the Phase I effort, further develop and enhance the toolset into a fully functioning prototype for retrofitting legacy code with new functionality. Demonstrate and evaluate the efficacy of the methodology and toolset on legacy embedded binary firmware.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of Phase II, the performer will support the Navy in transitioning the toolset for Navy use. The performer will develop a plan for integrating the toolset and related process into the Navy’s embedded control system security framework. Given the trend toward connecting existing industrial control systems (ICS) to the Internet for ease of management, many ICS that were never designed for outside exposure must now deal with external cyber threats. In such cases, the ICS components are extremely vulnerable. The solicited methodology and toolset can also be used for custom-hardening IoT devices beyond what security the original manufacturer cares to provide. For the above reasons, there exists a sizable market in both the private and public sectors for the solicited methodology and toolset.

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KEYWORDS: reverse engineering; binary modification; machine code; embedded security; firmware; function recognition

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

N161-071 TITLE: Additive Manufacturing Development of Naval Platform Heat Exchangers

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

ACQUISITION PROGRAM: FNC EPE FY17-03 Quality Metal Additive Manufacturing

OBJECTIVE: Develop methodology for metal additive manufacturing (AM) processing via ICME (integrated computational materials (science and) engineering) to minimize thickness/weight of heat exchangers and also allow for conformal designs that maximize thermal efficiencies and capacities for systems on Naval and Marine Corps platforms. The proposed effort should also explore the science base of AM process factors that will lead to development of the evaluation criteria and methodologies to qualify (AM) components across the Naval Enterprise.

DESCRIPTION: Requirements for increased heat rejection from system electronics are wide spread, existing across the board in naval ship, submarine, and aircraft/missile systems. As one example, submarines operating in warmer waters have difficulty handling heat dissipation from their electronic systems. The advent of innovative additive fabrication/manufacturing methods allows the reduction of weight and fin or wall thicknesses which enables HeX conformal designs that improve thermal cooling efficiencies and heat removal capacities.

Before heat exchangers produced using additive manufacturing processes can be introduced into Navy systems, there are a number of factors that must be addressed surrounding the reliability of the manufactured components. Through the use of ICME, AM processes can be evaluated and modified to minimize/eliminate defects control of process variability must be established. Process control will also help to determine the window in which acceptable components can be produced by the AM process that have similar or improved metallurgical microstructures, physical and mechanical properties when compared to the traditionally fabricated heat exchangers. The integrity and performance of the AM-fabricated heat exchanger compared to the traditionally fabricated heat exchanger (HeX) will be validated by (a) ICME methodologies, (b) destructive examination, (c) non-destructive examination of the HeX, and (e) testing of the heat transfer characteristics.

Initially, the effort should focus on the AM processing to deliver consistent wall thicknesses without defects that would compromise the expected life of HEs. Additionally, if funding and time are available, the development work should include integrated models considering fluid flow (pressure drop, effects of turbulence, viscosity, etc.), heat transfer, mechanical and materials properties, as well as innovative additive manufacturing methodology for the fabrication of efficient, thin-walled/low weight, low cost cellular ceramic electronics substrate, with highly enhanced (significantly improved) heat removal capability.

PHASE I: Design, employ and prove feasibility of an approach for a metal AM method to replicate a three-tubular design (triangular cross-section). Demonstrate desired properties such as consistent weight and wall thickness, i.e., devoid of defects, leaks or blockages while maintaining component thermal efficiency, with acceptable cost of manufacturing and realistic reliability factors (i.e. cost to performance benefits ratio are at least as good as the current HeX). Laboratory scale specimens should be fabricated and characterized by mechanical testing, and destructive and non-destructive evaluations. ICME should link metal thickness and associated properties with the AM process

PHASE II: Based upon Phase I effort, apply ICME tools to metal AM processing, to predict design limits (for minimizing wall thickness and HeX weight) needed to produce a more complex HeX product with significant changes in properties such as improved heat transfer capacity, reduced number of parts and joints, and that meets the baseline HeX criteria that would lead to Navy qualification. Validation of ICME tools and predictive analysis capabilities will be analyzed by comparing the physical, metallurgical and mechanical properties of an AM heat exchanger with a heat exchanger currently fabricated by traditional means to validate the production of a heat exchanger by one additive manufacturing process. The non-destructive methods will be correlated with destructive examinations. The involvement of a HeX OEM will be strongly encouraged to participate in developing the pathway for qualifying HeXs and components for Naval use.

PHASE III DUAL USE APPLICATIONS: Additive Manufactured electronic substrates will be transitioned into its intended system on a Navy platform. The OEM involved during Phase II will be part of the transition team. Phase III will include defining the additive manufacturing parameters for qualified full scale system production and establishing facilities capable of achieving full scale production capability of Navy-qualified HeXs. Heat Exchangers are universal and employed in numerous commercial systems that reject heat for engines, electronics, and other heat producing devices. The use of AM could lead to more innovative HeX designs capable of more efficiently removing heat because such designs could eliminate or severely reduce joints. AM processing of components that are qualified for Navy use could also be applied to commercial use.Heat Exchangers are universal and employed in numerous commercial systems that reject heat for engines, electronics, and other heat producing devices. The use of AM could lead to more innovative HeX designs capable of more efficiently removing heat because such designs could eliminate or severely reduce joints. AM processing of components that are qualified for Navy use could also be applied to commercial use.

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KEYWORDS: additive manufacturing; heat exchangers; qualification; reliability; wall thickness; weight; non-destructive evaluation

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

N161-072 TITLE: Expeditionary Solid Oxide Fuel Cell

TECHNOLOGY AREA(S): Battlespace

ACQUISITION PROGRAM: Deployed Joint Command and Control (DJC2) 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 5.4.c.(8) of the solicitation. 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 power and energy technologies to replace current combustion engine generators with efficient solid oxide fuel cell technologies for tactical systems.

DESCRIPTION: The current state of the art energy technologies deployed with tactical systems (e.g., Deployed Joint Command and Control (DJC2)) is combustion engine generators. Specifically, DJC2 uses four MEP-1070 60kW 60Hz generators (three live, one hot spare) in conjunction with several power distribution units (PDUs): two UEC 614-5010-0162 300kW PDUs, two HDT 2001592 400A PDUs, one HDT 2000579 200A PDU, and thirteen HDT 2002387 20A utility distribution boxes.

The current tactical power generation systems present operational commanders with many issues including:
• logistics burden too high for rapid relocation
• no capability to dynamically increase or decrease power generated to the time-varying load demanded
• lack of common and/or renewable power source
• no scalable expeditionary energy storage capability
• service life, mean time between failure, and mean time to repair increase maintenance demands at the tactical edge, and
• inefficiencies require large fuel demand for remote forward operational bases.

The current tactical power generation systems issues may be resolved through the incorporation of alternative energy technologies while also providing improved system capabilities and enhancements to system features such as:
• reduction in size and weight to improve relocate-ability and mobility,
• broader operational envelope (elevation, temp, humidity,…),
• quieter operation,
• more rugged (able to withstand G-loading, sea salt, rain, hail, snow,..),
• more efficient (kW/unit-of-fuel),
• easier to transport,
• longer service life,
• easier to maintain,
• longer mean-time-between-failure, and
• shorter mean-time-to-repair
• ability to match power generation to a changing power demand
• use of readily available renewable energy sources, and
• intelligent fault tolerance and graceful degradation.

The current capabilities use three MEP-1070 60 kW combustion generators for power generation and one as a hot spare. Each MEP-1070 generates 60 kW, weighs 3250 lbs, uses 3.5 gallons per hour (GPH) of fuel and produces harmful emissions, carbon monoxide (CO). The MEP-1070 require bulk cargo transport and needs a forklift for installation.l

In comparison to the current approach, a solid oxide fuel cell technology could be scalable (50 scalable units at 1.2 kW each would generate 60kW), weight less (50 units at 25lbs each would weigh 1250 lbs.), more fuel efficient (1/10 or 0.35 GPH), and produce non-harmful emissions (exhausts H2O (water) and carbon dioxide (CO2). The solid oxide fuel cells can be personnel and commercial airline transported and installed without need for heavy equipment.

The following are 'Build-to' parameters, including space, weight and power (SWaP) for the proposed system solution.

- Use common tactical fuels (JP5, JP8, DF2)
- Comply with Military-Standard (MIL-STD)-1275 1200 watts power output
- Use less than 1/10 gallon fuel per hour
- Operate at less than 45dB at 1 meter, sound generation
- Comply with Military Standards: MIL-STD-461F EMC, MIL-STD-810G Environmental
- Provide redundant and scalable operations
- 3000 hours maintenance interval
- Load demand following
- Under 25 pounds (man-portable)
- Produce zero harmful emissions, e.g., H2O and CO2 exhaust
- Transportable via commercial air

The new technology will be used to replace existing combustion engine generators used with deployed tactical C2 systems today in environments spanning Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) desert, mountain, and rugged terrain; jungle; natural disaster areas (flood, hurricane, cyclone), and medical relief efforts.

PHASE I: Determine feasibility for the development of a man portable 1.2KW fuel cell with the ability to use common tactical fuel, built to MIL-STD 810G environmental specifications and scalable to increase kWs. This would be used to demonstrate the ability to a) power the smaller DJC2 configuration which currently uses two 60kW generators (one live, one hot spare), and b) and the ability to switch from live to hot spare at least as efficiently as today (10 min switch time or less with no power drop).

PHASE II: Develop, demonstrate and validate higher power density fuel cell based upon the Phase I design to power the full DJC2 configuration which currently uses four 60kW generators (3 live, 1 hot spare) with the ability to switch from live to host spare at least as efficiently as today (10 min switch time or less with no power drop). Develop intelligent micro grid that would allow intelligent power management between power sources such as auxiliary power units, solar, or battery sources.

PHASE III DUAL USE APPLICATIONS: Integrate the prototype article into the DJC2 Systems and evaluate the performance in an operational demonstration (e.g., Bold Alligator) against current capabilities, using "build-to" parameters threshold/objective items and listed areas of enhancement. Evaluate prototype with the small and large system configurations; assess easy of scalability. Technology could be transferred to commercial sector for use in austere environments such as power stations to provide backup power, also as backup for commercial data centers.

REFERENCES:
1. http://dtic.mil/ndia/2012expwar/Backus.pdf

2. http://en.wikipedia.org/wiki/Deployable_Joint_Command_and_Control

3. http://www.public.navy.mil/necc/hq/Documents/NECC_FINAL.pdf

KEYWORDS: DJC2; SWAP; Expeditionary; Energy; Fuel Cell; Efficiency

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