DEPARTMENT OF THE NAVY (DON)
Small Business Innovation Research (SBIR)
DOW 2026 SBIR BAA Release 1
Phase I Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to topics:**
  - **DON26BZ01-NV001 through DON26BZ01-NV039**

- Submitting small business concerns (SBCs) are encouraged to thoroughly review the DOW SBIR/STTR Program Broad Agency Announcement (BAA) and register for the DSIP Listserv to remain apprised of important programmatic changes.
  - The DOW Program BAA is located at: https://www.dodsbirsttr.mil/submissions/login. Select the tab for the appropriate BAA cycle.
  - Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

- The information provided in the DON Proposal Submission Instructions takes precedence over the DOW Instructions posted for this BAA.

- **DON Phase I Technical Volume (Volume 2) page limit is not to exceed 10 pages.**

- Proposing SBCs that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF) or any combination of these are eligible to submit proposals in response to DON topics advertised in this BAA. Information on Majority Ownership in Part and certification requirements at time of submission for these proposing SBCs are detailed in the section titled ADDITIONAL SUBMISSION CONSIDERATIONS.

- Phase I Technical Volume (Volume 2) and Supporting Documents (Volume 5) templates, specific to DON topics, are available at https://www.navysbir.com/links_forms.htm.

- The DON may consider the following FAR and Non-FAR contract strategies when issuing Phase I awards: Firm Fixed Price (FFP), Basic Ordering Agreement (BOA), or Prototype Other Transaction (OT). The DON may consider the following FAR and Non-FAR contracting strategies when issuing Phase II awards: Cost Plus Fixed Fee (CPFF), FFP, BOA, or Prototype OT.

- This BAA is issued under regulations set forth in Federal Acquisition Regulation (FAR) 35.016 and awards will be made under "other competitive procedures". The policies and procedures of FAR Subpart 15.3 shall not apply to this BAA, except as specifically referenced in it. All procedures are at the sole discretion of the Government as set forth in this BAA. Submission of a proposal in response to this BAA constitutes the express acknowledgement to that effect by the proposing SBC.

INTRODUCTION

The DON SBIR/STTR Programs are mission-oriented programs that integrate the needs and requirements of the DON's Fleet through research and development (R&D) topics that have dual-use potential, but primarily address the needs of the DON. More information on the programs can be found on the DON SBIR/STTR website at www.navysbir.com. Additional information on DON's mission can be found on the DON website at www.navy.mil.

For questions regarding this BAA, use the information in Table 1 to determine who to contact for what types of questions.

TABLE 1: POINTS OF CONTACT FOR QUESTIONS REGARDING THIS BAA

Type of Question	When	Contact Information
Program and administrative	Always	Navy SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil or appropriate Program Manager listed in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic on the DOW SBIR/STTR Innovation Portal (DSIP). Refer to the Proposal Submission section of the DOW SBIR/STTR Program BAA for details.
	BAA Open	DOW SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions) Refer to the Proposal Submission section of the DOW SBIR/STTR Program BAA for details.
Electronic submission to the DOW SBIR/STTR Innovation Portal (DSIP)	Always	DSIP Support via email at dodsbirsupport@reisystems.com
Navy-specific BAA instructions and forms	Always	DON SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil

TABLE 2: DON SYSTEMS COMMANDS (SYSCOM) SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	SYSCOM	Email
DON26BZ01-NV001	Ms. Tatiana Sears	Marine Corps Systems Command (MCSC)	smb_mcsc_sbir_admins@usmc.mil
DON26BZ01-NV002 to DON26BZ01-NV014	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil
DON26BZ01-NV015 to DON26BZ01-NV021	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil

Topic Numbers	Point of Contact	SYSCOM	Email
DON26BZ01-NV022 to DON26BZ01-NV036	Ms. Lore-Anne Ponirakis	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil
DON26BZ01-NV037 to DON26BZ01-NV039	Mr. Scott Steward	Strategic Systems Programs (SSP)	ssp.sbir@ssp.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

The following section details requirements for submitting a compliant Phase I proposal to the DOW SBIR/STTR Programs.

(NOTE: Proposing SBCs are advised that support contract personnel will be used to carry out administrative functions and may have access to proposals, contract award documents, contract deliverables, and reports. All support contract personnel are bound by appropriate non-disclosure agreements.)

DOW SBIR/STTR Innovation Portal (DSIP). Proposing SBCs are required to submit proposals via the DOW SBIR/STTR Innovation Portal (DSIP); and follow proposal submission instructions in the DOW SBIR/STTR Program BAA on the DSIP at https://www.dodsbirsttr.mil/submissions. Proposals submitted by any other means will be disregarded. Proposing SBCs submitting through DSIP for the first time will be asked to register. It is recommended that SBCs register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Proposals that are not successfully certified electronically in DSIP by the Corporate Official prior to BAA Close will NOT be considered submitted and will not be evaluated by DON. Proposals that are encrypted, password protected, or otherwise locked in any portion of the submission will be REJECTED unless specifically directed within the text of the topic to which you are submitting. Please refer to the DOW SBIR/STTR Program BAA for further information.

Proposal Volumes. The following seven volumes are required.

- **Proposal Cover Sheet (Volume 1).** As specified in DOW SBIR/STTR Program BAA.

- **Technical Proposal (Volume 2)**
  - Technical Proposal (Volume 2) must meet the following requirements or the proposal will be REJECTED:
    - Not to exceed ten (10) pages, regardless of page content
    - Single column format, single-spaced typed lines
    - Standard 8 ½” x 11” paper
    - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
    - No font size smaller than 10-point
    - Include, within the ten-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified. Phase I Options are exercised upon selection for Phase II.
    - Work proposed for the Phase I Base must be exactly six (6) months.

— Work proposed for the Phase I Option must be exactly six (6) months.

- Additional information:
  - A Phase I proposal template specific to DON to meet Phase I requirements is available at https://navysbir.com/links_forms.htm
  - A font size smaller than 10-point is allowable for headers, footers, imbedded tables, figures, images, or graphics that include text. However, proposing SBCs are cautioned that if the text is too small to be legible it will not be evaluated.

- **Cost Volume (Volume 3).**
  - Cost Volume (Volume 3) must meet the following requirements or the proposal will be REJECTED:
    - The Phase I Base amount must not exceed $140,000.
    - Phase I Option amount must not exceed $100,000.
    - Costs for the Base and Option must be separated and clearly identified in Volume 3.
    - For Phase I, a minimum of two-thirds of the work is performed by the proposing SBC. The two-thirds percentage of work requirement must be met in the Base costs as well as in the Option costs. DON will not accept deviations from the minimum percentage of work requirements for Phase I. The percentage of work is measured by both direct and indirect costs. To calculate the minimum percentage of work for the proposing SBC the sum of all direct and indirect costs attributable to the proposing SBC represent the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) is the denominator. The subcontractor percentage is calculated by taking the sum of all costs attributable to the subcontractor (Total Subcontractor Costs (TSC)) as the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) as the denominator.
      - Proposing SBC Costs (included in numerator for calculation of the SBC):
        - Total Direct Labor (TDL)
        - Total Direct Material Costs (TDM)
        - Total Direct Supplies Costs (TDS)
        - Total Direct Equipment Costs (TDE)
        - Total Direct Travel Costs (TDT)
        - Total Other Direct Costs (TODC)
        - General & Administrative Cost (G&A)

        NOTE: G&A, if proposed, will only be attributed to the proposing SBC.
      - Subcontractor Costs (numerator for subcontractor calculation):
        - Total Subcontractor Costs (TSC)
      - Total Cost (i.e., Total Cost before Profit Rate is applied, denominator for either calculation)
    - **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. A value above or below $0.00 entered in the Cost Sharing field will not be considered in the Phase I contract award.**

  - Additional information:
    - Provide sufficient detail for subcontractor, material, and travel costs. Subcontractor costs must be detailed to the same level as the prime contractor. Material costs must include a listing of items and cost per item. Travel costs must include the purpose of the trip, number of trips, location, length of trip, and number of personnel.
    - Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

- — The “Additional Cost Information” of Supporting Documents (Volume 5) may be used to provide supporting cost details for Volume 3. When a proposal is selected for award, be prepared to submit further documentation to the SYSCOM Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

- **Company Commercialization Report (Volume 4)**. DOW collects and uses Volume 4 and DSIP requires Volume 4 for proposal submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DOW SBIR/STTR Program BAA for details to ensure compliance with DSIP Volume 4 requirements.

- **Supporting Documents (Volume 5).** Volume 5 is for the submission of administrative material that DON may or will require to process a proposal, if selected, for contract award.

  - Proposing SBCs must review and submit the following items, as applicable:
    - — **Majority Ownership in Part.** Proposing SBCs that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, are eligible to submit proposals in response to DON topics advertised within this BAA. Complete the certification as detailed under ADDITIONAL SUBMISSION CONSIDERATIONS.

  - Additional information:
    - — Proposing SBCs may include the following administrative materials in Supporting Documents (Volume 5); a template is available at https://navysbir.com/links_forms.htm to provide guidance on optional material the proposing SBC may want to include in Volume 5:
      - Additional Cost Information to support the Cost Volume (Volume 3)
      - SBIR/STTR Funding Agreement Certification
      - Data Rights Assertion
      - Disclosure of Information (DFARS 252.204-7000)
      - Prior, Current, or Pending Support of Similar Proposals or Awards
      - Foreign Citizens
    - — Details of Request for Discretionary Technical and Business Assistance (TABA), if proposed, is to be included under the Additional Cost Information section if using the DON Supporting Documents template.
    - — Do not include documents or information to substantiate the Technical Volume (Volume 2) in Volume 5 (e.g., resumes, test data, technical reports, or publications). Such documents or information will not be considered.
    - — A font size smaller than 10-point is allowable for documents in Volume 5; however, proposing SBCs are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DOW requires Volume 6 for submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DOW SBIR/STTR Program BAA for details.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)**. In accordance with Section 4 of the SBIR and STTR Extension Act of 2022 and the SBA SBIR/STTR Policy Directive, the DOW will review all proposals submitted in response to this BAA to assess security risks presented by SBCs seeking a Federally funded award. SBCs must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DOW SBIR/STTR Program BAA for details.

PHASE I EVALUATION AND SELECTION

The following section details how the DON SBIR/STTR Programs will evaluate Phase I proposals.

Proposals meeting DSIP submission requirements will be forwarded to the DON SBIR/STTR Programs. Prior to evaluation, all proposals will undergo a compliance review to verify compliance with DOW and DON SBIR/STTR proposal eligibility requirements. Proposals not meeting submission requirements will be REJECTED and not evaluated.

- **Proposal Cover Sheet (Volume 1).** The Proposal Cover Sheet (Volume 1) will undergo a compliance review to verify the proposing SBC has met eligibility requirements and followed the instructions for the Proposal Cover Sheet as specified in the DOW SBIR/STTR Program BAA.

- **Technical Volume (Volume 2).** The DON will evaluate and select Phase I proposals using the evaluation criteria specified in the Method of Selection and Evaluation Criteria section of the DOW SBIR/STTR Program BAA, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. The information considered for this decision will come from Volume 2. This is not a FAR Part 15 evaluation and proposals will not be compared to one another. Cost is not an evaluation criterion and will not be considered during the evaluation process; the DON will only do a compliance review of Volume 3. Due to limited funding, the DON reserves the right to limit the number of awards under any topic.

  The Technical Volume (Volume 2) will undergo a compliance review (prior to evaluation) to verify the proposing SBC has met the following requirements or the proposal will be REJECTED:
  - Not to exceed ten (10) pages, regardless of page content
  - Single column format, single-spaced typed lines
  - Standard 8 ½” x 11” paper
  - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
  - No font size smaller than 10-point, except as permitted in the instructions above.
  - Include, within the 10-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified.
  - Work proposed for the Phase I Base must be exactly six (6) months.
  - Work proposed for the Phase I Option must be exactly six (6) months.

- **Cost Volume (Volume 3).** The Cost Volume (Volume 3) will not be considered in the selection process and will only undergo a compliance review to verify the proposing SBC has met the following requirements or the proposal will be REJECTED:
  - Must not exceed values for the Base ($140,000) and Option ($100,000).
  - Must meet minimum percentage of work; a minimum of two-thirds of the work is performed by the proposing SBC. The two-thirds percentage of work requirement must be met in the Base costs as well as in the Option costs. DON will not accept deviations from the minimum percentage of work requirements for Phase I.
  - **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. A value above or below $0.00 entered in the Cost Sharing field will not be considered in the Phase I contract award.**

- **Company Commercialization Report (CCR) (Volume 4).** The CCR (Volume 4) will not be evaluated by the DON nor will it be considered in the award decision. However, all proposing SBCs must refer to the DOW SBIR/STTR Program BAA to ensure compliance with DSIP Volume 4 requirements.

- **Supporting Documents (Volume 5).** Supporting Documents (Volume 5) will not be considered in the selection process and will only undergo a compliance review to ensure the proposing SBC has included items in accordance with the PHASE I SUBMISSION INSTRUCTIONS section above.

- **Fraud, Waste, and Abuse Training Certificate (Volume 6).** Not evaluated.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)**. Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7) will be assessed as part of the Due Diligence Program to Assess Security Risks. Refer to the DOW SBIR/STTR Program BAA to ensure compliance with Volume 7 requirements.

ADDITIONAL SUBMISSION CONSIDERATIONS

This section details additional items for proposing SBCs to consider during proposal preparation and submission process.

Due Diligence Program to Assess Security Risks. The SBIR and STTR Extension Act of 2022 (Pub. L. 117-183) requires the Department of War, in coordination with the Small Business Administration, to establish and implement a due diligence program to assess security risks presented by SBCs seeking a Federally-funded award. Please review the Certifications and Registrations section of the DOW SBIR/STTR Program BAA for details on how DOW will assess security risks presented by SBCs. The Due Diligence Program to Assess Security Risks will be implemented for all Phases.

Discretionary Technical and Business Assistance (TABA). The SBIR and STTR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Proposing SBCs may request, in their Phase I Cost Volume (Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award, is to be included as part of the award amount, and is limited by the established award values for Phase II by the SYSCOM (i.e., within the $2,000,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee by the proposing SBC and must be inclusive of all applicable indirect costs. TABA cannot be used in the calculation of general and administrative expenses (G&A) for the SBIR proposing SBC. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project. An SBC receiving TABA will be required to submit a report detailing the results and benefits of the service received. This TABA report will be due at the time of submission of the final report.

Request for TABA funding will be reviewed by the DON SBIR/STTR Program Management Office.

If the TABA request does not include the following items the TABA request will be denied.

- TABA provider(s) (firm name)
- TABA provider(s) point of contact, email address, and phone number
- An explanation of why the TABA provider(s) is uniquely qualified to provide the service
- Tasks the TABA provider(s) will perform (to include the purpose and objective of the assistance)
- Total TABA provider(s) cost, number of hours, and labor rates (average/blended rate is acceptable)

TABA must NOT:
- be subject to any indirect costs, profit, or fee by the SBIR proposing SBC
- propose a TABA provider that is the SBIR proposing SBC
- propose a TABA provider that is an affiliate of the SBIR proposing SBC
- propose a TABA provider that is an investor of the SBIR proposing SBC
- propose a TABA provider that is a subcontractor or consultant of the requesting SBC otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider)

TABA requests must be included in the proposal as follows:
- Phase I:
    - Online DOW Cost Volume (Volume 3) – the value of the TABA request.
    - Supporting Documents (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "TABA" in the section titled Additional Cost Information when using the DON Supporting Documents template.
- Phase II:
    - DON Phase II Cost Volume (provided by the DON SYSCOM) - the value of the TABA request.
    - Supporting Documents (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "TABA" in the section titled Additional Cost Information when using the DON Supporting Documents template.

Proposed values for TABA must NOT exceed:
- Phase I: A total of $6,500
- Phase II: A total of $25,000 per award, not to exceed $50,000 per Phase II project

If a proposing SBC requests and is awarded TABA in a Phase II contract, the proposing SBC will be eliminated from participating in the Navy SBIR Transition Program (STP) and any other Phase II assistance the DON provides directly to awardees.

All Phase II awardees not receiving funds for TABA in their awards must participate in the virtual Navy STP Kickoff during the first or second year of the Phase II contract. While there are no travel costs associated with this virtual event, Phase II awardees should budget time of up to a full day to participate. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program.

Disclosure of Information (DFARS 252.204-7000). In order to eliminate the requirements for prior approval of public disclosure of information (in accordance with DFARS 252.204-7000) under this award, the proposing SBC shall identify and describe all fundamental research to be performed under its proposal, including subcontracted work, with sufficient specificity to demonstrate that the work qualifies as fundamental research. Fundamental research means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons (defined by National Security Decision Directive 189). An SBC whose proposed work will include fundamental research and requests to eliminate the requirement for prior approval of public disclosure of information must complete the DON Fundamental Research Disclosure and upload as a separate PDF file to the Supporting Documents (Volume 5) in DSIP as part of their proposal submission. The DON Fundamental Research Disclosure is available on https://navysbir.com/links_forms.htm and includes instructions on how to complete and upload the completed Disclosure. Simply identifying fundamental research in the Disclosure does **NOT** constitute acceptance of the exclusion. All exclusions will be reviewed and, if approved by the Government Contracting Officer, noted in the contract.

Majority Ownership in Part. Proposing SBCs that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, **are eligible** to submit proposals in response to DON topics advertised within this BAA.

For proposing SBCs that are a member of this ownership class the following must be satisfied for proposals to be accepted and evaluated:

a. Prior to submitting a proposal, SBCs must register with the SBA Company Registry Database.
b. The proposing SBC within its submission must submit the Majority-Owned VCOC, HF, and PEF Certification. A copy of the SBIR VC Certification can be found on https://navysbir.com/links_forms.htm. Include the SBIR VC Certification in the Supporting Documents (Volume 5).
c. Should a proposing SBC become a member of this ownership class after submitting its proposal and prior to any receipt of a funding agreement, the proposing SBC must immediately notify the Contracting Officer, register in the appropriate SBA database, and submit the required certification, which can be found on https://navysbir.com/links_forms.htm.

System for Award Management (SAM). It is strongly encouraged that proposing SBCs register in SAM, https://sam.gov, by the Close date of this BAA, or verify their registrations are still active and will not expire within 60 days of BAA Close. Additionally, proposing SBCs should confirm that they are registered to receive contracts (not just grants) and the address in SAM matches the address on the proposal. An SBC selected for an award MUST have an active SAM registration at the time of award or they will be considered ineligible.

Cybersecurity Maturity Model Certification (CMMC) Program. DOW has established the CMMC Program to verify that awardees have implemented required security measures necessary to safeguard Federal Contract Information (FCI) and Controlled Unclassified Information (CUI). CMMC Level requirements are identified within each topic. Proposing SBCs should anticipate that a Projected CMMC Level for Phase II award may be higher than the Projected CMMC Level advertised in the Phase I topic. Proposing SBCs should carefully review and consider the CMMC requirements as compliance may impact proposed costs and technical approach. Please review the DOW SBIR/STTR Program BAA for additional information on the CMMC Program.

Notice of NIST SP 800-171 Assessment Database Requirement. The purpose of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 is to protect Controlled Unclassified Information (CUI) in Nonfederal Systems and Organizations. As prescribed by DFARS 252.240-7997, in order to be considered for award, an SBC is required to implement NIST SP 800-171 and shall have a current assessment uploaded to the Supplier Performance Risk System (SPRS) which provides storage and retrieval capabilities for this assessment. The platform Procurement Integrated Enterprise Environment (PIEE) will be used for secure login and verification to access SPRS. For brief instructions on NIST SP 800-171 assessment, SPRS, and PIEE, please visit https://www.sprs.csd.disa.mil/nistsp.htm. For in-depth tutorials on these items, please visit https://www.sprs.csd.disa.mil/webtrain.htm.

Human Subjects, Animal Testing, and Recombinant DNA. Due to the short timeframe associated with Phase I of the SBIR/STTR 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 proposing SBC 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 is included under a Phase I or Phase II proposal, please carefully review the requirements at: https://www.nre.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

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

International Traffic in Arms Regulation (ITAR). For topics indicating ITAR restrictions or the potential for classified work, limitations are generally 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).

SELECTION, AWARD, AND POST-AWARD INFORMATION

Notifications. Email notifications for proposal receipt (approximately one week after the Phase I BAA Close) and selection are sent based on the information received on the proposal Cover Sheet (Volume 1). Consequently, the e-mail address on the proposal Cover Sheet must be correct.

Debriefs. Requests for a debrief must be made within 15 calendar days of select/non-select notification via email as specified in the select/non-select notification. Please note debriefs are typically provided in writing via email to the Corporate Official identified in the proposal of the proposing SBC within 60 days of receipt of the request. Requests for oral debriefs may not be accommodated. If contact information for the Corporate Official has changed since proposal submission, a notice of the change on company letterhead signed by the Corporate Official must accompany the debrief request.

Protests. Interested parties have the right to protest in accordance with the procedures in FAR Subpart 33.1.

Pre-award agency protests related to the terms of the BAA must be served to: osd.ncr.ousd-r-e.mbx.SBIR-STTR-Protest@mail.mil. A copy of a pre-award Government Accountability Office (GAO) protest must also be filed with the aforementioned email address within one day of filing with the GAO.

Protests related to a selection or award decision should be filed with the appropriate Contracting Officer for an Agency Level Protest or with the GAO. Contracting Officer contact information for specific DON Topics may be obtained from the DON SYSCOM Program Managers listed in Table 2 above. For protests filed with the GAO, a copy of the protest must be submitted to the appropriate DON SYSCOM Program Manager and the appropriate Contracting Officer within one day of filing with the GAO.

Awards. Due to limited funding, the DON reserves the right to limit the number of awards under any topic. Any notification received from the DON that indicates the proposal has been selected does not ultimately guarantee an award will be made. This notification indicates that the proposal has been selected in accordance with the evaluation criteria and has been sent to the Contracting Officer to conduct compliance review of Volume 3 to confirm eligibility of the proposing SBC, and to take other relevant steps necessary prior to making an award.

Contract Types. A Firm Fixed Price (FFP), Basic Ordering Agreement (BOA), or Prototype Other Transaction (OT) may be used for Phase I awards.

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per SBC per topic. The maximum Phase I proposal/award amount including all options is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $2,000,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $2,000,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

Contract Deliverables. Contract deliverables for Phase I are typically a kick-off brief, progress reports, and a final report. Required contract deliverables (as stated in the contract) must be uploaded to https://www.navysbirprogram.com/navydeliverables/.

Payments. The DON makes three payments from the start of the Phase I Base period, and from the start of the Phase I Option period, if exercised. Payment amounts represent a set percentage of the Base or Option value as follows:

Days from Start of Base Award or Option	Payment Amount
15 Days	50% of Total Base or Option
90 Days	35% of Total Base or Option
180 Days	15% of Total Base or Option

Transfer Between SBIR and STTR Programs. Section 4(b)(1)(i) of the SBIR and STTR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a BAA for SBIR may transition in Phase II to STTR and vice versa.

PHASE II GUIDELINES

Evaluation and Selection. All Phase I awardees may submit an **Initial** Phase II proposal for evaluation and selection. The evaluation criteria for Phase II is the same as Phase I (as stated in this BAA). The Phase I Final Report and Initial Phase II Proposal will be used to evaluate the SBC's potential to progress to a workable prototype in Phase II and transition the technology to 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 contract or by subsequent notification.

Awards. The DON will consider the following for Phase II award: Cost Plus Fixed Fee (CPFF), Firm Fixed Price (FFP), Basic Ordering Agreement (BOA), or Prototype Other Transaction (OT). Phase II awards 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/STTR-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 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the SBCs (e.g., the Navy STP).

PHASE III GUIDELINES

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

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DON26BZ01-NV001 TITLE: Amphibious Combat Vehicle (ACV) Maneuver Improvements

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Human-Machine Interfaces

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Improve the Human-Machine Interface for operator control in the transition from water to land and improve water mobility in the surf zone for Amphibious Combat Vehicles (ACVs).

DESCRIPTION: The ACV is an adaptation of an Italian Combat Vehicle with enough changes to weight and buoyancy that water mobility has been negatively impacted. Improvements are needed to the operator’s controls and water propulsion hardware to reduce operator workload and improve maneuverability in the water and surf zone.

The new design shall make the transition between land and water operations easier for the operator by simplifying the human-machine interface (i.e., having to monitor and actuate fewer controls). The focus should be on determining innovative functional capability and controls which will reduce cognitive load on the operator when entering and exiting the surf zone and traversing through water. The new design should also make the vehicle more responsive to the operator’s input. The new design needs to consider maintenance and corrosion control. The design needs to maintain or, if possible, improve water speed, bollard pull, and water operation fuel economy. The new design shall not result in degraded performance as baselined by the current propulsion system.

The ACV powerpack currently provides a maximum of 690hp at 1,800rpm (490kW) with maximum torque of 2,036 ft-lb (2,761 N-m) at 1,500rpm. The size of the area that an improved water propulsion device MUST FIT is 28 inches by 26 inches by 26 inches not including potential bracketry. The propulsion device must operate in shallow water where it will be exposed to sand, mud and small rocks in the water flow.

PHASE I: Design a new control system and concepts to improve steering in both the water and transition modes (land and fording). Modeling and simulation will be used to document the new design, and a control system model will be developed to simulate system operation with operator inputs, corresponding water propulsion system outputs, and system feedback to the operator. A bench top system may be built to show how the concept would work and allow users to comment on the design. The design will be documented in a performance specification and an architecture diagram to be used in Phase II to build a prototype for testing.

PHASE II: Develop the design concept from Phase I into a fully functional prototype. The prototype system will be lab tested once the design is mature. The test plan for the prototype will be prepared by the awardee, and reviewed by the government, to test the performance against the specification developed in Phase I. Lessons learned from the prototype system will be used to update the performance specification developed in Phase I.

Phase II Option (if exercised): Upon successful lab performance of the prototype system, the government will make an ACV available, and a refined design will be generated and integrated into the ACV. An updated computer model of the refined system will be generated to simulate operation of the refined design for the government prior to vehicle integration. The ACV with the refined design will be tested at a commercial or government facility to validate performance. The government will provide test support to include operators. The test plan for the refined design will be prepared by the awardee, and reviewed by the government, to test the performance against the updated Phase II performance specification. The refined design and test results will be documented in the final report.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of testing, the final design shall be provisioned and catalogued with the necessary logistical documents to enable ACV modification and employment of the system based on battalion desire to implement on their vehicles.
The main transition path will be to the ACV. Other military vehicles that require a fording or swim mode may also be interested, to include the Stryker and the Advanced Reconnaissance Vehicle (ARV). Commercial applications include amphibious vehicles used to deliver cargo to remote locations where ports are not available.

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2. ACV Entering Water: https://www.youtube.com/shorts/g37R9OcQ1nE
3. ACV Propellers: https://www.youtube.com/shorts/UWBseEba99M
4. ACV Launch from Beach with Camera at Propeller: https://www.youtube.com/shorts/KVLL_keP_d4

KEYWORDS: Amphibious; Maneuver; Controls; Water Propulsion; Water Mobility; Propulsor; Steering; Amphibious Combat Vehicle; ACV

DON26BZ01-NV002 TITLE: Integrated Metal Ceramic Matrix for High Strength Steels

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop an integrated metal matrix for high strength steels.

DESCRIPTION: Landing gear components are limited to the use of high strength steels due to their harsh loading applications and various environmental conditions. Typically, high strength steels are used to survive the load requirements. The two technologies currently applied to most landing gear components are Hard Chrome and high velocity oxygen fuel (HVOF). Each has their disadvantages that affects landing gear components. A replacement for Hard Chrome and HVOF is required to improve the readiness and safety of landing gear components.

Hard Chrome’s main disadvantage is that it hides corrosion underneath the chrome plating which can lead to stress corrosion cracking in high strength steels. This failure mode would cause the complete loss of a landing gear system as the landing gear essentially snaps into pieces due to high stresses of landing. If corrosion is found before stress corrosion cracking occurs it still leads to the complete scrapping of landing gear components. This is due to Hard Chrome having no repair method. The only option for Hard Chrome is to replace, remove, and then reapply which takes days of machining and post machining. In addition to the machining, the application requires hazardous chemicals and produces waste that creates a health and safety risk to the fleet and its manufacturing personnel. Lastly, another risk with Hard Chrome is the dimensional limitations it provides. If too little or too much Hard Chrome is applied, the coating will immediately delaminate and damage landing gear and hydraulic components due to the foreign object debris (FOD) inside the system.

HVOF comes with its disadvantages as well. HVOF requires extremely low surface roughness on the pistons which have poor tribology. The poor tribology causes the hydraulics seals to perform dry and wear the seals away extremely quickly. Hydraulic fluid cannot stick to the walls of the piston due to the low surface roughness.

On top of the hydraulic disadvantages, the surface roughness requires precision post machining for long durations to survive the landing gear environments. In the fleet, the main issue seen with HVOF is spalling when the landing gear experiences high strains. When this occurs, the landing gear components must be removed and replaced.

This topic seeks an innovative solution that provides an integrated metal matrix for high strength steels that boosts the performance of and extends a component's survivability and improves a system's operational readiness and lifecycle costs. Current technology for titanium uses waveform energy. The process generates a targeted physical reaction within a substrate, activating the substrate at an atomic level for precise placement and gradient depth control of an integrated infusion. This infusion results in a matrix composite material that leverages the strengths of both components. The chemical bonding between a ceramic and the titanium alloy involves a combination of covalent and ionic characteristics — sharing and exchanging of electrons. This combination enhances the mechanical properties of the composite material, such as properties and porosity mitigation for corrosion protection, hardness for wear resistance, thermal stability, and overall durability, resulting in a metal-matrix suitable for various high-performance applications. Current technology can tailor characteristics such as hardness, electrical conductivity, thermal and oxidation, and mechanical strength. These meticulous adjustments enable the creation of the matrix with specific, desired functionalities, enhancing their performance in various applications to defeat corrosion, wear, erosion, thermal, and other challenges. For instance, a metal matrix composite gradient depth infusions of titanium nitride (TiN) achieved hardness ratings of 2800-3100HV (micro-Vickers). Currently, the process is limited to transition metals; however, there is a need to adapt and develop it for application to high strength steels. This innovative solution will provide the benefits of both Hard Chrome and HVOF while eliminating the current limitations of the respective coatings.

PHASE I: The Phase I Option focuses on identifying a potential coating by evaluating the compatibility of metal integration properties with the proposed high- strength steel. This includes determining whether a metal matrix can be successfully formed and sustained on the high strength steel surface. Attention will be given to identifying optimal surface characteristics—such as roughness, texture, patterning, and placement adjustments—to enhance oil retention and lubricity within landing gear components. Desired material properties and suitable tooling methods will be established to achieve the required metal integration. Sample coupons will be created as feasibility evidence for developing the coating process. This will be followed by analysis and characterization of the metal integration within high-strength steel substrates. Finally prototype plans will be developed to realize initial geometric characteristics for a titanium alloy component tailored to the project's specifications.

PHASE II: Develop prototyped landing gear components with internal components using the developed integrated metal matrix. Perform landing gear qualification testing to ensure prototyped integrated metal matrix components can withstand landing gear environments.
Establish wear patterns, production process, and related properties.

PHASE III DUAL USE APPLICATIONS: Integrate the landing gear components into fleet aircraft.
Metal matrix composites are employed in advanced industries due to their high modulus and strength, favorable wear and corrosion resistance, and other good properties at elevated temperatures.
Aerospace: High-temperature components like exhaust nozzles, heat shields, and other components.
Engine components: Turbine disks, impellers, and other engine parts requiring high strength-to-weight ratios.

Structural components: Structures where lightweight and high strength are crucial.
Automotive: Engine parts like Piston rings, brake discs, and rotors benefit due to their high strength, wear resistance, and thermal conductivity.
Lightweight construction components to reduce vehicle weight, improving fuel efficiency.
Electronics: Thermal management heat sinks and electronic packaging to dissipate heat and improve device performance.
Industrial: Cutting tools due to their high strength and wear resistance. Wear-resistant parts in industrial machinery and tools where high wear resistance is needed.

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KEYWORDS: Landing Gear; Coatings; Metal-matrix; Ceramics; High-Strength Steels; Hard Chrome

DON26BZ01-NV003 TITLE: High Clutter Virtual Objects for Modeling and Simulation

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a modeling and simulation (M&S) application for generating high-fidelity, thermally-attributed virtual electro-optic and infrared (EO/IR) object models—specifically weather-explicit 3D clouds and/or debris fields—for integration into real-time scene generation systems.

DESCRIPTION: Developmental and Operational Testing (DT/OT) of Missile Warning Systems (MWS), Infrared Countermeasures (IRCM), and Intelligence, Surveillance, and Reconnaissance (ISR) systems are currently limited to in-flight tests or the use of recorded flight video in digital system models (DSM). These methods do not adequately replicate the complexity of battlefield, industrial, and urban environments, especially under high-clutter, thermally dynamic conditions.
To enhance system survivability and test realism, validated synthetic 3D scene models are required to represent high-fidelity thermal environments unachievable through traditional Test & Evaluation (T&E) methods. These models enable more effective assessment of performance and operational effectiveness across a range of mission scenarios.

The Navy's EO/IR Direct Inject (EOIRDI) initiative employs the Synchronized Kilohertz Injection Projection (SKIP) scene generation system to support hardware-in-the-loop engagements.
SKIP is capable of operating across multiple formats:

- 2k x 2k at 60 Hz
- 512 x 512 at 500 Hz
- 320 x 320 at 1kHz

To fully utilize SKIP's capabilities, synthetic test engagements must be developed to match specific system-under-test (SUT) frame rates and resolution formats, incorporating unique geographic locations and weather conditions.

This topic seeks a M&S application for generating high-fidelity, thermally-attributed virtual EO/IR object models—specifically weather-explicit 3D clouds and/or debris fields—for integration into real-time scene generation systems.

The tool must enable validated six degrees of freedom (6-DOF) physics-based simulations to support live, virtual, and constructive (LVC)-based survivability assessments of modern threat engagement systems in cluttered battlefield environments involving air-to-air missiles (AAM) and surface-to-air (SAM) threats. The solution must support scene generation at real-time frame rates (60 Hz, 500 Hz, 1 kHz) using the EO/IR rendering framework built on OpenSceneGraph (OSG) and Virtual Planet Builder (VPB). Models must include optical, thermal, and physical attributes—such as spectral absorption, emissivity, and reflectivity—across the MWIR band (3.0–5.0 microns), with scalability to 0.2–20.0 microns. The system will enable creation, rendering, and validation of thermally accurate clutter (clouds/debris) varying by temperature, atmospheric composition, and precipitation to support enhanced DT/OT of threat detection and survivability systems.

PHASE I: Perform an analysis to design a comprehensive 3D cloud and/or debris field model demonstrating the development strategy and defining the M&S requirements for software plugins using the OSG 3D virtual framework environment for integration into DoW scene generation systems. Explore the technical method for model engineering, system integration, verification and validation testing. Write a final report for prototype plans in phase II.

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

PHASE II: Development of 3D Cloud and/or debris field models for integration into DoW scene generation using the OSG framework. The radiometrically accurate 3D models are initially for use with a Navy Scene Generator system. Each model will be delivered with metadata from its generation that is needed to be fully incorporated into the Scene Generator both geometrically and radiometrically.

PHASE III DUAL USE APPLICATIONS: Continue 3D Cloud model development with the addition of new cloud, debris field, and other hot entity model types for addition of high clutter objects to threat engagement scenarios for high fidelity T&E of aircraft installed MWS and FLIR systems. All new 3D model types of data need include calibration meta data.
High clutter 3D cloud and debris field models have the potential for fire fighters and pilot training for building virtual training environments.

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KEYWORDS: Development Testing (DT); Digital System Model (DSM); Electro-Optical (EO); Infrared (IR); Intelligence, Surveillance, and Reconnaissance (ISR); IR Countermeasures (IRCM); Infrared (IR); Midwave IR (MWIR); Missile Warning Systems (MWS); OpenSceneGraph (OSG); Operational Testing (OT); Virtual Planet Builder (VPB)

DON26BZ01-NV004 TITLE: Aircraft Formation Flight Control Technology for Heterogeneous Formation Flight

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an advanced flight control architecture to enable greater range and endurance through precise automatic station keeping while flying in formation and exploiting vortex-generated upwash from upstream aircraft.

DESCRIPTION: Wake surfing (i.e., flying trail in close formation within the upwash of one or several lead aircraft) has demonstrated significant fuel savings on the order of 10-20%. Researchers have conducted multiple studies and executed flight demonstrations in the past that validated performance gains. However, the adoption of an operational capability still faces challenges.

One key challenge is the technical approach for trailing aircraft to maintain precise relative position behind upstream aircraft in the optimal location to maximize efficiency. While this task can be performed through manual pilot station keeping, the task is workload intensive and is not practical for long missions. There is a need for an autopilot flight control capability to maintain the position for optimum fuel savings (i.e., the “sweet spot”), realizing this significant range/endurance benefit opportunity with minimal or zero pilot workload. Flight control architectures must be capable of precise station keeping in aircraft formations of similar/dissimilar and manned/unmanned fixed wing aircraft. Flight control architectures may include techniques to sense the location of the vortex/upwash effects both with and without explicit knowledge of aircraft relative positions.

The objective is to create robust flight control laws for trailing aircraft in similar or dissimilar formations to exploit the benefits of wake surfing. Unique aircraft hardware and modifications should be minimized to the greatest extent possible to achieve this objective. To achieve robust control law development for precision formation flight, the problem can be broken into coarse and precision tracking problems, with some interdependencies between the two. It is strongly desired that both problems be solved without additional hardware integration for participating vehicles and zero data-link demands.

For coarse acquisition and tracking, it is expected that the relative position between participating aircraft needs to be established and maintained in the general vicinity of the lead’s wing-tip vortex. Relative position must be maintained while sequencing waypoints or tracking a heading or ground track to accomplish ingress/egress mission segments. Consideration in the development of coarse acquisition and tracking capability should be given to Global Positioning System unavailability.

For precision position tracking and control, it is expected that aircraft sensors (e.g. air data, inertial, flight controls) affected by the influences of the wing tip vortex on the trail aircraft can be identified and exploited to locate optimal position. Control architecture gains and surface mixing influences necessary for acquiring and tightly tracking the optimal location in the presence of the non-linear wing tip vortices and free stream turbulence must be considered.

PHASE I: Define and develop a control law approach that provides a robust coarse and precision tracking schemes for automated formation flight to improve range. Create a control law development plan detailing the approach, rationale, schedule, key evaluations, robustness analysis, and other milestones. The plan should clearly identify expected parameters to be used for both the coarse and precision tracking loops (e.g., engine fuel flow, pitch vs Angle of Attack relationship changes, trim impacts), requirements, and rationale for their selection/derivation. Expectations for parameters sources (such as existing hardware, datalinks, or derived parameters) should be clearly documented, and any new hardware requirements should be made explicit. Control law architecture for all axes, expected gain setting, expected surface mixing approaches shall be discussed. The plan shall identify key analyses and iteration cycles to be performed in the maturation of control law algorithms. Preliminary modeling and simulation results assessing feasibility of the concept, including an accurate representation of the trailing vortex effects, are desired but not required during this Phase.

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

PHASE II: Develop and implement a prototype solution for wake surfing including control algorithms (i.e., relative positioning and optimized vortex benefit positioning) evaluated and tuned for use between multiple dissimilar aircraft. Software capabilities also include: formation management algorithms, mission optimization algorithms, formation entry and exit algorithms/procedures, and displays unique to wake surfing. Implement the prototype solution in a six degree-of-freedom (6DOF) simulation environment (including pilot-in-the-loop) to demonstrate and evaluate the algorithms and displays. Produce analysis and reports describing the prototype solution and results.

The 6DOF simulation environment should include a) multiple aircraft (at least two aircraft of different type) to determine technical feasibility of the relative positioning algorithm and b) representation of the concept formation with 3+ aircraft to determine effect of larger formation sizes. The simulation must include an accurate representation of the systems that affect flight dynamic performance (actuation, latencies, hardware/sensors, etc.). Control algorithms should be able to handle different lead aircraft and aircraft sequencing inside the formation, handle a variety of maneuvers (e.g., turns and descents), enter and exit formation including failure contingency management, manage keep out zones for safety, and manage formation stability.

Navy aircraft simulation environments may be available for use and control law evaluation during Phase II.

PHASE III DUAL USE APPLICATIONS: Integrate the Phase II-developed algorithms and displays into future manned and unmanned platforms, including Collaborative Combat Aircraft Programs of Record. Dual use applications include relative navigation without GPS aiding, UAS swarming, and robust flight control systems.

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KEYWORDS: Wake Surfing; Formation Flight; Precise Relative Navigation; Vortex; Upwash; Long Range

DON26BZ01-NV005 TITLE: Low-Cost Multi-Mission Dip Sonar for Mine Warfare and Anti-submarine Warfare (Inner/Middle Zone)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Integrated Sensing and Cyber;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop initial designs for a reduced cost, next generation helicopter dip sonar system utilizing multi-frequency band capabilities for traditional and enhanced anti-submarine warfare (ASW) capabilities for both inner and middle zone coverage (broadening to wide area search) as well as introducing aviation (naval) mine countermeasure (AMCM) capabilities.

DESCRIPTION: The United States Navy has long utilized dipping sonar systems on aircraft for Air ASW. The most recent sonar systems continue to show dominance in the Air ASW role with the ability to cover larger and larger areas of ocean. Simultaneously, various configurations of acoustic, electro-optic and electromagnetic sensor systems have been used in AMCM operations, with the newest remaining fielded systems offering limited mission coverage. As the Navy looks to new maritime strike future vertical lift capabilities, there will be an increased effort to combine capabilities into fewer unique aircraft platforms. To facilitate the merger of missions into fewer aircraft, it will become crucial to also combine more mission capabilities into individual mission systems. The resultant design from this effort is expected to provide increased capabilities across more aircraft of a singular configuration with the combination of improved Air ASW capability and added AMCM capability into a singular mission system, which in turn also will reduce the expected training and logistics costs with fewer variants of equipment to cover. Additionally, with continued retirements of existing mine-countermeasures systems, the Fleet will have an urgent need for other air-based AMCM capabilities/coverage and may want to consider implementing capabilities on other naval helicopters using existing, modified, or new sensors of acoustic, electro-optic, magnetic, and radio-frequency types.

Traditionally, the Navy developed and fielded acoustic ASW and AMCM systems independently while the physics of the underwater acoustic environment is a shared problem with differing targets and typical frequency bands of interest as a result. Additionally, acoustic ASW systems (i.e., sonobuoys and helicopter dip sonars) are of compact size and can be utilized on a medium lift helicopter or smaller, while acoustic AMCM systems have typically targeted installation on heavy-lift helicopters. Incorporation of a secondary frequency band capability into a helicopter dip sonar transducer assembly would quickly bring AMCM capability to a typically large number of traditionally ASW helicopters and bring air-based AMCM capability to the Navy’s air-capable ships, simultaneously with ASW capability. The multi-mission capability of such a sonar transducer assembly would also allow one aircraft, without reconfiguring, cover both ASW and AMCM mission sets for reduced maintenance and reducing the equipment needed to be stored while afloat in space-constrained ships.

The objective is to develop initial designs for a reduced cost, next generation helicopter dip sonar system utilizing multi-frequency band capabilities for traditional and enhanced anti-submarine warfare (ASW) capabilities for both inner and middle zone coverage (broadening to wide area search) as well as introducing aviation (naval) mine countermeasure (AMCM) capabilities.

The system would also be utilized either in its full capability configuration or at a reduced capability configuration as a retrofit into the multi-mission helicopter as a replacement for the existing dipping sonar system transducer, while at a decreased unit and sustainment cost (below Class A mishap thresholds if lost in flight, with a goal of below a Class C threshold).

Minimally funded Science and Technology efforts have previously been performed to assess USN dipping sonar capability to detect naval mines using the system, acoustic pulses/frequencies, and processing in its existing ASW configuration and have shown success in detecting nearly every naval mine based on post-flight data analysis. Enhancing that capability with a secondary frequency band and associated beam steering, as well as uniquely developed pulses and processing across both frequency bands, is expected to provide a significant AMCM capability while retaining both traditional ASW superiority and enhanced ASW detection and classification capabilities for certain scenarios.

In addition to introducing AMCM capabilities into a traditional ASW sensor system, no significant improvements in the traditional ASW sonar transducer assemblies available from industry have been introduced since the last dipping sonar system competitive source selection conducted in the late 1980s. Increasing costs of the existing USN sonar systems continue to drive concerns regarding the long term affordability of the existing fielded systems and any future variants thereof, and continue to pose a risk of generating an equipment cost loss equivalent to a Class A mishap record if the transducer is lost from the aircraft. As such, decreasing the recurring production costs of a future transducer assembly are of significant concern and ensuring improved supportability. Noting that sonobuoys are similar advanced acoustic sensor systems made in large quantities for production unit costs of less than $15k/each indicates that a highly capable sonar transducer design would be capable of being generated with a much more reasonable forecast production cost well below $500k/each.

Additionally, the ability for the new sonar transducer to be retrofit in place of existing USN fielded sonar transducers (form/fit/function compatible) used on the existing USN aircraft while utilizing existing sonar processing (~3-5 kHz frequency band) and bringing AMCM capability and new added ASW capabilities to the traditionally ASW-focused helicopters is of interest utilizing a higher frequency band in the same unit.

Lastly, it would be a significant advancement in helicopter-based ASW capabilities if a tertiary frequency band below 2 kHz was also added to expand mission capabilities to broach wide area search and explore advantages of convergence zone type capabilities, while retaining the inherent existing direct path detection coverage of the mid-frequency 3-5kHz band, for full spectrum coverage of the surrounding areas.

The new multi-frequency band sonar transducer would be desired to have at least the following characteristics:
- Primary transmit array would be omnidirectional for ASW in the horizontal plane
- Primary acoustic transmit band for ASW: 3-5 kHz.
- Primary receive array would be capable of supporting 24 beams for primary ASW capabilities
- Consider using Single Crystal transducer technology or other new technology to reduce the weight and improve bandwidth.
- Overall weight must be less than 180 lbs.

- Primary electronics power and transmission signal power for the unit must be provided from an external transmitter/amplifier.
- Primary acoustic processing must occur offboard (not within unit)
- Secondary higher frequency band must be selected for AMCM mission optimization
- Secondary transmit and receive array functionality could reuse the primary arrays, utilizing electronic or physical manipulation as needed/possible to optimize AMCM. Alternatively, integrating other transmit and/or receive arrays within the same assembly may be acceptable.
- The secondary array capabilities would consider abilities to steer beams both horizontally and vertically depending on both mine and submarine targets of interest.
- As allowable, a tertiary capability of covering lower frequencies for longer range area searches and overlap with current other low frequency system operational frequencies (below 2 kHz) is preferred, broaching wide area search capabilities, with a system not requiring logistical complexities of storing large quantities of sonobuoys while associated to an aircraft deployed on a ship, and taking advantage of long range convergence zone detections
- Mechanically extended and retracted arrays are acceptable, as these are traditionally used in the most recent ASW sonar transducers.
- Will be capable of storage within an aircraft body for forward flight, ideally with an overall stowed diameter of no greater than 210 mm for the primary body and an overall length no greater than 1275 mm (some extensions for stabilizing features may be permissible).
- The CG of the sonar transducer assembly body will be designed to be as low as possible for stability in lowering operations, with an upper limit of no greater than 35% of the length of the overall unit as measured from the bottom.
- The final fielded unit would incorporate a water thermocouple for measuring the water column temperature during lowering operations, a method for bottom proximity detection, a capability to protect itself during electrostatic discharge when lowered from a helicopter into the sea water, redundant depth sensing capabilities, angular orientation reporting relative to vertical, and a method for determining bearing orientation of the array (e.g., magnetic compass, field sensors, other).
- Acoustic elements would be physically or electronically steerable in the vertical plane, providing enhanced sea bottom scanning for bottomed targets, and ideally, ability to determine target depth for setting of weapon depth deployments for improved success in target engagement
- The unit design would be able to withstand operating depths to at least 2500 ft.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Design a concept for a low-cost multi-frequency band sonar transducer assembly capable of supporting both ASW and AMCM mission sets. Create scale electronic models of the concept showing the integration of both capabilities within a single assembly, illustrate and explain conceptually how the assembly would be utilized for both ASW and AMCM missions in relation to the two (or more) primary frequency band capabilities.

Demonstrate via analysis and simulation of the ability to use the mid-frequency band to cover traditional both inner and middle zone ASW through mono-static and multi-static methods combined with new technology and unique operating/processing methods.

Via analysis and simulation, demonstrate the effectivity of the mid-frequency band and the higher frequency band for rapid detection of mines at various points in the water column including floating, moored, and bottomed types.
Prepare a Phase II plan.

PHASE II: Develop a scale prototype of the sonar transducer assembly designed in Phase I for demonstrating physical sizing, fit, weight, CG, and mechanical functionality (not necessarily operable except for manual manipulation) to allow for demonstration of fit into a USN ASW-capable helicopter. Develop and demonstrate an acoustically functional and watertight representative prototype array in water, including development of an initial design specification for the sonar transducer. Initial demonstration and validation via computer modeling in full, or in part, will be considered if funding availability limits full hardware/software prototype construction.
Prepare a Phase III commercialization/transition plan.

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

PHASE III DUAL USE APPLICATIONS: Develop, build, and deliver a flight-worthy and fully functional sonar transducer assembly. Conduct full box level functional and environmental qualification (test and/or analysis), support field testing conducted by the USN, and support flight test operations on a USN MH-60R in both anti-submarine and mine-countermeasure scenarios. Create a system specification and drawing set for the final product. Verify through test compliance to specification and verification of modeling performed in Phase II. Develop and deliver high level concept of employment and operation. Assess and report on viability of using for mine-classification in addition to detection capabilities. Enhancements in underwater sonar systems could be applied to improved sonar systems used for offshore geographical exploration (mining, oil, etc.), marine surveys, and additionally could be beneficial in accelerating methods for search/rescue/recovery of personnel and equipment associated with ships and aircraft lost at sea. Perform analyses and modeling on effectivity in these alternate roles and any other applications. Provide a final report of this assessment.

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KEYWORDS: Sonar; anti-submarine warfare; ASW; undersea warfare; USW; aviation mine countermeasure; AMCM; Mine detection; Acoustic

DON26BZ01-NV006 TITLE: High-Gain Directional Low-Frequency Sonobuoy Array

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Advanced Materials;Integrated Network Systems-of-Systems

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a high-gain, low-frequency vertical line array of vector sensors capable of long-range passive detection and enhanced signal processing, deployable in an A-size form factor.

DESCRIPTION: To enhance anti-submarine warfare (ASW) detection and directional sensitivity in deep waters, the U.S. Navy requires a high-gain directional, low-frequency (< 500Hz) sonobuoy array, housed in an A-size form factor. It is expected that array gain will be achieved by using modelled and measured vertical noise profiles. The system must leverage novel sensor configurations and array geometries to maximize low-frequency Signal-to-Noise Ratio (SNR) while remaining compatible with existing sonobuoy communication and processing platforms. Advanced beamforming, signal processing, and robust hardware integration are crucial for extended detection ranges and minimized false alarms. Environmental factors like multipath interference, ambient noise, self-noise, and sensor stability must be addressed to ensure reliable performance in contested environments. This sonobuoy will bolster fleet ASW capabilities by delivering superior signal clarity, longer-range detection, and a decisive operational advantage through improved sensor capabilities and operational durations.

The objective is to develop a high-gain, low-frequency vertical line array of vector sensors capable of long-range passive detection and enhanced signal processing, deployable in an A-size form factor.
The system will be deployed from Navy Maritime Patrol and Reconnaissance Aircraft, have capability across multiple operational environments, and will utilize the necessarily varied hardware configurations, passive processing, and frequency characteristics to consistently achieve critical ASW metrics.
The sonobuoy must support deep-water tactical operations. Deployment depths up to 1000’ and 8 hours of life is required. The array design will provide 17 dB of gain at the design frequency in a three-dimensional isotropic ambient noise field as a minimum. The maximum saturation level will be 128 dB/µPa at 100 Hz with a total dynamic range of 96 dB. The sensor solution must be low power and fit within an "A" size sonobuoy (4.875-inch diameter x 36-inch length, weight under 40 pounds). Acoustic data sent to the aircraft from each vector sensor shall consist of Omni, Sine, and Cosine data. The communications link must comply with NATO's STANAG 4718. Long term plans include using the array in a persistent sonobuoy.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Establish the baseline sensor requirements working in conjunction with the Navy Technical Point of Contact (TPOC). Perform comprehensive analytical and numerical modeling to define the optimal sensor and array design for achieving the necessary gain using low frequency vertical noise profiles. Concurrently, develop a preliminary system architecture that addresses array geometry, deployment mechanisms, and communication protocols. Conduct trade studies on various sensor technologies, including velocity sensors, to select the most effective array configuration. Environmental noise factors will also be evaluated to determine their impact on overall system performance. Conduct trade studies on passive processing enhancements and adaptive beamforming to maximize detection range at these low frequencies.

A proof-of-concept simulation for a tactical sonobuoy will be developed to demonstrate the feasibility of the proposed approach, guiding both design decisions and risk mitigation. The Phase I effort will conclude with the generation of a high-level prototype design to be implemented during Phase II, ensuring a clear path from concept to operational capability.

Demonstrate materials/software/hardware required for prototype development can be sourced, produced, or obtained within a reasonable timeframe to allow for prototype development without requiring design changes due to unavailability, backorders, or extended lead times.

Demonstrate that preliminary testing/modelling has been performed on the materials/software/hardware showing that they possess the characteristics used for modeling or that at least the component has the characteristics and performance required for the system to achieve the objectives.

Phase I Requirements:

- Test design concepts(s) that have been demonstrated and validated to meet the objectives and can be scaled down to fit within the A-size constraints.
- Awardee must provide a full report outlining where their models have been performed with sufficient accuracy and depth to produce meaningful results to meet the objective.
- Demonstrate that preliminary testing/modelling has been performed on the materials/software/hardware showing that they possess the characteristics used for modeling or that at least the component has the characteristics and performance required for the system to achieve the objective.
- Awardee must also prove the models and results provided in the report originated from the SBIR effort and provide evidence that the raw materials/software/hardware required for prototype development can be sourced, produced, or obtained within a reasonable timeframe to allow for prototype development without requiring design changes due to unavailability, backorders, or extended lead times.

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

PHASE II: Design and fabricate an over-the-side deployable sonobuoy prototype rooted in Phase I findings and conduct over-the-side testing in both controlled facilities and actual aquatic environments to validate performance.

Integrate beamforming and signal processing algorithms optimized for the low-frequency range, ensuring robust detection and adaptation under varied ambient noise conditions.

Provide a thorough evaluation of the system's capabilities in deep-water scenarios, refining hardware and software elements in collaboration with domain experts.
Finalize the design concept by detailing a comprehensive roadmap for Phase III transition, including manufacturability considerations and integration with existing ASW platforms to maximize system synergy.

Conduct a study to determine the feasibility of extending the concept to a persistent capability with an operational life of 24 hours or greater.
Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Develop a production-ready design and specification for the Phase II solution and its accompanying algorithms, then proceed with integrated engineering and operational testing of the air-deployed system to verify full operational functionality in Navy-supported scenarios.

Demonstrate the system's adaptability and resilience in diverse maritime environments, ensuring seamless integration with Navy airborne ASW platforms and laying the groundwork for operational deployment. Upon successful qualification, transition to the Fleet and refine operational parameters through at-sea trials, leveraging real-world performance data.

Lastly, explore commercial applications, including marine mammal detection, underwater resource exploration, and environmental monitoring, to extend the solution's utility beyond Navy missions. Technology developed under this SBIR topic could be leveraged to achieve smaller and lighter systems capable of attaining key ASW measurements. This type of system capability may be of interest to the undersea mapping, exploration, seismology, and weather communities and used for monitoring marine mammals or icebergs. Government agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Department of Commerce are continually trying to upgrade their measurement and data collection capability.

These sensors could fulfill a need to provide in-situ measurements for low rfequency acoustics. By developing reliable, low-cost sensor components, more capability and performance can be achieved.

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KEYWORDS: Anti-Submarine Warfare; ASW; Sonobuoy; Low-Frequency Acoustics; Directional Arrays; Passive Detection; Beamforming; Underwater Sensing

DON26BZ01-NV007 TITLE: Test and Alert System for Type 1 Encryption Device Hold-up Batteries (HUB)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a common Type 1 encryption device Hold-Up Battery (HUB) tester and accompanying low battery alert device.

DESCRIPTION: Develop a universal Hold-Up Battery (HUB) tester and integrated low-voltage alert system for Type 1 encryption devices. These devices rely on HUB batteries to retain mission-critical software. Failure to replace depleted batteries within specified intervals often renders them inoperable, necessitating costly returns to depots or vendors for software recovery.

The proposed solution must provide:
• A non-invasive HUB battery tester compatible across multiple device types
• A low-battery alert mechanism to signal impending voltage failure
• A streamlined method for monitoring and managing battery replacement intervals
This capability will significantly reduce lifecycle costs, improve operational readiness, and mitigate the risks associated with device storage in long-term vault conditions.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Investigate and propose design approaches for a universal HUB testing device compatible with a range of Type 1 encryption devices Emphasis will be placed on a non-invasive testing methodology to assess battery health without compromising device security or data integrity.
Evaluate the technical feasibility of developing a compact, attachable low-battery alert module capable of operating within storage conditions and security constraints typical of Type 1 encryption devices.
Identify common HUB battery characteristics across platforms and establish baseline voltage thresholds for end-of-life alerts.

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

PHASE II: Based on Phase I modeling, design and develop a prototype HUB testing device for Type 1 encryption devices. Execute Developmental Test and Evaluation (DT&E) activities to identify the system's capabilities, limitations and deficiencies. Provide DT&E data for cost, performance and schedule tradeoffs.
It is probable that the work under this effort will be classified under Phase II (see the Description for details).

PHASE III DUAL USE APPLICATIONS: Further develop the prototype(s) generated in Phase II for use in COMSEC facilities and Fleet activities that store and maintain Type 1 encryption devices with HUBs. By identifying and developing devices that test and alert to HUB status, this research benefits the private sector by enabling reliable and robust commercial solutions for testing, tracking and replacing batteries that may be failing. This could potentially lead to improved performance, reduced downtimes and replacement/recovery cost associated with these devices when the batteries fail.

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KEYWORDS: Type 1 Encryptor; Hold-Up Battery; HUB; COMSEC; Vault Storage; Bricked Encryptor; Battery Testing

DON26BZ01-NV008 TITLE: Automated Expeditionary Airfield Assembly

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Sustainment;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Research, develop, and evaluate robotic system methodologies for automating or augmenting the assembly of Expeditionary Airfield (EAF) matting to enhance operational efficiency.

DESCRIPTION: EAFs serve as vital shore-based aviation support systems that enable the rapid deployment and recovery of military aircraft in environments lacking established infrastructure. Currently, assembling EAF matting is a manual process carried out by Marines—a task that is physically demanding, labor-intensive, and exposes personnel to potential hazards.
Developing a robotic system capable of assisting with or fully automating this assembly process would offer significant operational benefits: increasing efficiency, reducing risk to personnel, and enabling Marines to focus on higher-priority mission objectives. The level of autonomy should allow for the robots to navigate and control without human assistance, which includes obstacle avoidance, path planning, and grasping. Such a solution would improve overall force readiness and effectiveness in austere and time-critical operational scenarios.

The approach includes defining and developing a viable system concept, while investigating various robotic configurations—such as mobile manipulators and assistive technologies—for their effectiveness in EAF mat handling, alignment, and interconnection across diverse and austere terrains.
The research will evaluate the proposed system's capacity to:

- Traverse and operate on uneven or unstable surfaces
- Manipulate and position heavy EAF mat sections with precision
- Endure harsh environmental and operational conditions
- Integrate seamlessly with current EAF deployment procedures

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Demonstrate the technical feasibility of a robotic system capable of automating or augmenting the assembly of EAF prefabricated surfaced aluminum (PSA) Flat Top-Nested (Top-N) Trackway mats. This research will lay the groundwork for future development of a deployable robotic solution, enhancing safety, speed, and efficiency in EAF setup operations.

Focus on designing and modeling key system components to evaluate performance across critical metrics, including payload capacity, reach, manipulation precision, power consumption, and operational endurance. Under the Phase I Option, if exercised, simulations will be conducted to assess system behavior in representative virtual EAF deployment environments and to identify key technical risks and milestones. The Phase I effort will culminate in a comprehensive final report detailing the proposed system architecture, design specifications, and simulation-based performance evaluations, along with a clearly defined Phase II roadmap for prototype development, field testing, and integration planning.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a functional prototype of the robotic system for automated or semi-automated assembly of EAF mats. Refine the selected robotic system concept and fabricate a fully functional prototype incorporating the chosen locomotion system, end-effectors, sensors, and control architecture.

Rigorous testing will be conducted in both laboratory and field settings, culminating in a demonstration of the prototype's capabilities in a representative EAF deployment scenario. Testing data and operator feedback will be used to refine the prototype's design and functionality.
Finally, a comprehensive transition plan will be developed, outlining the steps required to move the robotic system towards technology demonstration and eventual deployment, ultimately enhancing the capabilities and effectiveness of expeditionary forces.
The robot shall be able to handle the PSA mats in some manner to aid in the assemble of the airfield, be a closed system, and able be able to operate in a realistic environment.
The system will be judged on feasibility, time to assemble, ease of use, and overall size and mass.

Deliverables include a prototype; the open interface specification; software design documents; the uncompiled, human-readable source code; associated comments and documentation; and any tuned parameters and weights; schematics of the robot.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Leverage Phase II findings to develop a robust and deployable robotic system for EAF mat assembly, optimized for real-world operational scenarios. Refine the design and engineering of the locomotion system, end-effectors, sensors, deployment mechanisms, power and charging strategies, and control architecture using collected test date and operator feedback.
Crucially, the system will undergo hardening against electrical, environmental, and cyber threats. The resulting system must demonstrate sustained operation in deployed environments, achieving significant reductions in manning requirements, operational costs, and/or deployment time. Conduct rigorous field testing that culminates in a full-scale demonstration of EAF deployment, showcasing the system's deployment method and power management capabilities.

Collected test data and operator feedback will drive further system refinement and optimization of operational use cases. Evaluation criteria will include feasibility, assembly time, deployment method efficiency, power solution effectiveness, ease of use, and overall size and mass. Deliverables include a full-scale EAF assembly demonstration, open interface specifications, software design documents, uncompiled and documented source code, tuned parameters and weights, robot schematics, and a comprehensive deployment and delivery plan.

The technology developed for this SBIR topic will have dual use in construction allowing for the rapid deployment of flooring and laying of other interlocking material. Other technologies, such as the development of man-unmanned teaming, perception modeling, and enhanced understanding of unobservable environmental conditions, will drive advancements in robotics, computer vision, and autonomy, with broad implications across multiple domains.

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KEYWORDS: Robotics; Artificial Intelligence; AI; Navigation; Manipulation; Automation; Navigation

DON26BZ01-NV009 TITLE: Open Architecture for a Low Volume Software Defined Radio (SDR) for Navy Aircraft

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design, develop, and demonstrate an innovative airborne radio system with a reduction compared to current airborne radios. The solution will incorporate a Modular Open Systems Approach (MOSA) and Model-Based Systems Engineering (MBSE) methodologies to ensure seamless integration across Navy and Marine Corps platforms including fixed wing, rotary wing and UAV aircraft.

DESCRIPTION: The Navy seeks an innovative, open-architecture airborne radio system optimized for a minimal Size, Weight, and Power (SWaP) to ensure seamless integration across a wide range of NAVAIR platforms, such as the SH-60, F/A-18, E-2D, and MQ-4C.This system will leverage a MOSA to ensure future adaptability and significantly reduce the cost and complexity of radio upgrades. The goal is to provide a pathway for future modifications without impacting existing platform infrastructure. Developing aircraft radio systems presents significant challenges due to stringent SWaP constraints, harsh environmental conditions, and demanding Electromagnetic Compatibility (EMC) standards. Equally critical is robust cybersecurity, requiring adherence to standards like NIST SP 800-53 and the integration of security measures throughout the system design lifecycle.

The objective of this SBIR topic is to design, develop, and demonstrate an innovative airborne radio system optimized for SWaP efficiency. The system must satisfy current security and operational demands, while providing a modular, scalable architecture that accommodates future technology upgrades and supports evolving communication waveforms.

An open architecture is also critical to sustain radio systems through their lifecycle. The MOSA leverages a robust ecosystem of established standards, including Sensor Open Systems Architecture (SOSA) and Modular Open RF Architecture (MORA) that enable modularity and interoperability. Additionally, applying an MBSE to radio system design will enhance system understanding, enable early defect detection and improve documentation.

Additionally, the resulting radio system architecture should adhere to the following technical goals:
• Fit within the tight size constraints of two VNX+ standard cards (78 mm x 89 mm x 19 mm each). Note that a VNX+ power supply, backplane and I/O connectors will be external to the solution.
• Support two separate Transmit and Receive RF channels. One RF channel capable of 30MHz to 6HGz operating frequency and the other capable of supporting 30MHz to 31GHz
• Support at least 60MHz instantaneous bandwidth
• Support transmit power amplifier capable of reliably delivering an average 25 Watts of RF power on transmit channel 1 and 1 Watt of RF power on transmit channel 2

• Interoperability with MORA devices for control and I/Q data sharing
• Capable of Digital Pre Distortion (DPD)
• Capable of programmable RF waveforms including VHF/UHF communications waveforms including AM/FM, Air Traffic Control (ATC), Public Safety, Have Quick II, SATURN, SINCGARS, DAMA, MUOS, JPALS, and Automatic Direction Finding (ADF), Link-16
• Capable of 1024-QAM OFDM modulation with 1000 subcarriers

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop an initial design for a novel SwaP-optimized airborne radio system utilizing MOSA and MBSE principles that is readily integrable across Navy and Marine Corps platforms, encompassing fixed wing, rotary wing and UAV aircraft. Provide analysis to determine the feasibility of the design by meeting the technical goals defined in the Description.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype that includes the high-risk technology elements previously identified. Continue to refine the MBSE design developed in Phase I and demonstrate prototype functionality in a laboratory environment.
Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Further develop/refine the prototype(s) generated in Phase II for inclusion in a tactical radio for Navy and Marine aircraft that includes qualification and flight testing. By identifying radio technologies adaptable to harsh Navy and Marine aviation environments, this research benefits the private sector by enabling more reliable and robust commercial solutions. For example, technologies proven resilient in demanding military aircraft environments can be applied to industries such as mining, oil and gas exploration, or even emergency services communication, leading to improved performance and reduced downtime in these challenging conditions.

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KEYWORDS: Radio; Modular; Communications; Open; Signal

DON26BZ01-NV010 TITLE: E-2D Large Language Model Entity (ELLMENT)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and implement a traceable, explainable, referenced, and reasoned Large Language Model (LLM) that functions as an on-demand Natural Language Processing (NLP) decision-support assistant for Naval Flight Officers (NFOs) and mission crew aboard a carrier-based, all weather, tactical battle management, airborne early warning, and command and control aircraft.

DESCRIPTION: Artificial Intelligence/Machine Learning (AI/ML) technologies are transforming how complex data is understood and acted upon in operational environments. This SBIR topic seeks to explore the development of a domain-specific LLM system to support rapid insight generation from structured and unstructured documents (e.g., Tactics, Techniques, and Procedures [TTPs]), mission logs, communications, and other high-volume data sources relevant to tactical operations.

The goal is to deliver a modular, self-contained AI/NLP solution that can assist NFOs and mission crew by summarizing, reasoning over, and extracting meaning from dense operational material in real time. This LLM must be specifically designed to operate in a stand-alone configuration in accordance with information assurance policies, with mechanisms for traceability, where the information came from and how is it connecting to the goal, source attribution, and model transparency. The system must also support future extensibility to multi-modal data ingestion.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Define and develop the foundational architecture and baseline capability for implementing Large Language Model Operations (LLMOps) in support of mission decision-aid tools for the E-2D platform, as outlined by Gallagher et al. [Ref 2].
1. Security, Ethics, and Data Governance Planning

• The small business will collaborate with relevant Navy civilian representatives—such as TPOCs and PMA-231 S&T leads—to:
• Establish appropriate data classification levels for training and deployment environments
• Define a cybersecurity framework aligned with DOW and platform-specific requirements
• Incorporate an ethical AI governance structure, including bias mitigation and auditability provisions

2. LLM Selection and Mission Alignment
• An appropriate LLM architecture will be selected based on mission-specific demands of the aircraft operator, with consideration for:
• Performance in tactical and technical language domains
• Model transparency and explainability
• Compatibility with in-theater deployment constraints

3. Corpus Curation and Model Training
• The selected LLM will be trained on an aircraft relevant corpus, including—but not limited to—mission-specific Tactics, Techniques, and Procedures (TTPs), doctrine documents, and communication logs. Training methodologies will include:
• Prompt engineering
• Fine-tuning with Navy-specific linguistic patterns and use cases
• Retrieval-Augmented Generation (RAG) to support on-demand referencing of large knowledge bases

4. Evaluation and Output Validation
• Model performance will be assessed using a comprehensive metrics suite, as recommended by Diaz-de-Arcaya et al. (2024) and Gallagher et al. (2023), including:
• Response accuracy and relevance
• Appropriateness and alignment with operational context
• Bias detection and mitigation
• Trustworthiness
• Independent Subject Matter Expert (SME) evaluation

5. Deployment Pathways and Phase II Readiness
• As part of final Phase I efforts, the small business will:
• Evaluate and down-select hardware and software deployment options (e.g., computer architecture, human-machine interface designs)
• Develop a baseline implementation roadmap for transitioning to Phase II prototype construction and TRL advancement

PHASE II: The developed LLM will be deployed to a stand-alone laboratory environment, for rigorous evaluation in an Operator-in-the-Loop (OITL) configuration. In this setup, NFOs and mission operators will engage with the LLM across representative command and control mission scenarios to assess its efficacy as a real-time natural language decision-support system.
Subject Matter Experts (SMEs) in specific operations and AI/ML will conduct structured evaluations using predefined metrics identified in Phase I —including response accuracy, contextual relevance, trustworthiness, and bias sensitivity. Iterative testing cycles will drive continuous refinement of the model’s behavior and performance . Performance referring to the system’s suggestions compared to SME suggestions.

To support future scale-up, candidate computing architectures will be assessed, including emerging platforms such as quantum-accelerated processing (e.g., D-Wave). These evaluations will focus on increasing operational capacity, expanding conversational memory (buffer length) and handling of larger mission datasets in constrained compute environments.

A lifecycle monitoring framework will also be established to operate the LLM Ops strategy introduced in Phase I. This includes procedures for tracking long-term model performance, retraining triggers, audit logs, output traceability, and alignment with evolving mission requirements.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of final verification and validation (V&V) testing, the developed system will be authorized for transition to designated operational platforms and associated industry partners, in alignment with established Navy acquisition and technology transition procedures.

In parallel, the capability has garnered interest from additional mission-critical stakeholders—specifically ONR Code 32, in connection with Anti-Submarine Warfare (ASW) mission domains. This cross-domain interest highlights the system's adaptability and potential for broader operational utility beyond its original use case, further enhancing the value and return on investment for the Department of the Navy. The development and refinement of such an LLM pushes the boundaries of AI and NLP, contributing to the overall advancement of these technologies. The need for traceable, referenced data management promotes innovation in data governance, lineage tracking, and knowledge management, which are valuable for private sector organizations dealing with large datasets.

Examples of Dual-Use Applications include:

- Predictive Maintenance: Predicting equipment failures and optimizing maintenance schedules
- Supply Chain Optimization: Optimizing supply chain logistics
- Threat Detection: Identifying and responding to cyber threats
- Security Auditing: Automating security audits

Overall, this approach has a more focused and specialized domain than current commercial applications. While LLMs like Gemini and ChatGPT focused on cloud-based approach, the proposed LLM suggests that a targeted local network approach can be a forward design to target specific problems. Some examples of alternative cloud-based approaches could include Neuromorphic computing, Local LLMs, LLMs on edge devices, and Small Language Models (SLMs).

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KEYWORDS: Large language model; LLMs; Natural Language Processing; NLP; Multi-modal approaches

DON26BZ01-NV011 TITLE: Compact Battery Operated Mid-wave Infrared (MWIR) Hyperspectral, High-Definition, Real-Time Video Camera Integrated with Photonic Crystal

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Microelectronics;Quantum Science

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate a compact battery-operated mid-wave infrared (MWIR) hyperspectral imaging (HSI) photonic chip video camera for integration into mobile network enabled small sensor platforms.

DESCRIPTION: Hyperspectral imaging allows quantitative evaluation of material composition and spatial distribution and finds numerous applications in areas such as remote sensing and military reconnaissance. In particular, the operational utility of HSI for detection, recognition and identification of hard-to-detect targets in environments cluttered with background noise is especially critical. Spectral imaging can aid the detection, acquisition and tracking of a potentially camouflaged, low-signature target, with significantly improved accuracy that cannot otherwise be detected using more conventional imaging means.

Conventional HSI systems [Refs 1, 2] tend to use large, bulky optical elements, such as a Michelson interferometer or other tunable optical filter components to spectrally resolve the input optical signals, and therefore usually have the characteristics of significant size, weight, and power (SWaP) consumption, mechanical complexity, as well as non-compliance with military specifications. More importantly, the mechanical mechanism of the conventional tunable filtering system gives rise to extremely slow spectral scanning speed and thus, slow imaging speed at that rate of one hyperspectral image per approximately one to two minutes. Traditionally, hyperspectral algorithms have considered only static images, and existing algorithms process single frames without regard for sequential similarities or correlations. The difficulty in capturing and processing hyperspectral video sequences in real-time is correlated directly to the high dimensionality of the data. As a result, conventional HSI systems cannot be deployed to the more demanding field applications that require images that can be captured and analyzed on a real-time basis at a much higher frame rates due to HSI's inherent image acquisition speed bottleneck.

A typical hyperspectral image consists of a high-resolution 3-dimensional (3-D) data cube, with two dimensions in space and a third dimension in wavelength. A focal plane array (FPA) can only acquire a 2D data set in one exposure. In the conventional approach, spectral scanning is thus often used to attain the third dimension of wavelength for a 3-D data cube. As stated earlier, this process makes HSI operation very slow because wavelength scanning requires multiple exposures over a specific spectral range. In addition to the very slow scan speed, it also suffers from a low signal-to-noise ratio (SNR) resulted from a high level of noise in infrared detectors and a low light throughput caused by narrow-band filters used in spectral scanning. The use of narrow-band filters also limits the number of spectral bands. Infrared spectroscopy routinely uses spectral multiplexing to overcome the challenge of detector noise. This is known as the Fellgett's multiplexing advantage [Ref 3]). The best example is Fourier-transform infrared spectroscopy (FTIR). Instead of spectral scanning, it projects an unknown spectrum onto a serial of sinusoidal functions constructed by a Michelson interferometer and thus greatly improves light throughput. However, it is difficult to integrate FTIR with FPA because of their bulky size and single channel operation. Recently, on-chip multiplexing has emerged as a new approach for hyperspectral sensing. It uses the spectral response of judiciously designed nanostructures to construct the multiplexing basis. Exploiting optical interference and resonance effects at the nanoscale, these nanostructures can provide a highly complex and diverse range of response functions suitable for efficient multiplexing [Ref 2]. They can be directly integrated into FPA to have an ultra-compact form factor. Multiplexing can be performed in both spectral and spatial domain. Advanced data-driven optimization such as machine learning can be used together with compressive sensing to reconstruct 3D data cube in single-shot operation [Ref 4].

It is therefore the objective of this SBIR topic to develop a battery-operated, compact, high-performance MWIR HSI camera system capable of capturing HSI video at real-time or higher frame rates in the room temperature thermal infrared region. One of the key challenges in on-chip photonic multiplexing of a photonic crystal-integrated FPA is the computational design. Constructing the multiplexing basis is a delicate balance between the physical limit of on-chip photonic structures and the imposed requirement from demultiplexing algorithms. The former requires solving multi-scale Maxwell's equations, and the latter requires large-scale data-driven optimization of demultiplexing algorithms. The coupled design process needs to be iterated efficiently to reach any useful design. It is expected that this challenge can be addressed by using massively parallel simulation of electrodynamics paired with efficient optimization algorithms such as adjoint method.

The project should demonstrate a systematic design method that leverages large-scale simulation, machine learning, and data-driven design to realize real-time hyperspectral video imaging. The final goal of this project is to experimentally demonstrate a battery operated MWIR HSI video camera with the following specifications.
System required parameters include:

1. Wavelength range: 3-5 microns
2. Array size: Threshold -- 1280 x 1024 pixels; Objective -- 2048 x 1536pixels
3. Spectral resolution: below 5 nm
4. Pixel pitch: Threshold – 12 microns; Objective – 8 microns
5. Real-time hyperspectral video imaging Programmable; 0.0015 Hz to 125 Hz frames per second
6. Acquisition time of hyperspectral image with 500 spectral bands: < 40 ms or minimum 25 video data cubes (each with 500 spectral bands) per second.
7. Size and Weight: 7.5 grams and < 4.9 cm^3
8. Battery Type: Lithium-ion battery enhanced by using carbon-based nanostructures with a specific energy > 600 Wh/kg at 0.5C discharge rate, and specific capacity of > 600 Ah/kg.
9. Low power consumption, starting at 600 mW
10. Humidity   Non-condensing between 5% - 95%
11. Non-Operating Temperature Range   -57 °C to +80 °C (-65 °F to +176 °F)
12. Operating Temperature Range   -40 °C to +71 °C (-40 °F to +160 °F)
13. Operational Altitude 40,000 ft (~12km)
14. Shock 40g w/ 11ms half-sine pulse, 3-axis
15. Vibration   5.8 grms 3-axis, 1hr each

Responding to the 21.2 AC1 S&T Domain comments: Surface Optics produces multi-spectral camera that can only provide multispectral images with about 10 spectral bands. Also, their multi-spectral camera is in the SWIR band. This current topic is for the first time a topic that can produce MWIR hyperspectral images at better than real-time video frame rate (24 frames per second or higher) with up to 500 (not 10 in the multispectral camera situation) high-resolution hyperspectral images per frame. This current proposed technology can produce up to 50 times more spectral information than the current multispectral camera in the market. Hence, there is zero overlap in terms of technology innovation between what Surface Optics and other commercial concerns market as multi-spectral or hyperspectral cameras and this current topic. In fact, the current proposed topic's performance and SWaP are far superior to any commercially available hyperspectral images by a 10 to 1 to 50 to 1 wide margin.

PHASE I: Demonstrate the feasibility of using massive parallel computing to design hyperspectral photonic chips. The design should shorten the acquisition time by 100X, i.e., reducing the time from seconds in traditional HSI to a few milliseconds. It should improve the spectral resolution by 10 X, i.e., going from tens of nanometers to a few nanometers, which translates into over 500 spectral bands in the MWIR band (3 to 5 um). The spatial resolution should be consistent with today's FPA resolution to reach 3.1 -mega pixel for high-definition images. Lastly, the design could be realized in ultra-compact form factor, reducing traditional HSI's size and weight by 10 – 20 times.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the unit cell design and lattice lengths to allow for (i) polarization insensitivity, (ii) WFOV performance, and (iii) broadband performance. Demonstrate a fully coupled design process using machine learning and physical simulation. Perform experimental verification of the generated design by demonstrating a real time MWIR hyperspectral imager with 5 nm spectral resolution, 1.3-million-pixel count, at 30 Hz frame rate. Demonstrate tunable focal lengths using lens-embedded photonic crystals.

PHASE III DUAL USE APPLICATIONS: Outputs from Phase II are anticipated to be TRL 7 but may require additional effort to refine to a more manufacturable design.
Concentrate on the manufacturability as well as the fabrication process itself to prepare for commercial offerings of a fully functional product. Demonstrate and market the final product to DoW and the Navy transition partner. Perform additional Phase III planning once a design is established and manufacturing requirements and manufacturability become more apparent.
The commercial potential includes new handheld and portable instruments for chemical, photometric, and biological sensing. Photonic crystal cameras can be integrated into compact form factors that enable in situ measurement for manufacturing process analysis and in-process feedback control. Applications include solid-state lighting characterization and testing, emissions control, portable sensing, and personal health care.

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KEYWORDS: Photonic crystal; Hyperspectral; Camera; Focal plane array; On-chip; Filter

DON26BZ01-NV012 TITLE: Optical Power Limiters Countering Frequency Agile Lasers and Dazzlers

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Directed Energy (DE);Space Technology

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop Mid-Wave Infrared/Long-Wave Infrared (MWIR/LWIR) nonlinear optical (NLO) dyes embedded in sol-gel glass operating as an Optical Power Limiter that protects optical sensors from damage caused by high-intensity light by reducing transmittance at high input power levels such as from frequency agile lasers and dazzlers.

DESCRIPTION: The proliferation of commercial, visible, and infrared wavelength laser systems is increasingly becoming a threat to our warfighters, which drives the need for further research and development for electro-optical/infrared (EO/IR) sensor. Current fielded sensor protection equipment is limited to fixed wavelength filters. However, broad band filters that are designed to circumvent multiwavelength laser threats are plagued by low transmittance, which degrades the sensitivity and performance of the sensor. Future warfighter threats include frequency agile lasers and dazzlers which have the potential of defeating fixed filters. Self-activating (passive) devices, where protection is activated by the incoming radiation (optical limiters), are the best approach to counter frequency agile and short pulse laser threats. The current state of the art of optical limiters are hampered by off-state low transmittance, low laser damage threshold, high activation laser threshold, and narrow field-of-view (FOV) and bandwidth. In addition, a sensor's size, weight, and complexity greatly affect the user's acceptance as a potential optical-limiting device. A sensor protection device is generally designed as an insert, an add-on, or replacement to the optical system. The optical limiter must be designed not to impact the sensor's FOV and optical transmission. Currently available systems are very bulky and narrow band in their protection.

This SBIR topic solicits new, innovative NLO dyes embedded in sol-gel glass to provide sensor protection from frequency-agile laser and dazzlers operating in the MWIR/LWIR spectrum. The proposed NLO dyes embedded in sol-gel glass should allow ample transmission of ambient MWIR/LWIR light and be of high optical quality so as not to significantly degrade sensor performance. It should have a fast response time when exposed to dangerous fluence levels, sufficient to react to and block incident laser pulses to a high optical density. The dyes should be capable of changing from a high transmission state to a very low transmission state within sufficiently short time to block nearly all of the light contained in a light pulse emitted from frequency agile lasers and dazzlers . When harmful radiation is no longer incident, it must recover to a high transmission state in a short amount of time so that the sensor's optics are not interrupted or significantly degraded after exposure. The proposal should discuss in detail the spectral transmittance in the attenuating state, activation threshold, response time, optical density in the attenuating state, and recovery time of the technology, the electric and other parameters of the excited state to be taken for measurements, excimer formation as well as any other important technical details. The NLO dyes embedded in sol-gel glass critical requirements are:

1) Wavelengths – threshold MWIR 3 to 5 micron goal MWIR/LWIR 3 to 12 microns;
2) Response time: < 1ns
3) Recovery time: < 1ms
4) Low-intensity transparency is > 50%
5) For light intensity or fluence above the limiting threshold (LT), the attenuation is > 20dB
6) The Damage threshold (DT) is at least 10 times larger than that of the nonlinear optical material used
7) The fluence limiting threshold (LT) is below 500 milli-joules/cm^2/pulse
8) Multiple use without performance degradation exceeds 10,000 pulses

9) Wide acceptance and protection angles
10) Testing should be performed using f-number optics no greater than f/10, unless a higher f-number is required by a specific application
11) Dynamic range (~120 dB)
12) Rapid response time (~20 us)
13) Optical limiting threshold of 6.5 W / cm2 at room temperature.

Use of government materials, equipment, data, or facilities will not be offered and will not be required. If the technology is capable of exceeding any of the above requirements, the proposal should note this as well. Likewise, the proposal should note any limitations inherent to the proposed technology.
New and innovative material solutions may be proposed to provide new options for sol-gel glass production. Potential candidates include but are not limited to vanadium dioxide, use of commercially available or novel silanes and solvents. Processing approaches could include methods to control the rate of curing of the glass and the type, material, and shape of container used for the cure, as well as the cure temperature.

The goal is to develop a process that can make larger optical elements more reliably. Well established materials and processes may be proposed with a focus on improving the manufacturability, producibility, and reliability for current and next generation optical elements. Increasing size, manufacturing yield, and reducing cost while at the same time reducing manufacturing variability is desired. Proposers must have experience in the production of dye containing sol-gel glasses.
A second requirement of the optical elements are dyes which have the required optical transmittance/absorbance properties while being compatible with the sol-gel materials and production methods and are reliably available from domestic sources. This is currently a challenge. The performer will be required to identify suitable dyes for the optical elements and to design synthetic approaches to any dyes that are not commercially available from reliable domestic sources. The performer will synthesize any required dyes not commercially available from domestic sources in amounts exceeding 10 grams by the end of Phase II and have the capability to produce the dye(s) at batch sizes of at least 10 grams going forward or to work with another domestic producer to do so, or both. Proposers should have documented experience in the design, synthesis, and production of novel and existing absorbing and fluorescing dyes in the infrared regions of the spectrum and must have demonstrated the ability to reliably and reproducibly synthesize, purify, and characterize light-absorbing dyes at greater than 10-gram batch size. The proposal should clearly identify the current state of the art of the sol-gel and dyes of interest including both technical and manufacturing readiness and how the proposed work will advance readiness for the proposed optical elements.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a NLO dye embedded in sol-gel glass protection concept designed to meet the (NLO) dyes embedded in sol-gel glass critical requirements stated. Identify critical fabrication processes for

realizing this concept. Conduct theoretical analysis and limited laboratory laser irradiation experiments on sample materials or devices to prove the feasibility of the concept.
Demonstrate a clear ability to prepare at least 1 inch diameter optically clear sol gel glass boules that are suitable for cutting and polishing. Demonstrate experience in putting organic or organic/inorganic dyes into the sol gel and preparing 1 inch diameter optically clear sol gel boules that could be cut and polished into optical flats. Provide description and photos of procedures utilized in "Phase I-like" effort that will carry into the Phase II proposal. The Phase I deliverables will also include prototype plans to be developed in Phase II, 3-dimensional model, Weight Budget, Trade-off analysis, and preliminary lab test data and supporting analysis.

All NLO dyes embedded in sol-gel glass protection prototype testing is expected to be performed at the awardee's site with the awardee's equipment (no Government supplied equipment). Any remaining concept refinements needed after a Phase I completion will be addressed early in the Phase II effort, ideally in parallel with the design efforts.

PHASE II: Develop and demonstrate a NLO dye embedded in sol-gel glass protection prototype system. Prototype optical limiting for mid-infrared transparent windows should be built in the form, fit and function of, or integrated for use in conjunction with, common Embedded Image Periscopes (EIPs) or embedded vision blocks on ground combat vehicles. This a NLO dye embedded in sol-gel glass prototype shall be jamming, damage, and device tested for critical requirements listed in the Topic Description, broadband laser protection performance, linear absorption, and degradation to optical system performance in a laboratory environment. Factors to be considered for Advanced Naval Technology Exercise demonstration include, but are not limited to, optical density upon laser illumination, response time, recovery time, linear optical properties under normal daylight illumination, manufacturability, and environmental stability. Phase II deliverables will include a prototype a NLO dye embedded in sol-gel glass laser protection system limiter satisfying the critical requirements as specified in the Topic Description, interim sample materials (if applicable), test data, monthly progress reports, semi-annual progress reviews, a final review, and a final report.

The design process should include planning for demonstration and testing/measurements. Fabrication and demonstration of a prototype is expected to require a substantial portion of the Phase II program due to component purchase lead times and several iterations of fabrication to refine the process. With proper planning for demonstration and testing, the final portion of the Phase II program should be relatively short and produce high quality data that indicates the NLO dyes embedded in sol-gel glass protection prototype function as a high-quality optical component near a virtual focal plane.
It is probable that the work under this effort will be classified under Phase II (see the Description section for details).

PHASE III DUAL USE APPLICATIONS: Pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Phase III award may be for additional research and development or direct procurement of products and services developed in coordination with the program.

Commercial applications could include coatings on car windows to attenuate incoming headlights, and coatings on windows of buildings to reduce heating from the sun. This system could be applied to other military platforms as well as the commercial and private airline industries as a defense against real world terrorist threats.

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1. Vella, J. H. et al. "Experimental Realization of a Reflective Optical Limiter." Phys. Rev. Appl., vol. 5, no. 6, June 2016, p. 064010. doi: 10.1103/PhysRevApplied.5.064010
2. Alam, M. Z.; Schulz, S. A.; Upham, J.; De Leon, I. and Boyd, R. W. "Large optical nonlinearity of nanoantennas coupled to an epsilon-near-zero material." Nat. Photonics, vol. 12, no. 2, February 2018, pp. 79-83. doi: 10.1038/s41566-017-0089-9
3. Mann, S. A. et al. "Ultrafast optical switching and power limiting in intersubband polaritonic metasurfaces." Optica, vol. 8, no. 5, May 2021, p. 606. doi: 10.1364/OPTICA.415581
4. C. Wan, Z. Zhang, et al. "Ultrathin broadband reflective optical limiter" Laser Photonics Rev., 15 (6) (2021), Article 2100001, 10.1002/lpor.202100001
5. J. King, C. Wan, et al. "Electrically tunable VO2–metal metasurface for mid-infrared switching, limiting and nonlinear isolation", Nat. Photonics, 18 (1) (2023), pp. 74-80, 10.1038/s41566-023-01324-8

KEYWORDS: Sol-Gel Glasses; Laser protection; Frequency-agile laser; Dazzlers; Mid-Wave Infrared; Long-Wave Infrared

DON26BZ01-NV013 TITLE: AI-Assisted Modernization and Optimization of Theater Mission Planning Center (TMPC) Software

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an AI-driven toolset to automate the modernization of Theater Mission Planning Center (TMPC) software, focusing on refactoring legacy code, optimizing performance, integrating advanced cybersecurity, and ensuring compatibility with modern and next-generation mission systems.

DESCRIPTION: TMPC software is built on legacy code that presents challenges in maintainability, performance optimization, cybersecurity, and integration with evolving mission systems. Current modernization efforts rely on manual refactoring, which is time-consuming, error-prone, and costly. There is a critical need for an AI-driven capability to automate code refactoring, optimize computational efficiency, and integrate cybersecurity features without disrupting TMPC's core functions. This effort will enable seamless software upgrades while maintaining backward compatibility with existing operational platforms.

The proposed solution will leverage machine learning (ML) and natural language processing (NLP) to analyze, refactor, and optimize TMPC's codebase while preserving mission-critical functionalities. Additionally, AI-assisted software validation and security enhancements will ensure that modernized TMPC software meets the evolving requirements of Navy mission planning environments.
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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Conduct an analysis of TMPC's existing software architecture to identify modernization needs. Develop conceptual AI-based models for legacy code analysis, refactoring, and cybersecurity integration. Demonstrate proof-of-concept AI-driven refactoring on a representative TMPC software component. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype AI toolset for TMPC code modernization. Integrate cybersecurity enhancements and automated validation/testing. Conduct functional and performance testing and validation. Ensure compatibility with existing and next-generation TMPC hardware/software.
Work in Phase II may become classified. Please see note in the Description.

PHASE III DUAL USE APPLICATIONS: Bring the AI tool from prototype to full-scale, improving the speed, security, and cost-effectiveness of software upgrades.
The same technology that helps the Navy can also potentially help the private sector fix and secure older software more easily.

REFERENCES:

1. Hagardt, J. “Artificial Intelligence and Agile Combat Employment.” Military Review: The Professional Journal of the U.S. Army, May-June 2024. https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/May-June-2024/MJ-24-Hagardt/MJ-24-Artificial-Intelligence-UA.pdf
2. Plaff, C. A.; Lowrance, C. J.; Washburn, B. M. and Carey, B. A. “Trusting AI: Integrating artificial intelligence into the Army's professional expert knowledge. United States Army War College Press, 2023. https://press.armywarcollege.edu/monographs/959
3. “National Industrial Security Program Executive Agent and Operating Manual (NISP), 32 U.S.C. § 2004.20 et seq. 1993.” https://www.ecfr.gov/current/title-32/subtitle-B/chapter-XX/part-2004

KEYWORDS: AI-assisted; Legacy Code; Machine Learning; Natural Language Processing; Tomahawk; Mission Planning

DON26BZ01-NV014 TITLE: Non-Radio Frequency, Covert Maritime Transceiver

COMPONENT TECHNOLOGY PRIORITY AREA(S): FutureG;Integrated Network Systems-of-Systems;Microelectronics

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a reliable and covert transceiver for use in contested areas where the use of traditional radio frequencies are not permitted in order to remain concealed. The Navy is looking for new technologies that can transmit and receive wireless communications from distances of at least 5km. The signal medium may be, but not limited to, acoustic, infrared, or ultraviolet. The communications link must be highly resistant to interference, detection, and exploitation.

DESCRIPTION: Covert communications have continuously evolved during the history of warfare. Paradigm shifts in communication (in warfare) have enabled evolutionary tactical advantages that have lasted for finite periods of time until an adversary adjusts technology and tactics to detect, and in some cases monitor, seemingly covert communications. Various modalities are available to attempt to provide secure, covert communications including many Radio Frequency (RF) techniques, free-space optics (laser comm.) and others. Due to the United States's reliance on RF for communications and sensing (e.g., radar), various peer-adversaries have engineered around many of these modalities putting secure communications at risk. For this reason, it is necessary to go "out-of-band" to provide a modality of communication not commonly used and enabled by technology that is wholly new and therefore restricted by rarity. Another limitation to this application is the need to avoid bulky, power-hungry systems that may require a high degree of attention in order to operate properly.

Therefore, the Navy is looking for a low power, small communications transceiver that offers low probability of intercept (LPI) and low probability of detection (LPD). The new technology must be able to acquire, track, and maintain a secure communications link between rapidly moving vehicles (manned and unmanned). Emerging applications include cognitive operations with other autonomous systems for armed combat, Intelligence, Surveillance, Reconnaissance (ISR), casualty extraction, and field communications. Each of these applications have different objectives but all require uninterrupted, high bandwidth, and secure communications.
Attributes:

- Must be able to communicate between two or more points at least 5km away
- Low Size, Weight, and Power/Cost (SWaP-C)
- Reliable, continuous communication link
- Field Programmable
- LPI/LPD
- Flexible data rate requirement (up to 10MB/s)

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA 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 during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: The evaluation technical merit of Phase I proposals (evaluation criteria defined in the BAA instruction) will be based on design, system functionality, durability and feasibility. In the development of the system, assessment of the performance parameters and identification of the constraints and limitations is required, and a full rationale supporting the advantages and strengths of the design. Justification of the feasibility study will be based on research, part/component availability, sound engineering principles, and market research. Describe maximum transmission distance between points and the reliability of the wireless link.

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

PHASE II: The end state goal of the proposed initiative is to develop and test a prototype system that implements the Phase I design. This prototype will have its ability to communicate wirelessly between two points tested in a relevant environment with input and direction from the Government Technical Point of Contact (TPOC. The system should demonstrate that it meets the objective and system attributes in this SBIR topic and will be evaluated based on the reliability and capability of the communications link.

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

PHASE III DUAL USE APPLICATIONS: Complete final testing and perform necessary integration and transition for use in monitoring operations, remote surveillance and reconnaissance applications with appropriate platforms and agencies, and future combat systems under development.
Commercially, this product could be used to enable remote environmental and security monitoring or point to point secure communications.

REFERENCES:

1. Bekkali, H. Fujita and Hattori, M. "New Generation Free-Space Optical Communication Systems With Advanced Optical Beam Stabilizer." Journal of Lightwave Technology, vol. 40, no. 5, 1 March 2022, pp. 1509-1518. doi: 10.1109/JLT.2022.3146252
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3. Wang, B. et al. “Design and implementation of a new infrared transmitter and receiver.” 2012 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet), Yichang, China, 2012, pp. 3171-3173. https://ieeexplore.ieee.org/document/6201434
4. “National Industrial Security Program Executive Agent and Operating Manual (NISP), 32 U.S.C. § 2004.20 et seq. 1993.” https://www.ecfr.gov/current/title-32/subtitle-B/chapter-XX/part-2004

KEYWORDS: Covert transceiver communications; Field programmable; Wireless communications; interference resistant; Low power consumption; Cognitive applications; Radio Frequency; non-RF

DON26BZ01-NV015 TITLE: Virtual Reality Model Walkthrough

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop software for a commercially available Virtual Reality (VR) headset to view new ship construction models in an immersive environment.

DESCRIPTION: When constructing a DDG-51 Class Destroyer, Navy engineers regularly need to perform design reviews to verify and validate proposed ship changes. Currently, these design reviews are held using screenshots and model sharing of the ship’s Computer Aided Design (CAD) models. However, 2D rendering of 3D spaces and objects can make it challenging to assess the actual layout and configuration of items. This can lead to errors in the ship design process, requiring costly rework later in the ship construction cycle.
The Navy seeks an innovative solution for VR software that allows Navy engineers to view the ship construction models as though they were standing in space. The proposed solution would allow the shipbuilder and the Navy to be better able to detect and correct errors early in the construction process. Additionally, such software could be used to train new engineers in the layout and navigation of the ship before they board it for the first time. There is currently no commercial technology that can meet this need.

The development of VR software faces several technical challenges. First, the shipyards use Computer Aided Three-Dimensional Interactive Application (CATIA) and Ship Constructor CAD models. The VR model must be capable of accurately using the outputs of both these CAD programs. The Navy understands this can be difficult and will require good knowledge of CAD file formats. Secondly, the user must be able to navigate virtual space and manipulate the environment. Many VR programs have some form of self-directed navigation. Destroyer spaces can have complex interior layouts and minimizing any motion sickness the user might experience while navigating VR can be a challenge. The solution should be able to load and view multiple CAD files, navigating between them with minimal lag and overlaying them to view discrepancies.

PHASE I: Develop a concept for a VR Model Walkthrough solution that meets the requirements listed in the Description. Demonstrate the feasibility of the concept in meeting Navy needs and establish that the concept can be developed into a useful product for the Navy. Feasibility will be established via a program demo or other means deemed appropriate. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Based on the results of Phase I, develop and deliver a prototype VR Model Walkthrough solution. The prototype software will be evaluated to determine capability in meeting the performance goals defined in the Phase II Statement of Work. Product performance will be demonstrated through multiple evaluations over the development cycle. An extended test by Navy personnel will be used to refine the prototype into a design that meets Navy requirements. Prepare a Phase III manufacturing and development plan to transition the Virtual Reality Model Walkthrough to Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Develop operations, maintenance, and technical manuals for the software to support the transition to the Navy.
There are many potential commercial applications for a VR Model to aid engineering design and training. Notable examples include commercial construction, commercial shipbuilding, architecture, and test and research reactors.

REFERENCES:

1. Obukhov, A.D., Krasnyanskiy, M.N., Dedov, D.L. et al. “The study of virtual reality influence on the process of professional training of miners.” Virtual Reality 27, 2023, pp. 735-759. https://doi.org/10.1007/s10055-022-00687-7
2. Xie, Biao et al. “A Review on Virtual Reality Skill Training Applications.” Frontiers in Virtual Reality, vol. 2, no. 1, 30 Apr. 2021. www.frontiersin.org/articles/10.3389/frvir.2021.645153/full, https://doi.org/10.3389/frvir.2021.645153

KEYWORDS: Virtual Reality (VR); Ship Design; 3D Software; CAD Models; Ship Construction; Self-Directed Navigation in VR

DON26BZ01-NV016 TITLE: Superconducting Magnetic Energy Storage (SMES) Power Interfaces

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Scaled Directed Energy (SCADE)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Directed Energy (DE);Renewable Energy Generation and Storage

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Superconducting Magnetic Energy Storage (SMES) system to support intermittent pulsed power loads by providing a consistent load to the generation source during pulsed power duty cycle.

DESCRIPTION: A Navy ship’s electric plant and the electrical load aboard the vessel mimics an electrical microgrid structure to distribute power. Conventional plant designs have separate mechanical propulsion and weapons systems with the electrical plant to support hotel and combat systems. Future all-electric naval ships will require all prime movers to have the functionality of distributed electrical generators to power a wide variety of loads ranging from conventional electronics, electric propulsion systems, and pulsed power systems to drive electric weaponry. The pulsed power systems will draw power from the ship’s electrical distribution to enable continuous operation.
While large-scale energy storage may support operations, high-rate intermittent storage is necessary to ensure the electrical distribution and prime movers are provided with relatively consistent loading. During the charge process of the pulsed power system, a considerable amount of power will be drawn from the electrical grid for time durations on the order of seconds with a lapse in between charges. The large power drawn in an intermittent fashion is difficult to control and difficult for non-stiff electrical generators to supply. Enabling technologies to support a supplemental high-rate storage system is required for pulsed power loads to be effectively used on board the ship without disruption to other loads or damage to the distributed generators.

SMES systems are a relatively new technology that can charge and discharge energy at rates to support the various loads that new Navy ship designs are targeting. Innovative R&D is needed to model and validate novel high-rate, intermittent energy storage and control architectures that can rapidly accept high intermittent currents to load-level prime movers during the pulsed-power duty cycle. The architecture should be designed to minimize the impact this type of operation has on the electrical generators and support the pulsed load modules’ operation. The energy storage must be able to accept rapid charge from the generation system within the constraints of the duty cycle of the pulsed power system and then provide this stored energy on the order of seconds to allow for cyclic capability in a continuous manner. New high-peak power energy storage technologies and designs are needed to accomplish this goal. Control system architectures and algorithms must also be developed to ensure load leveling in all modes of operations while ensuring safety and constant operation. These devices, with the requisite conversion schemes, are necessary in highly dense packages to allow for implementation in volumetrically constrained environments. Proof of principle hardware tests and validated computer design models are desired.

The Navy seeks a full-scale pulsed power SMES system to store energy between 4-10 MJ at a 2-4 MW power level. The energy storage system developed is expected to charge at a rate of > 1 MW and to deliver power > 1 MW. The energy will be pulsed at a power duty cycle > 80% at a discharge/charge ratio of 1:1 and accept power at a sub-second response rate. The Navy desires the energy storage interface to withstand voltages > 1000 V.

PHASE I: Develop a concept for an intermediate storage approach that utilizes advanced high-rate components to continuously accept and provide power to operate on a load leveling basis. At a minimum, modeling and simulation should be performed to aid in proving the concepts are feasible. Small scale proof of concept experimentation may also be performed to demonstrate hardware's ability to drive high peak powers with compact and sensible architecture and package. Control algorithms that maintain load leveling should be developed and demonstrated on small-scale hardware systems. Provide objective quality evidence in the form of reports and briefings that their development will satisfy the technical specifications in the description. If modeling is performed the results of the modeling shall be included in the reports and briefings. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype that demonstrates the conceptual architecture and controls at a relevant scale that aligns to the requirements as provided within this topic for voltage and rates. Ensure that modes of continuous operation will be shown without degradation of the device and will support operations under elevated temperature regimes up to 122°F. (Note: Cooling and other interfaces shall be specified and demonstrated for performance.) Build additional intermediate storage devices to be tested at a facility by exposing them to a variety of pulsed power system concepts as well as abusive conditions. Cycle the modules for extended periods to fully characterize degradation and capacity loss with use under relevant conditions. Provide data and results from testing of the hardware, which shall be included in the reports and briefings to the Navy. Deliver any Phase II-developed hardware to the Navy for additional evaluation.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to Navy use. Apply the knowledge gained in Phase II to build a multiple-MW scale system to support intermediate storage operations, ensuring that the system will be able to provide load leveling performance as defined within the topic and will be demonstrated as such.
In microgrid applications, additional areas of usage are high-rate charge/discharge applications including fast-dispatch frequency regulation, large power system load leveling and scheduling.
SMES has been implemented to stabilize power in the electrical grid in papermill factories in South Africa and the electrical power feed for a semiconductor manufacturing facility in Japan. It could be commercially adapted for other manufacturing uses.

REFERENCES:
1. Christianson, O. et al. "Pulsed HTS Coil Performance." IEEE Transactions on Applied Superconductivity, vol. 27, no. 4, June 2017, pp. 1-4. https://ieeexplore.ieee.org/document/7852479/
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4. Lee, S. et al. "Design of HTS Toroidal Magnets for a 5 MJ SMES." IEEE Transactions on Applied Superconductivity, vol. 22, no. 3, June 2012, pp. 5700904-5700904. https://ieeexplore.ieee.org/document/6080708
5. “2019 Naval Power and Energy System Technology Development Roadmap.” Naval Sea Systems Command (NAVSEA). https://www.navsea.navy.mil/Portals/103/Documents/2019_NPES_TDR_Distribution_A_Approved_Final.pdf

KEYWORDS: Superconducting Magnetic Energy Storage (SMES); High-Charge Rate; High-Discharge Rate; Power Dense Energy Storage; Pulsed-Power Delivery; High-Duty Cycle Energy Storage

DON26BZ01-NV017 TITLE: Bridge Environmental Light Pollution Mitigation and Control

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Integrated Sensing and Cyber

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and deploy a safe, sustainable technology suited for controlling light pollution, thereby reducing ambient light levels across a bridge environment and providing adequate situational task lighting at select workstations across the bridge.

DESCRIPTION: The Navy seeks a light mitigation technology for adequate situational lighting compliant with the Bridge Light Pollution Mitigation and Control Program (BLPM & CP). A comprehensive review of collisions involving U.S. Navy ships cited bridge lighting conditions as a possible contributing factor, stating the need to adhere to military standards for light producing displays and equipment installed on the bridges of surface combatant ships. The principal BLPM & CP's objective is to resolve non-compliance of current bridge equipment and hardware with Military Standard MIL-STD-1472H, DOW Design Criteria Standard for Human Engineering [Ref 2]. Existing hardware often fails to satisfy requirements as outlined in the referenced standard (MIL-STD-1472H).

Light pollution mitigation efforts are necessary for all light producing technology installed on surface ship bridges/pilot houses. Reducing the undesirable effects of excessive or poorly designed lighting (i.e., light pollution) on night vision and bridge-watch stander performance will create greater situational awareness for crew members in a darkened bridge environment, therefore enhancing ship safety at sea.
The Navy seeks light mitigation technology for the bridge environment that complies with MIL-STD-1472H and enhances the effectiveness of all lights (e.g., screens, indicator lights, LED) during dark operations. This solution must also include a ruggedized work light that complies with free translation in three-dimensional space and free rotation on all three axes of rotation. There is currently no commercial technology that can meet this need.

The light should comply with all surface ship environmental standards regarding Electromagnetic Environmental Effects (E3), shock, vibration, and power quality and be able to produce light at the levels described in MIL-STD-1772H. The work light shall allow bridge watch standers to observe printed material at nighttime while still preserving night vision. A shipboard bridge work light must provide a focused beam of light with minimal glare, must be adjustable to direct light precisely where needed, and must offer the ability to control brightness levels with a cool color temperature to minimize eye strain while performing detailed tasks like reading or writing notes especially for crew members in a darkened bridge environment.

This scope of this effort includes all light emitting devices on the bridge, and is not limited to the following bridge systems:

- Navigation Radar
- Surface Search Radar
- Situational Awareness Radar
- Electronic Charting System
- Ship Control Consoles
- Voyage Data Recorder
- Bridge-to-bridge Radio
- Hull, Mechanical, and Electrical (HM&E) Systems

• Damage Control Equipment/Displays
• Command, Control, Communications, Computers, and Intelligence (C4I) Systems

Desired light mitigation solution parameters include but are not limited to:

• Overlay applications, easily applied to existing displays, requiring no special tools, equipment, hardware, fixtures, adhesives, tapes, or fasteners.
• Collapsible, foldable, stackable, and/or portable solutions to allow effective and easy storage when not in use.
• Various optical densities and sizes of Neutral Density filter material may be overlaid on displays.
• Solutions shall allow operator adjustment during application or installation.
• Temporary covers, fixtures, filters, shades, etcetera must not alter the original design characteristics nor interfere with normal operation of mitigated light emitting sources.
• Technology should not require external electrical power nor include additional electronic control systems or require any form of computer network connections.
• Solution shall not leave any adhesive residue behind on surfaces after removal.
• Mitigations may also include other formed caps to cover various instrumentations to reduce or eliminate light pollution associated with installed bridge equipment and other environmental light polluters.
• Solution must be able to withstand extreme environmental conditions (e.g., high humidity, persistent vibration, temperature below 40° degrees Fahrenheit, etc.).

PHASE I: Develop a concept for reducing ambient light levels across a bridge environment that meets the requirements outlined in the Description. Demonstrate the feasibility of the concept in meeting Navy needs and establish that the concept can be developed into a useful product for the Navy. Feasibility will be established via modeling or other means deemed appropriate. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype light pollution mitigation system. The prototype will be evaluated to determine capability in meeting the performance goals defined in the Phase I. Product performance will be demonstrated through evaluation, modeling, and demonstration over the required range of parameters. Prepare a Phase III manufacturing and development plan to transition technology for Navy use. Prototypes expected during Phase II must apply to indicators and systems. The Navy will measure the suitability and sustainability of prototype using the criteria outlined in the references.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the light pollution mitigation system to Navy use. Develop installation, maintenance, and operations manuals during deployment to support the transition to the fleet.

The potential for application beyond military use cases exists within the commercial shipping industries like commercial fishing, cruise lines, cargo transport, oceanographic exploration, and other seagoing operations involving the need for optimized crew performance on the bridges of large ships during darkened and nighttime conditions. There are many potential commercial applications for light pollution mitigation technology in inimical conditions.

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2. “MIL-STD-1472H, Department of Defense Design Criteria Standard: Human Engineering (15-SEP-2020).” https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=36903
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KEYWORDS: Bridge Illumination; Light Pollution; Darkened Ship; Night Vision; Safety at Sea; Collision

DON26BZ01-NV018 TITLE: Lightweight Beaching Ramp for Ships

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a durable, lightweight, corrosion-resistant beach ramp for newly constructed Medium Landing Ships (LSMs).

DESCRIPTION: The Medium Landing Ship (LSM) is a new construction beachable vessel intended to perform ship-to-shore amphibious movement of cargo, equipment, and troops. To accomplish the loading and unloading of equipment, a large vehicle ramp is needed for Roll-On/Roll-Off (RO-RO) capability. Large RO-RO ramps are used on multiple ship classes and are commonly made of heavy steel, susceptible to corrosion and maintenance issues. On beaching vessels, these ramps are constantly subjected to saltwater immersion and are expected to traverse a long distance to provide a safe transfer of vehicles to the shore. Without a properly functioning ramp, the primary mission of these beaching vessels is compromised. There is currently no commercial technology that can meet this need.
The Navy seeks a reliable, low maintenance, corrosion resistant ramp system for beaching vessels. The legacy ramps are mostly made of steel and are often submerged in seawater while rolling stock compromises paint protection causing corrosion. Due to complex geometric challenges of beaching a large vessel, complex articulating beaching ramps tend to be very long and heavy (typically about 75' and 110 tons). These length and weight challenges of deployment systems tend to be unreliable and often have mission degrading failures. The solution should be at least 13 ft in width and 75 ft in length and support a maximum vehicle load of 70 tons (tire contact load of 32,100 lbs. over 24" x 25.5" patch area). The ramp should be articulated from a single hinge point using hydraulics on the ship. However, the solution can be divided into as many subsections as necessary such as employing the use of multiple folds to accommodate the length and weight requirements. The time it takes to deploy the ramp, however, shall not exceed 30 minutes.

The technology should utilize maintainable systems for deployment and retraction. The developed solution should reduce maintenance requirements while maximizing reliability of the deployment/retraction system. The durability of corrosion resistant material should last the life cycle of the ship (30 years). The solution should take extreme environmental conditions such as wind, humidity, and sea spray into consideration as such conditions can decrease the life cycle of a technology. The solution should have a nonskid surface that is able to withstand the demands of high traffic during loading and offloading of heavy equipment and vehicles.

PHASE I: Develop a concept for a lightweight beaching ramp for ships that meets the requirements in the Description. Demonstrate the feasibility of the concept in meeting Navy needs by material testing and analytical modeling. If the Phase I Option is exercised, include the initial layout and capabilities to build the prototype in a Phase II plan.

PHASE II: Develop and deliver a scaled prototype beaching ramp that meets the requirements of the Description. The prototype will be installed on an appropriate test platform in a simulated environment for durability and load testing. These evaluation results will be used to refine the prototype into a design that will meet the LSM specifications. Prepare a Phase III development plan and cost analysis to transition the technology into Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the lightweight beaching ramp for Navy use on the LSM program. Refine the design of the lightweight beaching ramp based on Phase II testing results and prepare for Low-Rate Initial Production (LRIP).
The durable lightweight beaching ramp will have private sector commercial potential for all types of RO-RO ships of this scale operating in the near-shore or on-shore environment, which currently use expensive to procure and maintain steel designs. Commercial applications include ferries, RO-RO ships, transport aircraft, the oil and mineral industry, and cold climate research and exploration.

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3. Tao, S.;, Zhu, L.; Liang, Q. and Zhang, Q. "Reliability Analysis of Ro-Ro Vessel Movable Vehicle Ramps Under Vehicle Moving Load." Proceedings of the ASME 2024 43rd International Conference on Ocean, Offshore and Arctic Engineering, Volume 2: Structures, Safety, and Reliability. Singapore, Singapore, June 9-14, 2024. V002T02A026. https://doi.org/10.1115/OMAE2024-124733

KEYWORDS: Medium Landing Ship (LSM); lightweight Ramp; Lightweight ferry ramps; Advanced Materials; Corrosion resistance; Roll-On/Roll-Off (RO-RO) ramps

DON26BZ01-NV019 TITLE: Improved Portable Underway Replenishment (UNREP) Tester/Trainer

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum and Battlefield Information Dominance (Q-BID)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a portable Underway Replenishment (UNREP) Tester/Trainer to be used pier side to replace legacy in-port Shipboard Qualifications Testing that requires a supply ship and pier space for the two ships.

DESCRIPTION: Underway Replenishment (UNREP) systems are used to transfer cargo and liquid (i.e., fuel, water) at sea between U.S. Navy ships. A tensioned line is rigged between the two ships, and the cargo/liquid is transferred along the highline between the ships. Delivery ships (i.e., T-AKE, T-AO, and T-AOE) have the equipment used to transfer the cargo and fuel, while the receiving ships (i.e., combatants, carriers, amphibious) have a simple connection point to connect the line from the delivery ship and then receive the cargo/liquids.

The Navy requires in-port testing to verify the installation and training of the fleet on how to operate the UNREP systems. Currently this testing requires the delivery ship to connect their cargo and fuel systems to the receiving ship in addition to the pier space for the receiving and delivery ships. Delays in testing often occur due to limited pier space and delivery ships not being readily available. This has increasingly become an issue as the fleet increases their size, placing a greater demand for pier space availability. There is currently no commercial technology that can meet this need.

The Navy seeks a portable UNREP Tester/Trainer System that will test the current design and use innovative power and controls to meet the Navy’s needs. The new trailer should be able to test the UNREP stations on a receiving ship and provide training opportunities for the fleet while in-port. The proposed solution can be self-propelled or towable to allow use in various locations. It must be self-powered for UNREP testing/training. The trainer/tester will need to be fixed to the pier to allow all required testing. The testing/training will be for both cargo and liquid systems. Currently, cargo transfer uses a trolley that is pulled back and forth on the tensioned highline, while the liquid transfer uses a hose hanging from the tensioned highline. No fuel would be transferred; all liquid training and testing will be dry. The tensioned highline testing will include pulling at different angles including above and below the horizon and fore and aft of the station. The Navy UNREP testing requirements are further defined in NWP 4-01.4 [Ref 1].

PHASE I: Develop a concept for an UNREP tester/trainer that meets the requirements outlined in the Description. Demonstrate the feasibility of the concept in meeting Navy requirements and establish that the concept can be developed into a useful product for the Navy. Feasibility will be established via computer modeling or other means deemed appropriate. The Phase I Option, if exercised, include the initial design specifications and capabilities description to build a prototype solution in a Phase II plan.

PHASE II: Develop and deliver a prototype for an UNREP tester/trainer system. The prototype will be evaluated and tested to determine capability in meeting the defined performance goals. Product performance will be demonstrated through prototype evaluation, modeling, and demonstration over the required range of parameters. An extended pier side test with an active/available ship will be used to refine the prototypes into a design that will meet Navy requirements. Prepare a Phase III manufacturing and development plan to transition the UNREP tester/trainer system to Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the portable UNREP tester/trainer to Navy use. Develop installation, maintenance, and operations manuals for the UNREP tester/trainer to support transition to the fleet.
Additionally, the finished product has applications for the Military Sealift Command Fleet in qualifying mariners to operate with Navy Ships at sea. There is potential use as a test fixture for commercial companies that are trying to get into the UNREP business and are building their own UNREP systems that will need to meet the same requirements as current Navy design.

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3. Nikishechkin, P. A. "Practical Aspects of Constructing a Specialized Control System for Compact Machines." IOP Science 2020, January 2025. https://iopscience.iop.org/article/10.1088/1757-899X/971/4/042085/pdf

KEYWORDS: Underway Replenishment (UNREP); Pier side Training; Pier side Testing; Maintenance; Ship-to-ship Cargo Transfer; Tensioned Highline

DON26BZ01-NV020 TITLE: Auto-Focus Detection Capability for SONAR Systems

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Integrated Sensing and Cyber

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an auto-focus signal processing capability to optimize detection of quiet contacts by arrays of hydrophones.

DESCRIPTION: Arrays of hydrophones are used to detect, classify, and localize contacts in the ocean environment. Finding a contact, especially a quiet contact, is extremely challenging due to the large volume of data that needs to be searched as well as the large number of other noise sources (e.g., shipping, fishing, whales, etc.) that generate clutter on the displays.

Array signal processing, also known as beamforming, steers many beams to spatially filter the noise environment and generate a 3-D data volume that is a function of time, frequency, and bearing (i.e., steered beam) that are processed to generate several detection surfaces.

Several parameters can be adjusted to optimize the detection of a signal on an array. One of these parameters is focus range. (Other parameters are more sensitive and will be provided to Phase II awardees). However, only a limited number of display surfaces are typically generated due to processing constraints, and this may not provide the best opportunity to detect all signals. Furthermore, the operators typically have a large workload and are only able to search for a limited number of the available display surfaces.

Automation approaches have been developed for decades to help reduce operator workload. However, a well-trained operator can still detect lower Signal to Noise Ratio (SNR) signals than the state-of-the-art automation. The main reason for this is if the automation detection threshold is adjusted to detect lower SNR signals, it will cause an increase in the number of false alerts that detracts from the search process. Another approach that is used to reduce the operator workload is ORing, which combines multiple Passive Narrow Band (PNB) displays by taking the maximum value at each time/frequency bin and then combines all contacts found on any of the displays onto a single display; however, it also takes the maximum of the noise bins. This results in ORing loss by increasing the noise floor and reducing the overall SNR.

As a result, automation has not yet solved the operator workload problem and operators are still required to conduct manual search on a limited number of detection surfaces. This leads to system losses that can at times be significant and offers an opportunity to mitigate those losses with a new processing paradigm.

The objective of this SBIR topic is to develop a signal processing approach that will auto-focus on the signal processing (much like a digital camera does) with respect to parameters such as focus range. There is currently nothing available commercially.

The easiest example to understand is range focusing. Let’s assume we are trying to track whales and there are several of them at different ranges. If we process a single far field (i.e., distant) focus range, then the close-range whales may barely be detected. Instead, if we process several focus ranges, let’s say 10, from close to far, there will be one focus range where each of the whales displays the clearest signal with the highest SNR. Over time, the whales will swim closer and farther, and the best detection range will change. The problem is that the operator doesn’t have time to look at the detection surfaces for all 10 focus ranges so instead we need to combine them into a single display that contains the higher SNR instance of each whale regardless of the range where they are.
Different whales will also have different broadband signatures and would be more detectable when averaging over different frequency bands. The optimal frequency band may also vary as the ambient noise environment (such as nearby shipping and weather conditions) changes. If the processing generates a large number of detections in multiple frequency bands, then a user will be able to find the most detectable instance of each whale over time.

Processing multiple focus ranges is relatively straightforward and is largely just brute force processing. The innovative part of this SBIR topic is the use of this larger data volume to build a combined display that contains the best representation of every available signal. This combined display would be the primary search space for the operators and would also be provided with other automation algorithms. One of the keys to success will be developing an alternative to standard ORing that takes the maximum value at each pixel across the beams being ORed. It is speculated that improvements are possible since the SNR of the signals will be well behaved across the ORing dimension. For example, if multiple focus ranges are combined, there will be one focus range where the signal is strongest, but the signal will gradually degrade as the difference between the focus range and the actual range increases. For pixels that contain noise instead of signal, it is expected that the levels will be more random and that this could be exploited to enhance the signal without increasing the background noise.

Overall, it is expected that this auto focus approach will allow system gains that are currently not being realized with the current signal processing and automation approach. This would significantly improve system performance by providing earlier detections and longer holding times of contact without increasing the operator workload or requiring a complete overhaul of the signal processing and automation framework. And although this does come at an increased computational cost, it would allow us to squeeze every dB out of the signal processing.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for a technical approach for implementing an auto -focus signal processing and automation capability that accomplishes the intent identified in the Description. Demonstrate this approach by using the focus range parameter as an example using an unclassified simulated dataset. Establish feasibility through analysis and modelling.

During the Phase I period of performance, the government team will provide the simulated dataset that was developed to stress test the various conditions. If the performer does not have experience with array signal processing, this dataset would be preprocessed display surfaces for different focus ranges. If the performer does have experience with array signal processing, then this dataset could be either preprocessed display surfaces or element level timeseries array data. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in a Phase II plan.

PHASE II: Develop and deliver a prototype auto-focus signal processing and automation capability using additional optimization parameters identified by the Government team. This will be implemented as a research code and tested against classified datasets provided by the Government to the Phase II awardee(s). Based on the results of the testing, this approach will be refined to improve the system's performance.

It is important to note that this is not intended to be a tracker development effort unless the awardee's solution requires it. If needed, the government will process the test data using an existing tracker solution and provide the track data to the awardee.
Performance and technical requirements to be evaluated include earlier detections and increased time holding of quiet contacts, improvements in the operator's ability to search the data space, and/ or improvements in operator workflow.

Deliver a prototype, software description document, a working copy of the development code, and test results from processing two or more classified datasets.
At the end of Phase II, the development code may be used by the government team for an independent evaluation using additional datasets not provided to the awardee to determine whether follow-on Phase III efforts are justified.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use to allow for further experimentation and refinement. Develop production level code that is containerized and assist with integration efforts to incorporate the SBIR-developed code into the Government's Processing Testbed (PTB) which allows development software to be tested on real-time or playback data. Successful integration and testing in PTB would lead to further integration into production software.
This technology does have significant dual-use applicability. The underlying concept is built upon array processing fundamentals that are applicable to SONAR, RADAR, communications, geophysical exploration, astrophysics, and biomedical imaging.

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2. Zhu, Jiahua (Editor). "Advanced Array Signal Processing for Target Imaging and Detection." Basel,Switzerland: MDPI, 2024.

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KEYWORDS: SONAR; Array Signal Processing; Surveillance Automation; Acoustic Detection; Acoustic Target Classification; Sonar Operator Workload

DON26BZ01-NV021 TITLE: Robocasting Ceramic Sensors

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum and Battlefield Information Dominance (Q-BID)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a low-cost, flexible manufacturing technique to produce large format ceramics for undersea sensor applications.

DESCRIPTION: Piezoelectric ceramic materials are essential materials to produce undersea sensors. Many existing undersea sensors rely on a dry press manufacturing process that produces the ceramic components used in many fielded sensors. Existing piezoelectric ceramic components are becoming increasingly difficult to source due to a shrinking supplier base and a desire by many private companies to stop manufacturing lead-based products. Additionally, these components have been largely unchanged since the 1960's with little to no performance enhancements to ships' critical systems.
The goal of this SBIR topic is to support the development of new agile manufacturing techniques to produce large format ceramics and that require less capital overhead and would be easier to stand up in new cottage businesses if the current supply base continues to degrade. The secondary goal is to improve the electrical and acoustic performance of these large format ceramic materials by utilizing textured ceramic technology.

Textured ceramic materials have an aligned microstructure that can exhibit enhanced properties compared to traditionally manufactured ceramics with randomly oriented gains. One documented benefit is an improved piezoelectric performance for sonar sensor applications (early prototypes have shown upwards of 12dB improvement in performance, enabling sensors to detect potential threats much farther out). Current manufacturing techniques to produce textured ceramics are costly, inefficient, and typically limited to smaller sensor geometries. There is currently no known commercial technology that solves these problems.

There is a need for the ability to produce textured ceramic materials in a larger format than is currently available through tape casting and existing additive manufacturing techniques. The process of robocasting or direct ink writing of a shear thinning ceramic paste shows great potential as a flexible manufacturing technique to produce ceramics for undersea sensors. The hardware requirements for the robocasting process are often affordable, relatively simplistic instruments that can be adapted to additively manufacture ceramics. There has been recent research demonstrating that extruding a ceramic paste through a high aspect ratio nozzle can align high aspect ratio particles within a material, allowing to produce textured piezoelectric ceramics through a robocasting process.

The primary focus of this SBIR topic would be to validate the feasibility to integrate a Navy piezoelectric ceramic with a robocasting or direct ink write slurry system. The system must demonstrate the ability to properly extrude a ceramic paste that will support the buildup of sequential layers and produce a prototype part. Key criteria for success will include the ability to consistently extrude a layer of ceramic paste, support proper adhesion between layers, and produce high percent solids loading of the paste; and the ability to sinter the materials to produce dense final parts.

The secondary focus will be to demonstrate the ability of the additive manufacturing hardware to properly align high aspect ratio platelets during the printing process. These platelets should be dispersed in the piezoelectric ceramic and aligned within each print layer. This technique should be flexible enough to produce prototype samples of varying sizes. Common geometries include cylinders with 1in outer diameter as well as rings that are greater than 4in in outer diameter.

Prototype parts of multiple geometries will need to be produced and undergo binder burn off and sintering. Sintered prototypes will need to have electrodes applied and the parts will have to undergo a poling process. Prototype parts will be evaluated by Naval Surface Warfare Center Crane Division for density, surface finish, particle/grain alignment, texture fraction as well as electrical and acoustic properties. Textured prototype parts will be electrically tested for resonance frequency, capacitance, dielectric constants, and loss factors to be compared to traditionally manufactured non-textured materials. The awardee will aim to create a prototype that exceeds a capacitance of 200pf while minimizing the loss tangent. The awardee will then revisit particle alignment and binder composition as needed to improve acoustic and electrical performance.

PHASE I: Develop a concept for a ceramic paste suitable for additive manufacturing that utilizes Navy piezoelectric ceramics and can align high aspect ratio ceramic platelets within the constraints listed in the Description. Feasibility may be demonstrated by analysis, modelling, and simulation, the fabrication and testing of initial test geometries , or some combination of all three. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver prototype hardware based on Phase I work. Demonstrate the ability to construct a prototype ceramic that meets the constraints listed in the Description. The prototype hardware will be delivered at the end of Phase II ready to be tested by the Government.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to Navy use. Scale/volume/speed of production will also be optimized in this phase. Finalized equipment and consumables needed to produce the parts will then be made available for Crane/Navy to purchase. This new technology will support Navy programs/platforms by providing advanced piezoelectric transducers with better performance and capability.

This added technology/capability will also assist in other projects that require advanced, textured ceramics including hypersonic radomes as well as various sensors in the commercial sector and the military. Potential commercial applications include medical imaging devices, civilian watercraft navigation and fishing devices, and infrastructure inspection equipment.

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KEYWORDS: Additive manufacturing; Robocasting; Direct Ink Writing; textured ceramics; shear alignment; piezoelectric

DON26BZ01-NV022 TITLE: Extremely Wide Band Digital Recording System for Artificial Intelligence/Machine Learning Development

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a small and dense data recorder that can store > = 8 Petabytes of information in < = 4 u of 19-inch rack space, will be scalable and flexible in nature, and will demonstrate the interfacing to > = two different interface protocols each supporting > 400 GB/sec data transfer rates for > = 30 seconds.

DESCRIPTION: In today's environment, emphasis is put on how Artificial Intelligence/Machine Learning (AI/ML) can solve most of the Department of War's (DOW) problems as long as the AI/ML algorithms are trained correctly. This training requires vast amounts of relevant data. Unlike commercial websites where the algorithm developers can have the public train them based on security selection images, the DOW does not have vast stores of relevant data sets much less a global community to train the algorithms. Unfortunately, very few to none of the fielded program of record (POR) systems have the ability to record (at the tactical edge) relevant data products in sufficient quantity to help algorithm developers.

This SBIR topic is intended to develop extremely deep sensor data recorders for implementation/fielding on tactical platforms for tactical sensors at the tactical edge. These recording devices must be able to be integrated easily into the platform's sensor suite and be able to record the relevant data products for use in future algorithm development and training.
These recorders must easily adapt to various networking infrastructures (e.g., InfiniBand, NVLINK, PCIe, and or Ethernet, etc.) and support the extreme streaming bandwidths for wideband (500Mhz and greater I/Q data) Radio Frequency (RF) digital data and high definition (4 K or greater) streaming video. These recording devices must be scalable in nature, at a minimum take up less than or equal to 4u of face plate volume in a 19-inch rack, and record greater than 8 petabytes of storage.
These devices must meet all NSA data at rest encryption requirements and be developed in a manner to easily acquire a volatility certification letter. References 7, 8, and 9 are provided for informational purposes, further information may be provided to Phase II awardee. These prototype devices will be installed on manned and unmanned platforms. With that in mind, they must be developed with remote and/or autonomous operations in mind. These prototype devices will deliver the hardware and the requisite software to perform recording, playback, librarying, and search functions for the data on the devices.

Key requirements:

- Less than or equal to 4u of 19-inch rack volume

- Must meet class B shipboard installation Environmental Qualification Testing (EQT)
- Greater than 8 petabytes of data storage
- Must meet data at rest security requirements
- Must meet non-volatility certification requirements
- Have networking architecture demonstrating ability to configure to multiple types of networks
- Have a minimum of two different networking options where each networking option can sustain > 400 GB/s data rate
- Compliance with shipboard installation environmental qualification requirements
- Ability to perform data at rest encryption and the ability to meet volatility requirements for system posture changes
- Ability to consume data from a defined sensor and parse/tag this data
- Ability to record and playback from both local and remote users

Conduct, at a minimum, two lab demonstrations at the developer's facility and one integration and demonstration at a government lab. (Note: The government lab will provide testing and validation of the capabilities and provide immediate feedback to the developer for further refinement of the prototype.) Work with the government lab to develop a shipboard installation and testing plan. If the Phase II Option is exercised, focus on getting the prototype system ready to be installed and tested at sea during a government-defined testing event.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop and provide a detailed schedule out through Phase II options, as well as a detailed technical description as to how they will achieve success. The initial deliverable of the Phase I award will be a kickoff meeting detailing how they will get to the final briefing.
The final briefing will show specifically to meet the following requirements:

- Less than or equal to 4u of 19inch rack volume
- Meeting class B shipboard installation Environmental Qualification Testing (EQT)
- Greater than 8 Petabytes of data storage
- Data at rest security requirements
- Non-Volatility certification requirements
- Networking architecture demonstrating ability to configure to multiple types of networks.
- Interface descriptions on how external systems will interface and operate the prototype device remotely and locally
- Examples of the user interfaces and the schema for formatting, recording, librarying, and playback
- Cost and schedule program management plan
- Phase I option will be showcasing software modules and fundamental breadboard designs and present the detailed plans for Phase II and Phase II option.

PHASE II: Hold a kickoff meeting with a detailed development plan including costing (recurring and non-recurring separated) development; and detailed security and testing plans
These plans will include detailed:

- technical plans
- security plans
- EQT plans
- lab testing plans (both at developers facility and at government labs) utilizing different types of networks.
- ship installation and at sea testing (Phase II Option, if exercised, will be integration and testing at sea)

After the kickoff meeting and with government concurrence of the plan, the awardee will focus on developing the solution meeting all the security, environmental qualifications, and performance requirements agreed to.
The system to be developed shall meet the following requirements:

- < = 4u of 19 inch rack space
- > = 8 Petabytes of storage
- Minimum of two different networking options where each networking option can sustain > 400 GB/s data rate
- The prototype system will show compliance with shipboard installation environmental qual requirements
- The prototype system shall show the ability to perform data at rest encryption and the ability to meet volatility requirements for system posture changes.
- The prototype system shall show the ability to consume data from a defined sensor and parse and tag this data.
- The prototype system shall demonstrate the ability to record and playback from both local and remote users

There will be at a minimum two lab demonstrations at the developers facility and one integration and demonstration at a government lab. The government lab will provide testing and validation of the capabilities and provide immediate feedback to the developer for further refinement of the prototype.

- The awardee will work with the government lab to develop a shipboard installation and testing plan.
- The Phase II option Option, if exercised, will focus on getting the prototype system ready to be installed and tested at sea during a government defined testing event.

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

PHASE III DUAL USE APPLICATIONS: The awardee will clearly and in detail describe how this capability will transition to a Navy program of record (POR). This plan will also describe how it will be used in the POR and the initial concept of what data products will be recorded.
Any commercial industry looking for low cost optical processing on extremely large data sets will benefit from this technology.

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KEYWORDS: Digital Recorders: Radar Interfaces; Combat Control Interfaces; Electro Optic data; Continuous Digital Intermediate Frequency; CDIF; Burst Digital Intermediate Frequency; BDIF

DON26BZ01-NV023 TITLE: Risk-Aware Regenerative AI-based Multimodal Visual-Tactical (ISRT) (Observant-AI) – Monitor, Understand, Alert, and Assist

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Integrated Sensing and Cyber;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop risk-aware artificial intelligence (AI)-based computing methods motivated by three naval challenge problems that enable insightful active cross-domain (Sea-Space-Air-Land-Cyber) situational awareness and AI-assisted course of action and countermeasures in real-time conditions, namely, “LIVE” machine self-teaching (i.e., Regenerative AI); contextual machine exploitation; contextual networking to gain insights from accessible all-source-intelligence (ASI) and multimodal sensors; and proactive AI-assisted targeteer and decision support to manned and unmanned assets. The Observant-AI is envisioned as a distributed system of mission-focused AI agents that self-organize and share insights via ad hoc networking. The agents autonomously form mission-oriented collaborative teams to process and fuse multidomain anomalous events and activities for real-time AI-generated visual-tactical understanding, monitoring, alerts, and related operational risks. It applies natural language explanations for human-AI interactions, course of action assistance, and reasoning about risky engagements. For example, submersible X is tracking you, change course to southwest, speed up…; Cargo-Ship Y is armed, Container Marking is…, Departing Port XYZ; 20 UAVs are shadowing, armed, turn around go south; Littoral Zone X, Torpedo-Mines, Bottom-Mines, Deep Fencing, Actively Guarded, Speed Boats, Risk-High Navigation, Need Minesweeper, Check with CENTCOM; etc.

DESCRIPTION: Problem scope and capability concerns. First, over the past three decades, advancements in AI and machine learning (ML) for applications in hybrid networked teaming of manned and unmanned systems and sensors have unlocked new possibilities across a range of naval operations for novel missions. On the other hand, the defensive and offensive effectiveness of these technologies against near-peer adversaries remains a significant challenge.

Second, current Naval ISRT operations follow rigorous protocols supported by wide-ranging wargaming scenarios to plan tactics, techniques, and procedures (TTPs) with contingencies as operations unfold. TTPs focus on various situational details, such as adversary strength, leadership temperament, past and present operational performance, logistics, and exploitation opportunities for friendly cross-domain actions and effects. These plans are vital to be followed. However, they are extremely vulnerable to human biases and omissions that undermine the assessment of evidence, statistical analysis, and the understanding of cause and effect.

Third, generative AI methods are being integrated into the operational planning process and can enrich the development of a range of ISRT strategies. However, it must start all over again if “Unknown-

Unknown” events crash the ongoing TTPs. Also, generative AI needs high-quality training datasets; otherwise, it is prone to inaccuracies and biases.

This SBIR topic will develop Observant-AI agents as a class of regenerative AI that learn in real time, enables active visual and tactical monitoring of anomalous activities, and trigger I&W alerts in naval operations. The envisioned Observant-AI agents proactively enforce the fail-safe execution of approved ISRT operational plans. They exploit unexpected events in real-time by leveraging insights from all-source intelligence (ASI) and remote sensors (i.e., space assets). They generate and execute novel all-domain ISRT TTPs plans consistent with the approved plans to counter evolving adversarial intents and undesired events, LIVE. In other words, the Observant-AI agents enable fault-tolerant mission-focused reconfiguration by analyzing existing assets’ capabilities through novel tactical teaming arrangements from approved deployable capabilities (sensors, manned and unmanned weapon platforms, intelligence data sources, etc.). Observant-AI will automatically alert the chain of command at all levels with emerging or mission-altering observables that may interfere with operational objectives.
The goal of the effort is to perform a combination of offline and online predictive engagement modeling to plan for trusted AI-enabled TTPs that will strategically adjust plans in real time to adapt to emerging events and conditions. It will use Monte Carlo simulation to model the probability of various outcomes under countless AI-generated Red vs. Blue engagement (action-reaction) scenarios for offline TTP planning and mission success assessment. Regenerative AI will ensure Observant-AI can quickly adapt the blue’s creative ISRT strategies against near-peer adversaries (Red). Regenerative AI offers unique capabilities such as learning from sparse data and predicting complex interactions. It will achieve this objective by testing novel all-domain penetration strategies, including offensive cyber and information operations to find advantageous strategies, then running them against many emerging scenarios, identifying the vulnerability points and engagement risks, and modifying strategies to sustain their performance with acceptable risks.

Critical AI technology components and developments are as follows:

1. Contextual modeling: relational modeling, graph-based modeling, spatial modeling, logic-based modeling, uncertainty modeling, ontology-based modeling, hybrid context modeling.
2. Multidomain multimodal all-source intelligence data and signals: multi-level secure connectivity and access.
3. Data learning: decision tree classifier, multilayer perception classifier, collaborative filtering, frequent pattern mining, K-means, deep learning.
4. Data quality, data interoperability, data generation.
5. Data storage: signal-oriented database, graph-based database, associative database, text-oriented database.
6. Spatiotemporal synchronization methods for multimodal data across decentralized architectures.
7. Multimodal contextual signal processing and fusion.
8. Cross-domain contextual collaborative learning, inference, and recognition.
9. Contextual collaboration, adaptation, and teaming via ad-hoc networking.
10. Contextual reasoning, risk assessment, and risk reduction.
11. Contextual query, question-answering (Q&A), and natural language processing.
12. Contextual priority-based task management and balancing competing multifaceted ISRT operational objectives such as persistence, endurance, opportunistic collections, and targeting.
13. AI-risk escalation control methods that will not erode decisions across the integrated chain-of-command.
14. AI-assisted targeteer maneuvers and engagements.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Determine the technical feasibility of designing and developing the Observant-AI technology described in the Description section. Draw key distinctions for the proposed design approach compared to the current state-of-the-art naval ISRT information exploitation systems. Ensure that the proposed design reveals a clear set of steps that naval ISRT platforms and joint services can capitalize on now for a transformative AI-based ISRT operation with dominant applications within the next five years. Motivate the design with three compelling challenge problems supported by relevant datasets. Consider challenge problems corresponding to cross-domain littoral operations and navigational risks countering anti-access/denied-access enforcement scenarios. (Note: The scenarios need to consider seaside terrain, weather, the maritime order-of-battle, the movement; engagement rules and doctrine; logistics and supply demands, etc. Hostile enforcements may include hypersonic missiles, ballistic missiles attacks from land or undersea, sea-skimming cruise missile attacks, anti-submarine track and trail, torpedo attacks, anti-space jamming, littoral mining, swarming weapons, and decoy and deception tactics.) Perform testing and demonstrations may use a mix of OSINT datasets, synthetic datasets from DON, MCML, AIS maritime traffic, commercial satellite imagery, or similar sources. Conduct end-to-end Observant-AI system performance assessment, including:

1. Cross-domain contextual collaborative learning, inference, and recognition.
2. Multi-agent cross-domain contextual collaborative teaming and adaptation via ad hoc networking.
3. Cause and effect sensitivity analysis on contextual understanding.
4. Confidence rate on AI-generated proactive TTP enhancements on engagement plans, options, and risk reduction associated with the ups and downs of encounters.
5. Confidence rate on AI-risk escalation controls enabling trust decisions across the integrated chain-of-command.
6. Efficiency gains in human responsiveness through timely decision-making, chain-of-actions, and resources spent.

Performance criteria must include sensitivity (true-positive rate), specificity (true-negative rate), precision (positive predictive value), miss rate (false negative rate), false discovery rate, and false omission rate. Performance metrics (considering outcomes will depend on data quality):

1. Analytic Completeness: not just identifying and stopping hostile acts, but also how it occurred by synthesizing the entire chain of events what would have happened had it not been stopped < 95%
2. Uniqueness: Signature attributes definable and retrievable (who, what, why, where, when) < 95%
3. Validity: Supporting evidence < 95%
4. Consistency: Periodic signature updates of attributes from various sources that reinforce linkages < 95%
5. Accuracy: Overcoming noisy data < 95%
6. Accuracy metrics for ingesting and classifying multimodal data: structured data mining and interpretation - accuracy of 95% over 98% captured content; unstructured data mining and interpretation – accuracy of 90% over 95% captured content.

Deliverables include end-to-end initial prototype technology, T&E, demonstration, a plan for Phase II, and a final report.

PHASE II: Conduct proof-of-concept and prototype development incorporating the recommended candidate technology from Phase I. Demonstrate the operational effectiveness based on the following criteria: (a) prioritized sensor alerts, (b) prioritized threat escalation, (c) measured severity of events, and (d) measured analytic completeness. Test and demonstrate the improved capability based on the performance metrics detailed for Phase I with the following requirements: Analytic Completeness < 98%, Uniqueness < 98%, Validity < 98%, Consistency < 98%, and Accuracy < 98%. Provide the following deliverables: analytics, signal processing tools, models, prototypes, T&E and demonstration results, interface requirements, and final report. Final report will include a detailed design of the system and a plan for transition to the program of record in Phase III.
It is probable that the work under this effort will be classified under Phase II (see the Description section for details).

PHASE III DUAL USE APPLICATIONS: Advance these capabilities to TRL-7 and integrate the technology into the Maritime Tactical Command and Control POR, Marine Air-Ground Task Force Command and Control, or ISR processing platforms at the Marine Corps Information Operations Center. Once conceptually and technically validated, demonstrate dual-use applications of this technology in civilian law enforcement and security services.

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KEYWORDS: Risk-Aware, Regenerative, Artificial Intelligence, Machine Learning, Contextual, Multimodal, Cross-Domain, Visual-Tactical ISRT

DON26BZ01-NV024 TITLE: 3D-Heterogeneously Integrated Photonic (HIP) Imaging Sensor

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum and Battlefield Information Dominance (Q-BID)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Integrated Sensing and Cyber;Microelectronics

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Design, fabricate, and verify the performance of a 3D-heterogeneously integrated photonic (HIP) imaging sensor consisting of a detector array, read-out integrated circuit (ROIC), and photonic transmitter.

DESCRIPTION: Emerging military electro-optical and infrared (EO/IR) sensors enable high resolution through small pixels, wide field-of-view through large arrays, and high frame rate through high sensitivity and low latency. For the most advanced focal plane array (FPA) sensors, the data bandwidth dictated by the high pixel count and bit rate is reaching the limits of conventional copper wire interconnects. Datalinks using optical interconnects offer a unique and commercially mature solution that can obviate the copper bandwidth limitation, while offering additional advantages of lower power, lower cost, and on-chip integration. For large arrays, the high data rate can be further managed by tiling synchronized, independently addressed smaller arrays, which divides the serialized data stream into multiple parallel paths, while also improving foundry yield. However, existing FPA layouts place read-out electronics, including column analog-to-digital converters, serializers, and bias sources, along the periphery of the imaging chip. To enable tiling with sub-pixel gaps between tiles, the peripheral electronics must be moved below the detector layer. A photonic layer could also be added to create a 3D vertically integrated FPA stack, enabling large arrays to operate at exceptionally high data rates. 3D heterogeneous integration of the FPA stack can be accomplished using bump-bonding, direct-bond integration, or other techniques, but ultra-low capacitance connections are required for low-noise operation to permit the short photon integration times inherent to high-frame-rate imaging. As militarily relevant EO-IR imagers often operate at cold temperatures of 100K+/-20K, the 3D HIP FPA transmitter must also perform well under cryogenic conditions. When tiled in large arrays of small pixels, the 3D-HIP imaging sensor will provide concurrent wide-FOV, high-resolution, and ultra-high frame rate, circumventing conventional imaging sensor paradigms. Frame rate should use 1 KHz as the goal is to address high data rate challenges, however, since the pixel size and format are flexible for this effort, this is not a hard requirement. This SBIR topic’s intent is the development and maturation of 3D heterogeneous integration (3DHI) of electrical and optical/photonic layers that achieves high bandwidth interconnection.

PHASE I: Perform a trade study of design variables. Create a concept for a 3D-HIP imaging sensor design. All design features must be supported by quantitative modelling, simulations, or general trade analysis. The design should be adaptable to all EO/IR spectral bands, formats, and pixel sizes. Address detector, ROIC, and photonic layer designs and interconnections. Within the photonic layer, the laser type and location (inside vs outside the cold space), the optical modulation scheme, optical and electronic bandwidth and compatibility, and energy efficiency must be addressed. The proposed design must include a detailed noise analysis, including component capacitance projections and variances, along with other noise sources. A full link analysis must be provided, including both energy efficiency and data bandwidth. Prepare a Phase II plan that includes the fabrication, integration, and testing strategy.

PHASE II: Fabricate a prototype 3D-HIP imaging sensor based on the Phase I design. It is expected, but not required, that detector, electronic, and photonic layers will be fabricated and integrated at separate foundries, potentially using different foundry nodes. While only a 3D-HIP transmitter is required, the output must be received and processed into imagery. Fabrication of a symmetrically designed transmitter and receiver pair is encouraged. Moreover, the transmitter chip should be compatible with formation of a tiled array. The transmitter-to-receiver connection should employ optical fiber of nominally 1 meter length. The transceiver performance will be thoroughly documented in the Phase II final report.

PHASE III DUAL USE APPLICATIONS: Support the transition to Navy use. High-resolution, wide-FOV, high-speed imagers will find wide use in many commercial and industrial applications such as computer vision, autonomous navigation, security and industrial facility surveillance monitoring.

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KEYWORDS: Sensors, read-out integrated circuit, ROIC, photonics, tiling, chiplet, heterogeneous integration

DON26BZ01-NV025 TITLE: Leveraging Machine Learning for Advanced Passive Sonar Tracking

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Develop advanced automation to detect, locate, classify, and correlate contacts across multiple sonar sensors and multiple display surfaces.

DESCRIPTION: Passive sonar systems employ a standardized signal processing pipeline to track, classify, and localize underwater contacts. This automated process, often referred to as "automation," begins after front-end processing generates visual displays for sonar operator analysis and automated processing. Existing algorithms that track energy signatures on these displays typically include Kalman filters, probabilistic multi-hypothesis trackers, and particle filters. However, these traditional tracking methods, as implemented in current operational systems, often fail to fully leverage the potential of modern machine learning techniques. This SBIR topic seeks to incorporate cutting-edge machine learning technologies into passive sonar processing to significantly improve tracking, classification, fusion, and localization of current anti-submarine warfare passive sonar systems. The specific threshold and goals for performance improvement are as indicated in the following table.

Targeted Improvement	**Metric**	**Threshold**	**Objective**
Tracking	Increase Hold Time Ratio	10%	20%
Tracking	Reduce Time to Detect	10&	20%
Classification	Increase Probability of Correct Classification	10%	15%
Classification	Reduce Probability of False Alerts	10%	15%
Track Fusion	Increase Probability of Correct Association	15%	20%
Localization	Reduce Area of Uncertainty	15%	20%

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and

Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop algorithms that improve sonar automation for tracking, localization, classification, and multi-sensor fusion. The approach will reduce the burden of operators to maintain and promote tracks and be supported by theory.

PHASE II: Implement the proposed approach in a simulated environment (e.g., MATLAB) and demonstrate stated performance using government-provided data from a Navy sonar system. Important metrics will be, but not limited to, probability of correct association, hold time ratio, time to track, and probability of correct classification.
It is probable that the work under this effort will be classified under Phase II (see the Description section for details).

PHASE III DUAL USE APPLICATIONS: Support transition to Navy use.
This effort is anticipated to have dual-use applications in commercial surveillance systems with towed arrays or ISR uncrewed aerial vehicles. The performer shall identify possible non-Navy applications for their technology.

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KEYWORDS: Multi-sensor data fusion, operator workload reduction, advanced automation

DON26BZ01-NV026 TITLE: Passive-Active Combo System for Unmanned Characterization of Littoral Environments

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Integrated Sensing and Cyber;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Develop a lightweight, integrated passive imaging and LiDAR system, deployable on an unmanned aerial platform for target detection, feature characterization, and bathymetry retrieval in littoral environments. The system should be light enough for deployment from a Group 2 (max. gross takeoff weight: 21 – 55 lbs.) unmanned aerial vehicle (UAV).

DESCRIPTION: Achieving and maintaining maritime dominance in the coastal battlespace requires the Navy and Marine Corps to have superior situational awareness. A key component of this dominance is the ability to rapidly characterize shallow, nearshore environments [Ref 1] in real-time using agile, unmanned aerial platforms. To this end, a system is needed that provides (1) bathymetry retrieval; (2) detection and discrimination of underwater targets; and (3) characterization of the land-ocean interface (i.e., surface type, topography, and shallow-water bathymetry).

Current UAV-based shallow water and littoral zone characterization relies on either (1) passive imagers alone or (2) bathymetric LiDAR systems deployed on larger airborne platforms or in separate missions. While passive imagers effectively characterize surface features, bathymetric LiDAR is necessary for bathymetry retrieval and underwater target detection. Simultaneous deployment of both a high-performance passive imager and a bathymetric LiDAR on a Group 2 UAV is challenging due to payload weight limitations. Systems that attempt this combination often compromise sensor performance or utilize topographic LiDAR [Ref 2], which uses near-infrared wavelengths unsuitable for bathymetry retrieval. One potential solution is a system that can accommodate a passive imager and a dual-wavelength LiDAR that operates at two wavelengths – one where light penetrates deep into the water column and another with very little to no penetration into the water column – which can be used to effectively discriminate between LiDAR returns from the water surface and the substrate. The heaviest part of a topo-bathy LiDAR is the scanning component. A non-scanning, nadir-viewing LiDAR system would be light enough for simultaneous deployment on a Group 2 UAV. The passive imager could be hyperspectral or multispectral but should provide sufficient spectral information to spectrally characterize the water column and the land-ocean interface and discriminate underwater objects and features. Single nadir lines of LiDAR returns from adjacent flight lines could be mapped onto corresponding spatially explicit imaging data to build three-dimensional profiles of bathymetry. Coincidental LiDAR and imaging data could also be used to train a regression-based machine learning (ML) model to estimate depths from the imaging data, similar to previous empirical approaches [Ref 3].

The system should provide rapid onboard processing of passive spectral and LiDAR data and real-time downlink of preliminary output to a ground station. The output should include a true-color composite of the target area, a topo-bathy map, a target detection map (showing locations of targets of interest, which could be new objects or objects with known properties pre-programmed into the system), and a terrain characterization map (showing information on the terrain type, concentration of optically significant constituents in the water column, and bottom type). Performers may use simple or sophistical techniques to retrieve information from spectral imaging data, such as simple band-ratio algorithms, spectral inversion based on radiative transfer modeling, spectral derivatives, or ML techniques. The system should provide the above information for coastal waters up to 20 meters depth in moderately turbid waters (diffuse attenuation coefficient at 490 nm, Kd(490) ˜ 2-4 m-1). Note: SBIR funds may be used to purchase a Group 2 UAV to serve as a platform for the imager + LiDAR combo system.

PHASE I: Develop a preliminary observing system simulation experiment to simulate optical and spectral models for the combined passive imaging and LiDAR system. Perform sensitivity analysis of system performance for a range of design configurations under varying conditions of turbidity and optical complexity of shallow water environments. Conduct a feasibility study for the proposed system. Provide a report of the feasibility study and an initial layout of the proposed system design.

PHASE II: Develop the prototype based on optimal design configurations determined from the Phase I feasibility study. Finalize the approach for exploiting spectral information from the passive imager and combining spectral information with LiDAR returns for retrieval of three-dimensional bathymetry and characterization of the water column and the nearshore terrain. Limited demonstrations of the prototype are also required.

PHASE III DUAL USE APPLICATIONS: Upon successful demonstration of the prototype in Phase II, the system shall be flight-tested, developed into a commercial product against existing requirements of the Navy's Airborne Littoral Mine Detection System (ALMDS) and the Marine Corps' Standoff Explosive Detection System for operational coastal characterization and mine detection for transition consideration.
Blue-green LiDAR serves environmental monitoring, underwater mapping, and marine ecology purposes. With effective and specific processing, data acquired from this technology can be tailored for either commercial or military applications.

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KEYWORDS: Passive + active imaging system; topo-bathy LiDAR; mine detection; coastal characterization; unmanned aerial systems; nearshore bathymetry

DON26BZ01-NV027 TITLE: Automated Ice Detection and Polar Navigation Tool (PolarNav)

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Integrated Sensing and Cyber;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a prototype for a system that integrates information on sea ice conditions from a diverse set of sources, including shipboard instruments, airborne and spaceborne sensors, and sea ice model output, to yield optimized route options as a planning aid for navigation through ice-infested waters in polar regions.

DESCRIPTION: Recent trends of warming in the Arctic have led to a steady decrease in the extent of multi-year sea ice, a corresponding increase in seasonal sea ice, and an overall lengthening of the navigable season [Refs 1, 2], thereby making the Arctic increasingly open to maritime traffic. Vessels operating in and near sea ice must make navigation decisions that balance the capabilities of the ship with the objectives of their voyage. Such route planning is complicated by the dynamic nature of sea ice, as it is subject to movements caused by a number of factors such as the Beaufort Gyre, transpolar drift, and weather events, which are even more pronounced on the thinner, seasonal ice. A system capable of aiding navigation teams in route planning based on ice observations and forecasts over time scales on the order of hours to days is essential for safe navigation through polar regions.
Currently, ice navigation relies heavily on manual processes. A majority of route planning information comes from satellite imagery, either optical or synthetic aperture radar (SAR), or from forecast information from entities like the U.S. National Ice Center. Due to dynamic weather conditions and rapid movement, the operational value of overhead imagery is sometimes temporally limited. These longer-range data sources are augmented by shipboard systems, such as onboard radar systems for icebergs, in-situ ice floe, and pack ice detection, which typically have detection ranges on the order of a few tens of kilometers. These close-range systems help inform tactical navigation decisions and near-term route planning.

Key aspects of ice analysis, whether conducted onboard or remotely, are ice edge definition, identification of ice types (e.g., seasonal ice, multi-year ice) and concentration, and detection of ice features such as ridges and icebergs. This analysis is then presented to the navigation team and command who assess the current and planned route and make course adjustments as necessary. Current ice forecasts do not always adequately account for projected ice movement over the next 12-96 hours, which is crucial for effective route planning. Moreover, the analysis and route planning are often separate functions, each conducted by distinct teams based on their own personal experience and knowledge. This separation can lead to suboptimal decisions and increased risk.

The goal of this SBIR topic is to develop a prototype tool that helps ships make safe navigation decisions in the Arctic. The tool should leverage established ice prediction models and incorporate other available sources to assimilate models and improve forecasts. These additional sources may include:

- Onboard sensors: Radar, thermal cameras (forward-looking infrared), and microwave sensors on the ship.
- Aircraft sensors: Sensors on airplanes and unmanned aerial systems (if available).
- Satellites: Optical and SAR data, dynamically updated with every new overpass.
- Iceberg records: Historical data on where icebergs have been seen/located (e.g., from the U.S. Coast Guard's International Ice Patrol).

The envisioned product is a geographic-information-system-based tool that uses artificial intelligence, first-principles algorithms, and automated data processing schemes to combine information from the above sources, update model-based predictions, provide 12–96-hour sea ice forecasts, and suggest potential navigation routes. Route options should consider vessel specifications, such as ice resistance characteristics and fuel consumption rate, and provide options for fastest route to destination, shortest route to destination, route with minimal wear/tear on vessel and crew, and maximum safe speed based on ship hull type/construction. Ultimate route decisions should be left to the vessel's navigation team.

PHASE I: Draft a conceptual framework for dynamic route planning based on sea ice characterization and forecasts from data fused and integrated from disparate sources. Define and develop in detail the concept and methodologies for extracting and combining data from diverse sources to provide nowcasts and forecasts of sea ice conditions and route planning options at tactically relevant spatial and temporal scales. Prepare a report containing preliminary results of retrieving sea ice characteristics using fused multi-modal satellite imagery, a framework for improving predictions through assimilation of data from diverse sources, and a framework for dynamic route planning which will be the basis for the proposed tool. If the Phase I Option is exercised, carry out a simple demonstration using multi-temporal and sequential datasets from multiple satellites and/or in situ measurements and modeled sea ice predictions for a specific region to test approaches for improving predictions of sea ice distribution and movement and use the combined information for route planning in hindcast and forecast modes.

PHASE II: Develop a prototype data analysis and route planning software tool that can be tested operationally on a vessel and is in the form of a standalone system with a display interface showing the latest satellite imagery of the ocean in the vicinity of the vessel, akin to the display on a Global Positioning System (GPS) based automobile navigation system. This prototype should be able to connect to data streams from instruments onboard the vessel, near-real-time satellite data that could be downloaded through the vessel's onboard communication system (e.g., satellite communications), and sea ice model output; produces nowcasts and 12-96-hour forecasts of sea ice conditions; and provides multiple route options for navigation, optimized for the fastest route, shortest route, the most fuel-efficient route, or the route with the least ice encounter.

PHASE III DUAL USE APPLICATIONS: Further develop the prototype into a commercial tool for integration onto a U.S. Coast Guard icebreaker or an ice-hardened Navy vessel. The tool, operating onboard the vessel in a place of the navigation team and command's choosing, shall provide real-time updates of sea ice conditions in the vicinity of the vessel and route options that the vessel navigation and command team can use to make informed decisions for sailing through ice-infested waters. The tool will also find its use in commercial industries such as shipping, fishing, and tourism in the polar regions.

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KEYWORDS: Polar navigation; artificial intelligence/machine learning; AI/ML; sea ice forecast; route planning; satellite imagery; data fusion; Arctic; Antarctic; ice identification; ice classification; ice

prediction; ice analyst; Meteorology and Oceanography; METOC; remote sensing; modeling; shipboard sensors; human-machine interface; big data

DON26BZ01-NV028 TITLE: Overlay/Bond Coatings that Resist Hot Corrosion in Navy Gas Turbines

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop overlay or bond coatings and a coating model that enables longer service and prediction of corrosion, oxidation and overall degradation when exposed to marine Naval environments as a function of corrosivity, stress, and various temperature combinations via integrated computational material engineering (ICME), which will foster creation of new coatings resistant to these degradation modes.

DESCRIPTION: Marine gas turbine engines serve as primary and auxiliary power sources for several current classes of ships in the U.S. Navy. It is desirable for marine gas turbine engines to have a mean time between removals of 20,000 hours. While some engines have approached this goal, others have fallen significantly short. The main reason for this shortfall is various forms of hot corrosion (Type I and Type II) damage in the hot section turbine hardware due to intrusion of salts from the marine air and/or from sulfur in the gas turbine combustion fuels.
The synergistic effect of stress- and deposit-induced high temperature corrosion can lead to other corrosion mechanisms. Corrosion fatigue as well as fatigue often initiates at stress risers. Metallurgical examination of several failed marine gas turbine blades that had operated between 5,000 and 10,000 hours was performed and compared to “unfailed” blades with 18,000 operating hours from a similar marine engine. Deposition occurring at sites under the platform of unfailed turbine blades revealed pitting at those sites.

Further examination revealed poor coating quality (i.e., high porosity and variable thickness) under the platform of first stage turbine blades that allowed salts to permeate through the coating to the alloy surface and initiate hot corrosion. Further coating examination under the platform showed highly variable coating thicknesses (0-40 µm) in the curved area of transition between the under platform and the blade stem. In a few cases, coatings were non-existent on the “unfailed” blades. The Cobalt Chromium Aluminum Yttrium (CoCrAlY) coating, when present, usually was porous or the available coating under the platform was highly contaminated due to lack of adequate spray deposition in these non-line-of-sight areas. CoCrAlY coating thicknesses at other sites along the blade stem were 35 µm to 105 µm (1.4 to 4.1 mils) and devoid of porosity. The corrosion that was observed under the platform in all cases was caused by Type II, low-temperature hot corrosion, which occurs in the temperature range of 649°-732°C (1,200°-1,350°F). Corrosion penetrated the porous coating and caused further undercutting of the coating along the coating/alloy substrate interface, Type II hot corrosion caused pitting at these locations under the platform, which caused stress risers where corrosion fatigue cracks initiated. These pits advanced through the blade stems to varying degrees.

The synergistic effect of stress- and deposit-induced high temperature corrosion leads to the premature failure of aero turbine blades reportedly due to stress corrosion cracking. The lower shank of aero gas turbine blades, which operates below 600°C is susceptible to this mode of failure. Two important factors that lead to stress corrosion cracking of single crystal nickel-based superalloys are the type of deposits that form on components (these include alkali chlorides and sulfates which are introduced through the environment) and the concentration of SO_x in the environment. Therefore, it is important to understand the synergistic role of deposits and sulfur containing gases on the stress corrosion cracking susceptibility of single crystal nickel-based superalloys below 600°C.

PHASE I: Demonstrate an understanding of what differences and influences exist between aviation and marine propulsion. Determine the mechanism for the observed corrosion at 500°-550°C. if stress corrosion cracking (SCC) is the prevalent corrosion mechanism, determine the interplay with NaCl, Na2SO4, SOx, and stress. For a given concentration of the chemical compounds, determine at what stress initiates SCC. Initiate correlations that should begin to formulate the ICME model framework to create a coating that would avoid reactions leading to SCC. (Note: For shipboard operations this would be either an overlay or diffusion coatings. For aero applications, this would lead to creation of a bond coat that would also promote long thermal barrier coating (TBC) life (goal: > 5K hours) and assist in maximizing corrosion and oxidation resistance by changes in coating chemistry and structure while not impacting fatigue, SCC, or substrate strength of the substrate alloys. It is suggested that the starting TBC be yttria-stabilized zirconia.) Lastly, perform a short-term (~200 hours) high temperature test to validate the feasibility of the ICME model.

PHASE II: The ICME framework shall be further expanded to include compatibility of the TBC to different bond coats as well as further development, modification, and maturation of the ICME model. Collaboration with coating and engine gas turbine original equipment manufacturers (OEMs) is encouraged for advice and direction for further developments of the ICME models and strategies. Correlate into the ICME-derived model the interaction of chromium and aluminum content in a coating that leads to the formation of chromia or alumina scales. Coatings on several alloys shall be tested to determine coating compatibility and assess the impact of coatings on alloy substrate properties in a burner-rig or similar test environment that includes salt ingestion. Coatings shall be applied onto alloy substrates by at least one recognized commercial coating process (line-of-sight and/or non-line-of-sight). The expected deliverables will be: (1) optimized coating corrosion resistance to SCC for a given set of alloys and (2) an ICME-derived model that would predict and assist in the development of future overlay or bond coats to minimize SCC in gas turbine that are compatible with multiple alloy substrates.

PHASE III DUAL USE APPLICATIONS: The ICME model will be further developed and matured through the expansion of bond coat/overlay coat chemistry and structure with the selected strategies to mitigate salt interaction that could lead to SCC. TBCs are permeable so the bond coat must form an impermeable barrier to avoid salt interaction with the alloy substrate that would tend to cause SCC. Engage with a gas turbine engine OEM to have an appropriate bond coat-TBC system applied on select static and/or rotating engine components of a current Navy engine and testing in cycling temperature test. The expected deliverables will be: (1) a TBC(s) compatible to corrosion and hot corrosion-resistant bond coat substrates, (2) TBC(s) resistant to SCC in the marine environment, and (3) an ICME-derived model that would predict and assist in the development of future TBC systems (i.e., alloy, bond coat, TBC, TBC strategy to minimize SCC with marine aero engine operational environment). Engage with a marine engine OEM to further develop the TBC technology for incorporation into current and future Navy ship engines.
Development of long-lived TBC systems able to withstand hot corrosion and subsequent SCC at temperatures below 600°C for U.S. Navy applications will also enable more efficient service for commercial applications that employ industrial gas turbines. Marine gas turbine engines are industrial gas turbines that are intended for Naval use. Successful development of better coatings for the current alloys, capable of extended service in the highly corrosive Naval operating environment, should enable subsequent use in commercial applications such as cargo ships, cruise ships, ferries, and tankers if the business case justifies the results.

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KEYWORDS: Hot Corrosion, Stress Corrosion Cracking, Environmental-Induced Cracking, Corrosion Fatigue, Gas Turbines, Superalloys

DON26BZ01-NV029 TITLE: Low Cost Malleable Metastructure Adherents for Maritime Environments

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Scaled Directed Energy (SCADE)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Microelectronics;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a material with the ability to rapidly and cost effectively produce metastructures or frequency selective surfaces which can be adhered to naval assets or similar systems (e.g., apertures, super-structures substructures, deployable, etc.).

DESCRIPTION: Several industries and Department of War (DOW) systems rely on Frequency Selective Surfaces (FSS), metastructures, or comparable materials to protect critical assets, including communications, radar, and Electromagnetic Warfare (EW) systems. Similar materials are also used as protective coatings for Electro-Optical/Infrared (EO/IR) systems—particularly in airborne and maritime applications—where they are consistently challenged by harsh maritime environments. These coatings, covers, and materials are susceptible to degradation from salt, ultraviolet (UV) radiation, and water intrusion due to their attachment to substructures, structures, or apertures.

Furthermore, the manufacturing and application of these materials are often considered expensive, time-consuming, and technically demanding due to platform-specific requirements. Recent constraints within the industrial base—such as the reduced availability of certain materials like CFC resins and polymers—have further exacerbated production challenges. These limitations have driven up costs, which have not benefited from economies of scale or broader adoption.

This SBIR topic seeks to develop alternative solutions that offer frequency selectivity, moldability (to conform to existing superstructures, substructures, or complex geometries), and resilience to maritime environments. In theory, such advancements would enable optimal dynamic performance across RF, microwave, or EO/IR domains, while maintaining durability in challenging conditions.

FSS remains the incumbent solution of choice, given its broadband frequency response, manufacturability, and superior durability in maritime conditions—advantages not matched by commercially available polymer-based fiberglass radomes, which typically lack frequency selectivity or the directive enhancements required by DOW systems. The reduction in availability and manufacturability of certain composites—due to regulatory restrictions or hazardous byproducts—has created an urgent need to pursue viable alternatives. Operating apertures across multiple frequency octaves remains a significant challenge for manufacturers and original equipment manufacturers (OEMs). Addressing the outlined challenges while achieving required performance objectives will likely demand innovation across multiple technical disciplines, including:

- Frequency Response – such as L, S, C, X and Ku Band and/or EOIR: Optical, midwave, longwave, others
- Advanced high-performance materials (ceramics, polymers or superalloys)
- Novel manufacturing or machining techniques
- Advanced 3 D optimized material additive manufacturing
- 3D optimized structures, magnetics or similar (inductor/capacitive/parasitic imbedded circuits)
- Highly resilient coatings, or new coating application techniques to existing materials
- Highly flexible embedded thin film materials

While existing materials with modifications will be considered, alternative solutions are also welcomed. However, the potential impact of these alternative designs—relative to existing materials or coatings—will be a factor during the selection process. Proposers should clearly identify any necessary mitigation considerations (e.g., storage, handling, disposal, etc.) required to support a credible path to qualification and approval for shipboard or airborne use.

The primary objective of this SBIR effort is to develop a material capable of broadband performance—defined here as the ability to provide frequency response across multiple octaves compared to existing materials. However, the proposed material must also be operationally viable and capable of meeting several critical performance objectives. Specifically, the solution should:

1. demonstrate through-performance (S21) in a near-field environment across multiple frequency octaves.
2. operate effectively across multiple bands of the EO/IR spectrum.
3. adhere to materials with sharp angles and varied geometries.
4. be capable of long-term storage without degradation after manufacturing or adherence to a structure.
5. withstand at least five years in a maritime environment without significant performance degradation (defined as <0.5 dB variance).
6. be rapidly applied to a surface with minimal preparation, achieving adherence in less than 24 hours.
7. demonstrate a reduction in abatement of signal return in multiple bands within the microwave and or the EO/IR energy regime radio frequency/midwave (RF/MW).
8. demonstrate that at scale the production cost can be lower than production of existing materials.

Acceptable solutions must also align with intended deployment scenarios, including shipboard/surface, Unmanned Aerial Systems (UAS), and land-based applications. For demonstration purposes, a commercial broadband antenna or a commercially available EO/IR camera may serve as the interface to evaluate proposed materials as radomes, covers, or adapters under defined boundary conditions. Demonstrations must show functional performance across at least two frequency bands—within the L-band to Ku-band range (e.g., S-band and C-band).

PHASE I:
1. Material Concept Evaluation
Investigate and identify novel materials or coatings capable of providing broadband frequency selectivity across RF, microwave, and EO/IR domains, with an emphasis on alternatives to restricted or environmentally hazardous substances (e.g., CFC resins, specific polymers).
2. Environmental Compatibility Assessment
Assess the proposed material's theoretical or lab-based resistance to maritime environmental stressors, including saltwater exposure, UV radiation, and water ingress.
3. Geometric and Structural Adaptability
Demonstrate initial feasibility for adherence or conformability of materials to complex substructures and geometries relevant to DOW platforms (i.e., airborne, shipboard, and ground-based).
4. Initial Performance Modeling
Develop simulation-based predictions or benchtop validations of frequency performance across multiple octaves in the RF and EO/IR spectrum (e.g., S21 transmission characteristics, optical transmission in multiple EO/IR bands).
5. Risk and Mitigation Planning
Identify potential risks (e.g., storage, degradation, application time) and propose mitigation strategies for eventual shipboard or airborne qualification.

PHASE II:
1. Prototype Fabrication
Design, manufacture, and deliver functional prototype(s) of the developed material or coating, tailored for maritime-relevant conditions and representative platform geometries.
2. Performance Validation Across Frequency Bands
Validate the prototype's frequency-selective behavior through laboratory and controlled-environment testing. Demonstrate multi-band performance (minimum two distinct bands, e.g., S- and C-band) from L-band to Ku-band.
3. EO/IR Performance Characterization
Conduct EO/IR transmission testing to confirm broadband optical performance through multiple EO/IR spectral bands, suitable for integration with commercial EO/IR sensors.
4. Environmental Endurance Testing
Evaluate long-term durability under simulated maritime conditions, including extended salt spray, UV exposure, and temperature/humidity cycling to validate 5+ year service life with minimal (<0.5 dB) performance degradation.
5. Rapid Application Demonstration
Demonstrate field-level application procedures confirming surface adherence with minimal preparation and application time under 24 hours.
6. Platform Integration Assessment
Assess integration potential with at least one DOW-relevant application (e.g., UAS radome, shipboard sensor cover), including initial qualification planning and boundary condition analysis.

PHASE III DUAL USE APPLICATIONS:
1. Qualification for Operational Platforms
Complete the qualification and certification process for use of the material on military platforms (i.e., shipboard, airborne, and land-based), including necessary safety, handling, and environmental compliance documentation.
2. Transition to DOW Programs of Record (PoRs)
Integrate the developed material into one or more PoRs or acquisition pathways (e.g., Navy UxS platforms, EW pods, surface combatant radar housings) through partnerships with prime contractors or system integrators.
3. Production Scale-Up and Cost Reduction
Establish a scalable manufacturing process that ensures material consistency, repeatability, and cost-efficiency, including options for low-rate initial production (LRIP) and full-rate production (FRP).
4. Commercial Dual-Use Expansion
Explore and initiate commercial applications of the developed material or coating, including broadband antennas, protective camera housings, or telecom equipment enclosures, leveraging interest from non-defense markets.
5. Sustainment and Lifecycle Support Plan
Develop a comprehensive sustainment strategy including repair, refurbishment, and replacement options, tailored for DOW logistics pipelines and long-term deployment in austere environments.

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KEYWORDS: Frequency Selective Surfaces, Metastrucutures, Engineered Materials, Coatings, Metamaterials, Phase Changing Materials

DON26BZ01-NV030 TITLE: Artificial Intelligence and Machine Learning (AI/ML) for Additive Manufacturing (AM)

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Advanced Materials;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Automate additive manufacturing (AM) through advanced computational techniques (i.e., artificial intelligence and machine learning [AI/ML], digital twins, etc.) to select optimal materials and manufacturing parameters to meet mission requirements in terms of component performance.

DESCRIPTION: AM has enabled new designs and rapid fabrication. However, there are no automatic tools available to computationally link across build platform to part performance. This SBIR topic seeks to leverage AI/ML, digital twins, and process simulation to select optimal materials and manufacturing parameters to meet rapidly changing mission requirements. A user should be able to input material type, part geometry, and AM system details into the prototype tools to automatically generate optimized build parameters along with accurate mechanical performance predictions.
While some tools in the current market can address part of this need, none are known which can integrate across the entire material lifecycle from pre-build to performance in a single ready-to-use package. The focus of this effort will be investigating legacy parts (i.e., obsolete castings and forgings) which need rapid production to avoid long lead times. Leveraging physics-informed AI/ML technologies and digital twins to optimize printing based on geometry and material properties will mitigate build defects and reduce post-processing while enabling performance prediction.
From a technical standpoint, the prototype tool(s) developed under this topic should seamlessly integrate across the component lifecycle, from initial design (or reverse engineering) to build parameter optimization to mechanical performance prediction in structural metals, to enable the user to accurately fabricate mission-critical components. The tool(s) must be part and AM build system agnostic to ensure scalability to multiple locations across the Navy’s manufacturing enterprise with various materials, systems, and performance requirements.

PHASE I: Define and develop a concept which leverages AI/ML, digital twins, and process simulation to select optimal materials and manufacturing parameters to meet rapidly changing mission requirements. Perform modeling and simulation with pointed physical testing for validation on a single component to demonstrate feasibility of the proposed concept. Required Phase I deliverables (in addition to the Contract Deliverables listed in the DON BAA instruction) will include a report on how the proposed concept will be expanded should the proposer be awarded a Phase II contract.

PHASE II: Expand the concept into full prototype tool development and validation using at least two additional components of different material classes and AM build systems. Demonstrate reduction in material fabrication time through automatic parameter generation while also reducing defect rates and material waste. Required Phase II deliverables will include:

a) A report on how the proposed concept can be expanded to other materials and systems not demonstrated in the Phase I and II taskings
b) Production of prototype tool(s) ready for delivery and demonstration at two U.S. Navy affiliated facilities.

PHASE III DUAL USE APPLICATIONS: Delivery of the final prototype tool(s) to U.S. Navy facilities will demonstrate the feasibility of the proposed solutions. Follow-on demonstrations to non-Navy participants will enable other DOW, DoE, government, and industry partners to ability to view the solution and continue transition to other facilities. The expectation is that the tool(s) will be leveraged by any organization in need of efficient digital tools to predict component performance based on manufacturing details.

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KEYWORDS: Additive Manufacturing; AM; Artificial Intelligence; AI; Machine Learning; ML; AI/ML; Digital Twin

DON26BZ01-NV031 TITLE: Tele-Operated/Autonomous Mechatronic Vehicle Kits for Use In Mixed Disaster Environments

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Create a mechatronic kit (roughly 3 feet wide, 3 feet long, 3 feet high, and weighing 220 pounds) with parts that can be easily swapped and reconfigured – including motors, sensors, and software – so that small teams can quickly build and change the mechatronic system in the field to handle many different tasks.

DESCRIPTION: First responder teams are small and have many tasks. Mechatronic solutions could help, but current solutions suffer from key shortfalls:

- They are an overly special purpose, limited in broad utility
- They lack common architecture, and cannot be repurposed or decomposed/recomposed for easy transport and repair
- They cannot be physically combined for additional power, speed or endurance
- Many key prime mover components are not manufactured at United States

This topic aims to create mechatronic prototypes that first responders can build in the field from basic parts (like frames, motors, computers, and controls). These mechatronic systems will be easy to customize for different needs. Preconfigured applications could include:

- Simple logistics support (e.g., carrying, loading, unloading)
- Intermediate applications (e.g., inspection, search and recovery)
- Advanced capabilities (e.g., waterproof, fire resistant, cold tolerant)

This topic aims to develop an open-ended physical architecture like an “Erector Set” with potential for endless variation.

PHASE I: Identify and design a prime mover configuration (such as electric brushless DC hub motors with Electronic Speed Control (ESC)) suitable for powering a variety of mechatronic systems with the following characteristics:

- o Rapid installation and removal
- o “Stackable” or arrangeable for higher power applications
- o Adaptable to track drives, direct wheel drives, gear trains, power take-offs (PTOs), propulsion shafts or other motive configurations
- o Domestically manufactured

Define and develop a suitable standard, material and configuration for structural purposes with the following characteristics:

- o Wide discretion in final configuration
- o Ease of assembly/disassembly
- o Folds, collapses or breaks down into minimal space
- o Able to host sensors and/or payloads

Prototype desired

PHASE II: Develop a prototype kit that resembles an erector set with multiple options for field construction of useful small mechatronic systems for logistics, security, surveillance and force projection at remote installations by small groups of first responders.
Develop prototype configurable U/Is that controls mechatronic vehicles/devices and allow for easy customizability by the first responders. Threshold: deliver 10 kits; objective: deliver 32 kits.

PHASE III DUAL USE APPLICATIONS: Product has utility to a wider group of users in three ways:
- Joint users, law enforcement, security forces, homeland security and other users with similar mission sets
- The development of an industry-recognized construction standard for small and mid-sized customized mechatronic systems
- STEM, academic research activities, hobbyists and industrial partners who are transitioning from sub-scale to intermediate mechatronic systems

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KEYWORDS: Mechatronic; Automation; Robotics; Modularity; Flexible; Configurable

DON26BZ01-NV032 TITLE: Automated Assessment and Adaptive Training for Simulated Fire Support Coordination

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Design and develop training tools that assess individual performance in a scenario-based fire support simulator and adapt instruction/scenarios based on that assessment without the need of an instructor in the loop.

DESCRIPTION: Recent Marine Corps publications have emphasized that effective fires employment remains a critical element of Marine Corps lethality and readiness [Refs 2, 3]. Fire support coordination (FSC) is the complex process of planning, integrating, and synchronizing the delivery of indirect fires (e.g., artillery, mortars) and close air support (CAS) to assist maneuver forces on the battlefield. At the company level, fire support is executed by a Fire Support Team (FiST) composed of several members, such as a FiST lead, Forward Observer (FO), Fire Support Officer (FSO), Joint Forward Observer (JFO), and Joint Terminal Attack Controller (JTAC). Some of these roles have a prescribed training pipeline (e.g., JFO, JTAC), whereas others do not (e.g., FiST Lead). The focus of the training for these roles is on individual skill development rather than team-based, integrated execution of fire support in support of a maneuver element. Opportunities for Marines to train collectively in combined arms integration are limited currently. Simulation-based training is available at a few designated locations, but these events require substantial instructor support to simulate different roles across multiple fires agencies and platforms (e.g., Fire Direction Center, CAS aircraft, Ground Force Commander). Live-fire Integrated Training Exercises (ITX), such as Fire Support Coordination Exercises (FSCEX), are costly (e.g., munitions), time and manpower intensive, occur infrequently, and have safety and external agency constraints not present in virtual training (e.g., FAA, host-nation restrictions). Furthermore, both simulated and live training environments require instructors to observe and assess performance with no automated assessment tooling. Across live and simulated events, these assessments are often not standardized and are subjective in nature, limiting opportunities for systematic assessment at the team or individual level. The lack of systematic assessment also limits the ability for Marine Corps to diagnose and address performance impacting the lethality of FiSTs.

Marines need a capability to assess foundational skills in their individual roles (e.g., crawl phase) that is embedded within a realistic fires simulator without requiring instructor facilitation or a full complement of FiST members. Automated assessment within the simulator allows for more objective-based metrics of performance and diagnosis of strengths and weaknesses of individual trainees. That enables schoolhouses and units to track performance on standardized metrics, which could be helpful for readiness assessments. Furthermore, Training and Education 2030 [Ref 3] outlines a student-centered adaptive training solution that tailors the training to the individual Marine based on an assessment of performance and prior research has demonstrated improved student learning outcomes and decreasing time through adaptive training methods – e.g. remediation or adaptive scenario difficulty [Refs 1, 4].

The desired capability of the fire support training solution is to provide tailored training to the individual FiST trainee based on the system’s assessment of performance, targeting skill areas where the trainee is weakest. Providing targeted reps and sets will maximize training time in the crawl phase in addition to improving preparation for the team-based virtual (e.g., walk phase) and live exercises (e.g., run phase). Providing a capability that allows FiST members to practice individual skills ahead of time ensures that trainees can focus on team skill development such as communication and coordination skills with other entities during the time and resource constrained team-based events. Simulation solutions must communicate via standard federated simulation protocols (e.g., DIS6/7, HLA RPR FOM [Refs 5,6]). Preference is given, but not required for submission, to proposals that incorporate or interoperate with existing and/or approved DOW simulation platforms with existing Authority To Operate (ATO) documentation for USMC.

PHASE I: Define and develop a concept for a scenario-based fire support simulation for individual FiST members that incorporates embedded assessment and adaptive training capabilities without the need for an instructor present. The focus of Phase I is developing and demonstrating an individual training solution for a FiST lead while also developing the broader concept for the remaining FiST individual roles. The concept shall include: (1) specific plans for how fundamental skills will be assessed at an individual FiST member level within the simulation and how the simulation will adapt based on the embedded performance assessment (the FiST lead focus / use case must be used to demonstrate a prototype to showcase the maturity and innovation for the proposed solution); (2) an evaluation plan to determine the validity of the assessments and training effectiveness.

PHASE II: Develop a prototype for a scenario-based fire support simulation that incorporates embedded assessment and adaptive training capabilities without the need for an instructor or role players present for the FiST lead role. Develop a plan to expand the assessment and adaptive training capabilities for additional roles in the FiST. Conduct validation of assessments with appropriate end users with coordination assistance from ONR.
Produce the following deliverables: (1) a working prototype of the system with performance data output that can be readable by instructors; (2) supporting software documentation; (3) an assessment validation report that demonstrates the suitability and utility of the training capability in the USMC training pipeline; (4) plans for expanding the assessment and training capabilities to new roles within the FiST.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop the software for evaluation to determine its effectiveness in either a formal Marine Corps schoolhouse or other training setting. As appropriate, focus on broadening capabilities of the training prototype to support additional roles, mission types, and fire support capabilities (e.g., loitering munitions, UAS, etc.).
Applications for dual-use include simulation-based individual and team assessments for training, such as law enforcement and air traffic controllers. The requirement to train and assess large numbers of aircraft controllers to meet personnel shortages has made global headlines. For air traffic control, having objective assessments and simulation-based training is paramount for safety considerations. Other relevant civilian applications that require significant simulation-based resources to train and assess individual and team skills in simulation-based environments include esports, which is a multi-billion-dollar industry with expected continued growth (https://www.statista.com/outlook/amo/esports/worldwide).

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KEYWORDS: Assessment; embedded assessment; adaptive training; fire support; simulation-based training; scenario-based training

DON26BZ01-NV033 TITLE: Applied Neuroanalytics for Optimization of Naval Training and Operational Readiness

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Artificial Intelligence (AAI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Human-Machine Interfaces;Human-Machine Interfaces

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate a neuro-enhanced artificial intelligence (AI) system that captures, analyzes, and operationalizes neurophysiological and behavioral data to provide near real-time, adaptive feedback for improved training efficiency, performance, and operational readiness of U.S. Navy personnel.

DESCRIPTION: The U.S. Navy Force Design 2045 (CNO NavPlan 2024) highlights the importance of the warfighter and human-machine teaming in the future fight, emphasizing the criticality of developing high-performing teams and leaders that are resilient, adaptable, and warrior tough while supporting an increasingly hybrid Fleet of manned assets augmented with thousands of unmanned assets. The future fight will likely require operators to 1) digest and synthesize large amounts of data from an extensive network of humans and machines, 2) make decisions more rapidly due to advances in AI, enhanced connectivity, and autonomous weaponry and 3) oversee a greater number and types of robotics, including swarms (RAND, 2024).

Critical features of this paradigm shift towards manned-unmanned teaming and emphasis on improving warfighter performance are how we train operators. Training is at the forefront of the modernization of Naval operations to enhance readiness and lethality, and this will depend heavily on the cognitive resilience and decision-making capacity of warfighters in these novel, high-stress environments. Traditional training paradigms typically neglect real-time measurement and integration of cognitive and physiological performance states (e.g., mental effort, task engagement, lapses and slips of attention, complacency, mental fatigue, and stress). Emerging technologies for advanced data analytics grounded in neuroscience provide new capability that can enhance warfighter development and mission success by embedding neurofeedback into live and synthetic Naval training environments, providing novel analytical features and data to adapt training in near-real time and accelerate learning at the point of need.

The U.S. Navy seeks to identify a major step forward in neuro-enhanced AI systems to reduce time-to-proficiency and predict Sailor readiness within the unique maritime military environment. This envisioned capability will leverage and further develop Commercial Off-the-Shelf (COTS) neurotechnologies along with complimentary biosensors (e.g., electrocardiography [ECG], electromyography [EMG], eye tracking) and behavioral monitoring tools for Navy-specific use cases to interface with personnel, enabling adaptive and responsive system interaction based on near real-time human state data.

This SBIR topic will prioritize two key demonstrated factors in support of its objective: (1) the ability to collect neural, physiological, and behavioral data in parallel with operators using a desktop or higher fidelity simulator; and (2) the ability to analyze and interact with that data, both in near real-time and post-hoc, using an advanced language-understanding system coupled with an extensive foundational model of the human psychophysiology and/or behavior to provide feedback. This effort will complement existing Navy initiatives, such as those led by NAVAIR, NAWCAD, and NAWCTSD, enhancing existing learning environments through the addition of a brain-based performance layer.

The platform will deliver an autonomous solution for near real-time feedback, improved after-action reporting, and guided adaptation of training scenarios via open data standards that can be used to improve understanding of Sailor state (static and dynamic), which will be imperative for improving warfighter performance and training towards an ever-evolving mission in the future fight.

PHASE I: Design and validate a strategy for integrating the neuro-enhanced AI system with existing Navy training architectures (e.g., NAWCTSD training systems or LVC frameworks). Define and characterize mission-relevant cognitive states predictive of optimal warfighter performance. Develop a system architecture that fuses neurophysiological, behavioral, and mission/environmental data for predictive insight.
Deliver system architecture documentation, a feasibility analysis of neuro-enhanced AI system data integration with Naval training systems, a preliminary data model for cognitive and physiological performance state prediction, and a prototype development roadmap for Phase II.

PHASE II: Build and demonstrate a working prototype of the system integrated within a Navy-relevant training environment. Instrument a Naval operational team (e.g., aircrew, ship bridge) for real-time neurophysiological data collection and adaptive training response. Implement a neuro-enhanced advanced language understanding system for AI-driven coaching, guiding warfighter and instructors in near real-time.
Deliver an Institutional Review Board (IRB) application/approval; a cybersecurity and RMF compliance report; data strategy documentation and integration with existing Navy training platforms; a live data collection event demonstrating improvements in performance and mission readiness; updated data exchange framework using API or Navy-compliant standards.
DON will provide Phase II awardees with the appropriate guidance and assistance for human research protocols though the performer will be responsible for obtaining any required Institutional Review Board (IRB) determinations. IRB determination as well as processing, submission, and review of all paperwork required for human subject use can be a lengthy process. As such, no human research will be allowed without IRB review and work will not be authorized until approval has been obtained, typically as an Option to be exercised during Phase II.

PHASE III DUAL USE APPLICATIONS: Validate system effectiveness for improving warfighter performance and readiness; demonstrate adaptive capabilities with AI-based recommendations; achieve authority to operate (ATO) with Navy training platform(s). Support transition of the SBIR-developed neuro-enhanced AI system.
Validated capabilities will be relevant for:
• Naval Aviation: Enhancing pilot and flight officer readiness and cognitive workload management.
• Surface Fleet Training: Real-time feedback during complex shipboard simulations.
• Submarine Operations: Monitoring mental states during long-duration missions.
• Medical Teams Afloat: Enhancing high-stakes clinical team performance.
• Special Operations Forces: Resilience training and peak performance optimization
Commercial applications include aviation, e-sports, medical simulation, and elite training environments where human performance optimization is critical.

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KEYWORDS: Neuroanalytics; Human Performance; Predictive Analytics; Brain-Computer Interface (BCI); AI-Enabled Coaching; Real-Time Training Adaptation; Cognitive Load Monitoring; Aircrew Readiness; Adaptive Learning; Large Language Model; NAVAIR; NAWCTSD

DON26BZ01-NV034 TITLE: Effects of Additive Loading on Electromagnetic Properties in 3D Printing

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Scaled Hypersonics (SHY)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Assess the effects of additives into 3D-printed input materials that are structurally and thermally viable for weapon system components, to determine the changes to electromagnetic (EM) properties that can be achieved based on how the additives change the material properties of 3D printed materials, and changes required to the 3D-printing process to ensure sufficient additive concentration to achieve relevant EM property changes. The end goal of this research is to establish what EM behavior effects are possible with relevant material properties for weapon systems and what additive composition are needed to obtain them. An initial use case of an antenna radome for a weapon system navigation receiver will be explored.

DESCRIPTION: Many different 3D printing techniques are currently employed today and the use of this technology has progressed from niche, one-off manufacturing to producing large components, printing directly onto complex-shaped objects, and even mass manufacture. The majority of the printing that is performed, however, focuses on pure polymer materials. There is a need to develop technologies to attenuate electromagnetic (EM) radiation for relevant purposes specific to many military applications. Pure polymer materials traditionally used for 3D printing do not attenuate Radio Frequency (RF) and are often transparent to key frequencies. The incorporation of additives into the polymer input materials can change the EM properties of the bulk material as evidenced by initial research by the Naval Surface Warfare Center Dahlgren Division. The full benefit applied to more relevant applications needs to be addressed. The work in this SBIR topic is meant to determine what EM attenuation behaviors are possible with the incorporation of additives, for materials intended for use in relevant environments. This includes analyzing changes to the physical properties of the produced materials to determine how the thermal and mechanical properties as well as the printability of the materials are affected, to include changes needed to the printing process to create more relevant effects.

PHASE I: Produce additive incorporated 3D-material substrates and conducting characterization of the electromagnetic changes. (Note: The form of the materials will depend on the printing techniques employed, but could include filaments, powders, or resin materials, selected based on applicability to the expected operating environment for weapon system antenna radome.)

PHASE II: Print antenna radome representative samples with different additives and additive concentrations to assess the EM property control potential along with structural and thermal performance. Impacts to the printing process will also be assessed to determine if modifications to 3D printer software/hardware are required to reach full benefit. These assessments will inform the selection of final material and additives for Phase III.

PHASE III DUAL USE APPLICATIONS: Print a full-scale antenna radome prototype, with additive selection and concentration, to meet specified performance parameters for frequency transmission and rejection. Antenna radome prototypes will be characterized for EM, structural, and thermal performance prior to testing an actual weapon system. Rapid printing of prototypes using validated material specifications and printing methodologies will also be conducted to demonstrate the feasibility of in-theater replacement part manufacture with modified EM response characteristics.
Given the ever increasing spectrum usage & crowding a dual use application would be antenna radome designs that provide a high rejection, tight bandpass to mitigate non-desired frequency interference. Additional dual use application would be tuning for thermal performance for commercial antenna applications in high solar load environment where the additives would be tailored to improve heat dissipation and reduce impact of ultra-violet radiation degradation to structural material properties of the radome.

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KEYWORDS: Additive; Manufacturing; Electromagnetic Properties; EM; 3D Print; Nanomaterials; Transparency; Reflection; Emission

DON26BZ01-NV035 TITLE: Integrated Multidisciplinary Design, Analysis, and Optimization Framework for Hypersonic Boost-Glide Weapons

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Scaled Hypersonics (SHY)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software;Hypersonics;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an integrated multidisciplinary design, analysis, and optimization (MDAO) framework for hypersonic boost-glide weapons that enables concurrent optimization of vehicle geometry, mission trajectory, and control strategy by leveraging existing modeling tools, incorporating reduced-order models, applying artificial intelligence and machine learning (AI/ML) to accelerate design and reduce computational cost, and providing early insights into system cost estimation, manufacturability, and technology development roadmaps.

DESCRIPTION: The Department of the Navy (DON) requires advanced simulation and optimization capabilities to accelerate the conceptual design and mission planning of hypersonic boost-glide weapons. These systems must deliver long-range strike capabilities, survive extreme thermal and structural environments, and maintain maneuverability for terminal effectiveness against defended targets. Designing such vehicles is highly complex due to the strong coupling between aerodynamic heating, structural loading, control authority, system mass, and mission trajectory.

Conventional design approaches treat these disciplines in isolation and in sequence, often resulting in suboptimal performance, prolonged development timelines, and increased costs. MDAO methods offer a more integrated approach, enabling concurrent consideration of key factors and improved trade space exploration. However, coupling high-fidelity models across multiple domains creates significant computational challenges. Practical MDAO frameworks must incorporate reduced-order models, surrogate approximations, and robust optimization techniques that balance computational efficiency and modeling accuracy [Refs 1, 3, 4].

This SBIR topic seeks innovative tools and methods that support an integrated MDAO framework for the design and optimization of hypersonic boost-glide weapons. Solutions should enable concurrent optimization of vehicle geometry, mission trajectory, and control strategies while accounting for launch platform constraints such as volume, mass, interface requirements, and environmental loads. The framework should also address internal system considerations such as payload integration, guidance and control subsystems, and thermal protection. The capability should support conceptual-level design and deliver outputs that inform system cost estimation, manufacturability, technology development roadmaps, and risk reduction strategies.

Proposals should demonstrate capabilities in the following areas:

• Aerodynamic and trimmed flight analysis to predict forces and moments over a broad range of Mach numbers, including control surface deflection effects and geometric deformation. Integration with existing computational fluid dynamics tools is encouraged.

• Aerothermal modeling to estimate heating loads and surface temperatures, including convective and radiative heat transfer and thermal protection system behavior.
• Structural analysis to evaluate stresses, strains, and deformation under combined aerodynamic and thermal loads, with support for high-temperature materials and composite structures.
• Mass properties and internal system layout to optimize placement of payloads, sensors, power systems, and thermal subsystems while maintaining center-of-gravity control and packaging feasibility.
• Trajectory and control optimization to evaluate and enhance flight performance while meeting constraints on range, maneuverability, survivability, and terminal accuracy.
• System-level integration into an existing or proposed MDAO architecture such as ADAPT [Ref 2] or OpenMDAO, with support for geometry parameterization, solver coupling, multi-objective optimization, and design variable management.
• Uncertainty quantification and robust optimization to evaluate sensitivity to variations in input parameters, models, or environmental conditions, and to ensure resilient design outcomes.
• AI/ML methods to accelerate convergence, construct reduced-order models, support adaptive sampling, and enable data-driven design exploration. Solutions may also include optimizing the objective function itself by learning weighting factors for multi-objective problems, generating surrogate models for expensive simulations, discovering improved formulations via symbolic regression, or adaptively refining the objective function as new information becomes available.
Proposed solutions should leverage existing tools, frameworks, and prior government investments wherever feasible. The resulting toolset should support traceability between design inputs and mission-level measures of effectiveness, helping guide early-phase trade studies and enabling faster transition to detailed design and development.

PHASE I: Develop a prototype MDAO framework for hypersonic boost-glide weapons. Integrate key modules and demonstrate coupling with existing architectures such as ADAPT or OpenMDAO. Apply the framework to optimize a representative boost-glide vehicle, capturing control surface deflection effects and geometric deformations over a notional trajectory. Evaluate computational efficiency, model fidelity, and extensibility. Prepare a Phase II plan.

PHASE II: Develop a fully integrated MDAO framework that enables co-design of vehicle geometry, trajectory, and control strategies for hypersonic boost-glide weapons. Incorporate launch platform constraints and model in-flight geometric deformations, control surface deflections, and effects such as ablation. Demonstrate manufacturability and cost-informed design on a non-canonical configuration. Leverage AI/ML to accelerate optimization, support surrogate modeling, and enable adaptive, data-driven design exploration. Validate the framework on realistic scenarios and implement workflow automation to support repeatable, efficient design cycles.

PHASE III DUAL USE APPLICATIONS: Transition the MDAO framework and supporting modules to practical applications within the Department of War and commercial aerospace sectors. Conduct extensive validation and optimization across a broad range of hypersonic vehicle configurations and flight conditions. Support integration into existing design and analysis workflows to enable use within operational design environments. Collaborate with industry and DOW stakeholders to ensure compliance with deployment standards. Develop comprehensive training materials, user documentation, and technical support resources to enable adoption by both expert and non-expert users.

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KEYWORDS: Hypersonics; Multidisciplinary Design, Analysis, and Optimization; MDAO; Computational Fluid Dynamics; Artificial Intelligence / Machine Learning; AI/ML; Software Tools; Aerodynamics

DON26BZ01-NV036 TITLE: Solid-Fuel Rotating Detonation Ramjet (SF-RDR) for High-Speed Propulsion

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Scaled Hypersonics (SHY)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Hypersonics

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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 the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a throttleable solid-fuel Rotating Detonation Ramjet Engine (SFRDE) system by integrating a controllable gas generator to precisely regulate fuel supply, enabling stable and efficient Rotating Detonation Engine (RDE) operation.

DESCRIPTION: The Department of Navy (DON) seeks innovative solid-fuel detonation-based propulsion solutions that can deliver superior performance and operational flexibility. The RDE is a promising candidate to replace current constant-pressure combustion systems, due to its high-thermal efficiency, wide-operating Mach range, short combustion time, and small volume. However, to fully realize the benefits of an RDE for naval applications, particularly in the context of ramjet operation, the ability to operate an RDE on solid fuels and precisely control thrust output is crucial. This SBIR topic focuses on developing a throttleable solid-fuel rotating detonation ramjet (SFRDE) system, enabling dynamic adjustments to a coupled gas generator to enable optimal performance across a wide range of mission profiles.

To date, RDEs have been demonstrated to operate at ramjet relevant conditions; however, the applicability of RDEs to ramjet cycles has largely focused on the use of gaseous or liquid fuels [Refs 1, 2]. The use of solid fuels in RDEs presents additional complexities. Fuel formulations must be carefully tailored to provide detonable fuel at ramjet relevant temperatures. The use of a gas generator to provide the combustible mixture could potentially lead to solid particles clogging the fuel injectors. The design of the gas generator is also crucial to provide a mixture adequate for sustained detonability and coupling with the RDE inlet. Recent studies have demonstrated the viability integration of solid propellants and rotating detonation engines through the use of gas generators [Ref 3]. The proposed research should address the following two key areas to achieve a throttleable SFRDE:

Throttleable Gas Generator Development: Design and develop a compact, lightweight, and throttleable gas generator capable of precisely controlling the flow rate and composition of the fuel and/or oxidizer supplied to the RDE. Additional considerations should include the selection of appropriate gas generator propellants based on performance, stability, and safety considerations, as well as consideration of ignition methods suitable for the gas generator.

Combustion Chamber Design: Optimize the rotating detonation engine combustion chamber design for stable rotating detonation wave propagation and efficient mixing of the gas generator's output with the primary oxidizer stream. Design considerations should include injector geometry and placement to promote rapid mixing and flame stabilization; chamber geometry to facilitate detonation wave initiation and propagation; and thermal management strategies for both the gas generator and combustion chamber.

PHASE I: Design, develop, and demonstrate: (1) a throttleable gas generator subsystem and (2) that the gas generator provides a combustible mixture detonable at ramjet relevant temperatures. Solutions are preferred that are capable of demonstrating a subscale SFRDE system with the throttleable gas generator. Demonstrations should achieve sustained detonation operation for nominal durations of 0.5 to 3.0 seconds after reaching steady state. The subscale should trace directly to the conceptual design and planning for tactical-scale prototype to be developed under Phase II.

PHASE II: Develop and fabricate a tactical-scale prototype of a throttleable SFRDE. Performance and operation will be demonstrated under ramjet-relevant conditions during ground-test. The tactical prototype shall reflect the geometry and functionality of an operational system but is not required to be flight-weight. The ground-test campaign nominally will characterize performance across throttle settings, including thrust, specific impulse, combustion efficiency, and response time. If a limited ground test campaign is conducted, data collected should provide sufficient information to validate system-level performance models to assess the SFRDE's impact on overall ramjet cycle performance. Awardee(s) should provide a manufacturing readiness assessments and initial cost estimates of Low-Rate Initial Production (LRIP).

PHASE III DUAL USE APPLICATIONS: Further improve the SFRDE system and expand on the experimental demonstration for Navy-relevant conditions and vehicle geometries. These demonstrations shall be conducted via ground test facilities at simulated ramjet operating conditions. If supported by transition partners, Phase III may include development of flight-representative hardware or subcomponents and associated validation for integration into a future flight demonstration. Awardee(s) should improve manufacturing readiness assessments and cost estimates provided during Phase II.
The commercial potential of this device lies in the component fabrication and potential secondary applications. The development of rotating detonation combustor hardware, and lessons learned in combustion diagnostic system integration will be directly applicable to future advanced solid-fuel propulsion system efforts. The sub-systems and technologies developed could be used across a broad range of power-generation, thermal management, and aerospace applications. The system has applicability to energy production research and development efforts ongoing in RDEs by industry and government agencies, including NASA and the Department of Energy.

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KEYWORDS: Solid Fuel; Rotating Detonation Engine; Gas Generator; Detonation; High-Speed Propulsion; Ramjet

DON26BZ01-NV037 TITLE: Synthetic Alkali Atom Vapor Density for Atom-Based Sensors

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum and Battlefield Information Dominance (Q-BID)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Integrated Sensing and Cyber;Microelectronics;Quantum Science

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Simplify the thermal management of practical atom-based quantum sensors based on alkali atoms by creating a passive atom source operated at thermal equilibrium based on a synthetic alkali vapor density for rubidium or cesium atoms.

DESCRIPTION: Quantum sensors based on atoms offer the opportunity to produce measurements with excellent sensitivity or long-term stability, making them attractive use in atomic clocks, magnetometers, or inertial sensors. In these sensors, the atomic vapor represents the sensing media where variations in signal magnitude from fluctuations in atom number can lead to instability or loss of sensitivity. Maintaining consistent signal throughout environmental conditions represents one of several key design criteria for atom-based sensors for use outside the laboratory.
Many atom-based sensors rely on heavy alkali atoms, specifically rubidium and cesium. This is because of the simplified, hydrogen-like energy level structure, the availability of narrow-linewidth semiconductor diode lasers on the relevant D1 (795/895 nm) and D2 (780/852 nm) transitions, the accessibility of commercial microwave electronics at the 3-10 GHz hyperfine splittings, and the ease of production of vapor phase atoms at modest temperatures. The temperature dependence of the alkalis [Ref 1] leads to thermal stabilization at 80-130°C (ideal for vapor cells at 10e12-10e14/cc) or closer to room temperature (ideal for atom trapping at 10e8-10e10/cc). These temperatures rarely align with thermal profiles of other aspects of the system, requiring additional design at the expense of size, weight, and power (SWaP). Active approaches to alkali regulation have been demonstrated to manipulate the vapor to a non-equilibrium state. These approaches involve forced chemical reactions, intercalated graphite, alkali impregnated materials glasses [Refs 2,3]. In each case, a feedback loop must respond to measurements of the vapor density, leading to extra sensor complexity.
An equilibrium vapor density represents the simplest atom source which can be synthetically adjusted to an elevated temperature through a mixture [Ref 4]. Here, a primary species mixed with a secondary species reduces the equilibrium vapor density of both species by the mixing ratio following Raoult's Law [Ref 5]. Selecting a lower vapor density secondary species limits the negative impact of additional atom-atom collisions. Such an approach can be applied to laser-cooled systems in addition to vapor cells to enable equilibrium operation at elevated system temperature, providing tight thermal regulation at low power.

PHASE I: Develop and demonstrate a method to produce a predetermined mixture of primary and secondary alkali species allowing for reduction of equilibrium vapor density of the primary species.

Mixtures consistent with supporting laser cooling at elevated temperatures from 30-85°C should be demonstrated corresponding to ~10-10,000× reductions in the primary species. Spectroscopic (or equivalent) determinations of the primary species density in the mixture should be evaluated against unmixed samples of the primary alkali species. A detailed synthesis approach for each mixture along with vapor density evaluations will be submitted.
In the Phase I Option, if exercised, stability of the mixtures against thermal cycling should be demonstrated for the mixtures produced in the Phase I Base.

PHASE II: Produce mixtures capable of supporting laser cooling and trapping at elevated temperatures over the 30-85°C range. Mixtures will be produced in or transferred into chambers that support optical access, magnetic fields, and ultra-high vacuum conditions compatible with atom trapping for evaluation. Spectroscopic (or equivalent) evaluation of the primary alkali reduction will be determined as in Phase I. In addition, atom trapping performance will be evaluated to determine number of atoms and loading time constant at a range of temperatures around the target temperature. The proposer may partner with other organizations if atom-trapping evaluation capability is not available in house. A plan to produce delivery mechanisms for mixtures in a variety of warm atom and cold atom scenarios will be submitted.
Deliver at a minimum three (3) samples (containing > 1 mg each) of the atom-trapping material in a proposed delivery mechanism to the Navy at the conclusion of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the demonstrations and continual advancement of laser cooling technologies, the atom source should lead to dramatic improvements in the SWaP of cold atom systems. Support the Navy in transitioning the technology to Navy use.
The end product technology could be leveraged to adapt atom-based sensors to a variety of thermal environments to support biomedical, communications, and navigation applications.

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KEYWORDS: Quantum sensing, magneto-optical trap, atom source, atomic clock, atom interferometer, atomic magnetometer

DON26BZ01-NV038 TITLE: High-power, Long Coherence Length Blue Laser

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum and Battlefield Information Dominance (Q-BID)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Integrated Sensing and Cyber;Microelectronics;Quantum Science

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Develop a blue wavelength, high-power laser with a long coherence length capable of high pulse repetition frequencies.

DESCRIPTION: In recent years, blue laser diode technology has enabled improved data storage, enhanced fluorescence imaging, metal processing, and other applications [Ref 1]. Lasers in this wavelength band also fall within the ‘optical window’ of water and will experience less attenuation than other wavelength bands [Ref 2]. The wavelength band will also experience less diffraction compared to other communication wavelengths [Ref 3]. This SBIR topic seeks to develop a blue laser capable of high pulse repetition rates and long coherence length light while maintaining a high optical power.
Target specifications for the desired product include:
• High optical power output: 10 W continuous wave
• Optical wavelength: 425 nm to 475 nm
• Long coherence length: > 10 m
• High pulse repetition frequency: > 100 MHz
• Laser will need to operate continuously and reliably for lifetime of 2000 days

PHASE I: Perform a design and materials study to assess the feasibility of the proposed technology or process to meet the target specifications listed above. A final report must include an assessment of:
• Preliminary design and simulation of laser technology
• The size, weight, and power (SWaP) implications of the proposed technology
• Pathway to meet the lifetime target specification including accelerated life testing
• The scalability of the approach for low quantity prototypes, low-rate production, and full rate production.
The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build laser prototype in Phase II.

PHASE II: Build and demonstrate the laser technology and characterize its performance against the target goals of optical power, wavelength, coherence length, pulse repetition frequency, beam quality, and continuously and reliable laser lifetime.
Deliver five (5) representative lasers to the Navy at the conclusion of Phase II that can be further tested.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continue development to assist the Government in integrating the technology with relevant technologies. Beyond Navy applications, the proposed laser technology will be relevant for a range of commercial and scientific applications including holography, spectroscopy, and medical sciences.

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KEYWORDS: Diode laser; blue laser; fiber amplifier; pulsed laser; high power laser; coherence length

DON26BZ01-NV039 TITLE: Reentry Test Body Telemetry Antenna

COMPONENT TECHNOLOGY PRIORITY AREA(S): Hypersonics;Nuclear;Space Technology

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

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OBJECTIVE: Design, develop, and test a reentry body antenna or antenna system capable of transmitting high speed, real time, inflight, encrypted data. The data transmission should be in bands alternate to S band such as the K & Ka bands and communicate with geostationary satellites used as a pass-through mechanism to relay the encrypted data to ground.

DESCRIPTION: The development of a next-generation telemetry communications antenna for Navy Submarine Launched Ballistic Missile (SLBM) reentering test bodies is critical in advancing developmental technologies being evaluated on flight tests. While common ground tests such as wind tunnels, arc jets, and vibration provide insights into predictable reentry environments, flight testing remains the gold standard in evaluating reentry bodies (RBs) and their onboard technologies. Flight tests evaluate a reentry body’s ability to withstand the harsh and sometimes unpredictable environments of flight to include launch, separation, and reentry.

The current technology to monitor SLBM payloads during flight include a transmitter/receiver system between the reentry body and ground stations. Data is captured during flight and transmitted to the ground in the S band (2-4 GHz), making data transfer slower than higher frequency bands [Ref 3]. Due to the S band being a highly populated frequency band and the power on the RB required to telemeter data in the S band back down to the ground receiver, midflight data transmission is both slow and costly. Additionally, since the transmitter/receiver system today is only between the RB and ground station, real time data transmission is lost during a portion of the flight when the RB is the furthest away from the ground, otherwise commonly known as “over the top” of the flight trajectory as well as during reentry when the body enters plasma blackout. To solve this problem, the technology proposed should use alternate frequency bands, such as K and Ka bands (18-40 GHz) and make use of geostationary satellites as a pass-through mechanism to capture real time data from the RB and telemeter the encrypted data back down to the ground at high speeds in order to minimize data transmission latency and loss. The use of alternate frequency bands allows for high data rate information exchange [Ref 1]. This new technology would solve the issue of losing real-time data transmission midflight.

By having real-time, high-speed data throughout the duration of flight on a flight test, the Navy can better understand technology performance throughout the various environments and environment transitions and can more effectively diagnose issues or failures resulting in faster technology maturation.

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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain at least a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Prepare a detailed plan to accomplish the objective to include 1) A clear and concise definition of the problem; 2) Definition of the System Requirements; 3) Proposed technology solution 4) Draft technology solution specification; 5) Identification of trade-off studies to be studied and how the trade studies will influence product design; 6) Optimized structural and thermal designs; 7) detailed plan to achieve prototype development and testing; 8) detailed plan to achieve system integration and qualification. Attempt to meet all requirements while achieving optimal encrypted data transmission performance in reliability, form factor minimization, and connectivity while meeting all integration requirements. AES256 is a standard.
In summary, the Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Implement the program plan described in the Phase I deliverable. Three prototypes should be delivered. The first prototype should be able to be incorporated onto a test flight such as a sounding rocket or full scale test on a Multi-Service Advanced Capability Hypersonics Test Bed (MACH-TB) platform to evaluate its performance [Ref 4]. The second prototype will be used for destructive ground test activities required for qualification and the third prototype will be used for non-destructive ground test and qualification activities.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: The final product will be an antenna or antenna system that is matured to its final form factor, qualified to Trident II D5LE environments. The product shall meet all size, weight, and power constraints for implementation onto a reentry test body.
A possible non-DoW use for this effort can be improved communications for commercial space payloads in multiple bands.

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KEYWORDS: Telemetry; flight test; reentry body; encrypted data transmission; high frequency data transmission; geostationary satellite; high speed data