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

IMPORTANT

- **The following instructions apply to topics:**
  - **N251-001 through N251-073**

- Information on the 25.1 SBIR and 25.A STTR Topics Workshop can be found at https://navysbir.com/nw25_1.htm.

- Submitting small business concerns are encouraged to thoroughly review the DoD SBIR/STTR Program Broad Agency Announcement (BAA) and register for the DSIP Listserv to remain apprised of important programmatic changes.
  - The DoD 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 DoD Instructions posted for this BAA.

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

- Proposing small business concerns 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 small business concerns 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 provides notice that Basic Ordering Agreements (BOAs) may be used for Phase I awards, and BOAs or Other Transaction Agreements (OTAs) may be used for Phase II awards.

- 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 small business concern.

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 DoD SBIR/STTR Innovation Portal (DSIP). Refer to the Proposal Submission section of the DoD SBIR/STTR Program BAA for details.
	BAA Open	DoD SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions) Refer to the Proposal Submission section of the DoD SBIR/STTR Program BAA for details.
Electronic submission to the DoD 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
N251-001 to N251-005	Mr. Jeffrey Kent	Marine Corps Systems Command (MCSC)	sbir.admin@usmc.mil
N251-006 to N251-023	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil
N251-024 to N251-052	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N251-053 to N251-065	Ms. Lore-Anne Ponirakis	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil

Topic Numbers	Point of Contact	SYSCOM	Email
N251-066 to N251-073	Mr. Jon M. Aspinwall III (Acting)	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 DoD SBIR/STTR Programs.

(NOTE: Proposing small business concerns 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.)

DoD SBIR/STTR Innovation Portal (DSIP). Proposing small business concerns are required to submit proposals via the DoD SBIR/STTR Innovation Portal (DSIP); and follow proposal submission instructions in the DoD SBIR/STTR Program BAA on the DSIP at https://www.dodsbirsttr.mil/submissions. Proposals submitted by any other means will be disregarded. Proposing small business concerns submitting through DSIP for the first time will be asked to register. It is recommended that small business concerns 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 DoD SBIR/STTR Program BAA for further information.

Proposal Volumes. The following seven volumes are required.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD 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 small business concerns 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 on the Proposal Cover Sheet (Volume 1) and in Volume 3.
    - For Phase I, a minimum of two-thirds of the work is performed by the proposing small business concern. 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 small business concern the sum of all direct and indirect costs attributable to the proposing small business concern 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 Small Business Concern Costs (included in numerator for calculation of the small business concern):
        - 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 small business concern.
      - 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. If a value above or below $0.00 is entered in the Cost Sharing field the proposal will be deemed non-compliant and will be REJECTED by DoN.**

  - 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)**. DoD 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 DoD 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 small business concerns must review and submit the following items, as applicable:
    - **Majority Ownership in Part.** Proposing small business concerns 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 small business concerns 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 small business concern 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
      - Allocation of Rights between Prime and Subcontractor
      - 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 small business concerns are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD requires Volume 6 for submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DoD 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 DoD will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. Small business concerns 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 DoD 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 DoD 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 small business concern has met eligibility requirements and followed the instructions for the Proposal Cover Sheet as specified in the DoD 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 DoD 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 small business concern 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 small business concern 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 small business concern. 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. If a value above or below $0.00 is entered in the Cost Sharing field the proposal will be deemed non-compliant and will be REJECTED by DoN.**

- **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 small business concerns must refer to the DoD 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 small business concern 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 DoD SBIR/STTR Program BAA to ensure compliance with Volume 7 requirements.

ADDITIONAL SUBMISSION CONSIDERATIONS

This section details additional items for proposing small business concerns 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 Defense, in coordination with the Small Business Administration, to establish and implement a due diligence program to assess security risks presented by small business concerns seeking a Federally-funded award. Please review the Certifications and Registrations section of the DoD SBIR/STTR Program BAA for details on how DoD will assess security risks presented by small business concerns. 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 small business concerns 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 small business concern 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 small business concern. 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. A small business concern 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 <u>NOT</u>:

- Be subject to any indirect costs, profit, or fee by the SBIR proposing small business concern
- Propose a TABA provider that is the SBIR proposing small business concern
- Propose a TABA provider that is an affiliate of the SBIR proposing small business concern
- Propose a TABA provider that is an investor of the SBIR proposing small business concern
- Propose a TABA provider that is a subcontractor or consultant of the requesting small business concern 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 DoD 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 <u>NOT</u> 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 small business concern requests and is awarded TABA in a Phase II contract, the proposing small business concern will be eliminated from participating in the Navy SBIR Transition Program (STP), the DoN Forum for SBIR/STTR Transition (FST), 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 small business concern 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). A small business concern 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 small business concerns 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 small business concerns 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, small business concerns must register with the SBA Company Registry Database.
b. The proposing small business concern 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 small business concern become a member of this ownership class after submitting its proposal and prior to any receipt of a funding agreement, the proposing small business concern 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 small business concerns 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 small business concerns should confirm that they are registered to receive contracts (not just grants) and the address in SAM matches the address on the proposal. A small business concern selected for an award MUST have an active SAM registration at the time of award or they will be considered ineligible.

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 252.204-7019, in order to be considered for award, a small business concern 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 small business concern 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 small business concern 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 small business concern, and to take other relevant steps necessary prior to making an award.

Contract Types. The DoN typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In addition to the negotiated contract award types listed in the section of the DoD SBIR/STTR Program BAA titled Additional Considerations, for Phase II awards the DoN may (under appropriate circumstances) propose the use of an Other Transaction Agreement (OTA) as specified in 10 U.S.C. 4021/10 U.S.C. 4022 and related implementing policies and regulations. The DoN may choose to use a Basic Ordering Agreement (BOA) for Phase I and Phase II 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 small business concern 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 small business concern'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 typically awards a Cost Plus Fixed Fee contract for Phase II; but, may consider other types of agreement vehicles. 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 small business concerns (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.

Navy SBIR 25.1
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N251-064	Sparse Data Initialization for Machine Learning Weather Prediction Models
N251-065	Active Scenarios Learning of Evolving Situations, Multimodal Counterfactual Reasoning, and Explanations Toward Artificial Intelligence-assisted Wargaming
N251-066	Carbon-Carbon Modular Structures
N251-067	Radiation Hardened Gallium Nitride Electronics
N251-068	Smart Contracts for Supply Chain Risk Management (SCRM)
N251-069	Highly Applicable Mechanical Metamaterial (HAMM) for High G-Load Flight Structures.
N251-070	Carbon-Carbon Structures with Embedded Electronics
N251-071	Novel Autonomous Dead Reckoning Navigation
N251-072	Lithium Niobate Fabrication and Processing
N251-073	Robust Fiber-to-Photonic Integrated Circuits (PIC) Coupling for the Near-Infrared (NIR)

N251-001 TITLE: Directional High Front to Back Ratio Low Frequency (< 90 MHz) Antenna

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Microelectronics

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 compact lower frequency communications antenna in the High Frequency (HF) (3MHz – 90MHz) spectrum with the ability to direct gain in a desired direction and minimize the gain in the opposing direction. The antenna is to be lightweight, compact, and tactically relevant. The antenna should be employed near enemy forces such that it can transmit in the direction of friendly forces and in the opposing direction minimize the power radiated.

DESCRIPTION: The Marine Corps seeks a compact (less than 6ft long), lightweight, lower communications frequency antenna (High Frequency (HF)/Very High Frequency (VHF) Range). The ability to adjust the frequency (microelectronics or physically) is required to maintain a minimum size. The antenna must operate in the 1.5MHz to 90MHz range (Threshold) and it is desired to operate slightly below the HF and in the HF/VHF/Ultra High Frequency (UHF)/Extremely High Frequency (EHF) ranges (Objective). Antennas as described above are already available at larger lengths (10’ Whip and Vertical Dipole 12’ to 18’). It is required to use such an antenna connector that is already fielded/used antenna in HF radios. See references for HF radios and links for associated antenna.

Directional gain should be maximized in a given direction, and in the opposing direction minimized (180 degrees). A drop of 30dB in the opposing direction (Threshold), 60+dB in the opposing direction (Objective) is desired. Low frequency Radio Frequency (RF) has a low directivity making the drop in gain difficult. Adaptive structures are sought that would allow non-hazardous materials (Threshold) to be used. Materials used typically in anechoic chambers are hazardous (Absorptive Foam) and usually pyramidal, which is too large for tactical use. Therefore, it is desired that alternate materials or active structures be used to ground the RF energy. References discuss the types of material absorption that may work and current research into this area.

Antenna form factors are usually vertical polarized using a dipole antenna. Thus, a structure suited to controlling energy in a compact (6ft or less) antenna are desired. The thickness of the material required should be less than 2” to reduce the operational impact (Threshold) and less than 0.25” is desired (Objective) and could be some type of antenna coating or grounded shielding that allows directional radiation. Thin materials that can absorb or ground the RF energy in a certain direction while minimizing the effect on the dipole antenna are required. The use of a directive low frequency antenna use case is limited to military use thus very little research has been done to provide directive HF antennas. Advanced material research is deemed necessary, partnership with a university or research institution on advanced materials is encouraged.

PHASE I: Define and develop concepts for a device to absorb RF energy in the opposing direction of the directive gain for a compact antenna. Using modeling and simulation, determine the technical feasibility of the design of such a device. Describe the method and recommended materials required to build a structure and how it can be used tactically with HF radio antennae. Provide a Phase II development plan with performance goals and key technical milestones that will address technical risk reduction and includes development of a prototype.

PHASE II: Develop a scaled prototype integrated with a representative RF antenna that covers the frequency range and provides the required directivity and front to back (180 degree) power drop in a desired direction. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and Marine Corps requirements for HF transmission with a military radio. Demonstrate radio performance in the desired direction, and drop in detectability in the undesired direction in a prototype demonstration. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps (tactical use) requirements and satisfies MIL-STD-810 environmental factors. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for their use. Develop the antenna directivity solution for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for testing and validation to certify and qualify the system for Marine Corps use.

The compact antenna has use in the commercial and amateur radio market based on its ease of use. The directivity capability could be used to improve communications (reduce interference) in a particular direction.

REFERENCES:

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2. Ruiz Perez, Fernando. “Carbon-based, radar absorbing materials: A critical review.” Journal of Science Advanced Materials and Devices 7(3):100454, April 2022. DOI:10.1016/j.jsamd.2022.100454. https://www.researchgate.net/publication/359886052_Carbon-based_radar_absorbing_materials_A_critical_review
3. “AN/PRC-160(V) Wideband Hf/Vhf Manpack Radio.” L3Harris. https://www.l3harris.com/all-capabilities/an-prc-160v-wideband-hf-vhf-manpack-radio
4. “L3Harris’High-frequency Radio Solutions Provide On-the-Move Communications in Satellite-denied Environments.” L3Harris Spectrum Magazine, October 2020. https://issuu.com/l3harrisspectrum/docs/spectrum_magazine_ausa_2020_9oct2020/s/11138710

KEYWORDS: High Frequency (HF); Advanced Materials; Radiation absorbent materials (RAM); Radio Frequency (RF); absorption of RF; Directivity; Very High Frequency (VHF); Ultra High Frequency (UHF); Extremely High Frequency (EHF)

N251-002 TITLE: Amphibious Combat Vehicle Weight Reduction

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials

OBJECTIVE: Develop lightweight components using advanced materials or innovative design to replace heavier components on the ACV that can withstand the harsh environmental conditions of use in the littorals.

DESCRIPTION: The Amphibious Combat Vehicle (ACV) is an amphibious armored vehicle designed to transport Marines on land and in the water. There are several versions of the vehicle. The ACV – Personnel (ACV-P), ACV Command and Control (ACV-C), the ACV Medium Caliber Cannon (ACV-30), and the ACV Maintenance and Recovery (ACV-R). The ACV-30 and ACV-R are the heaviest variants but all variants would see performance improvements by reducing weight. Components identified as having potential for weight reduction include engine access covers, drive shafts, ramp door, ramp, hatches, external fuel tanks, external metallic and metallic/composite add-on-armor components, suspension, turret exterior panels, and bow plane. Proposed material changes must address corrosion issues expected from use in and around salt water. Weight reduction will improve fuel efficiency and can lower the Center of Gravity and Center of Buoyancy. Reduction of un-sprung mass will improve ride quality. Weight reduction without loss of performance also enables trades in other ACV performance areas to increase readiness or capabilities. The Program Office has set a goal of no more than $20 (production cost) per pound of weight savings and a minimum threshold of 2000lbs total reduction.

PHASE I: Review the vehicle drawings to identify components for potential weight reduction. Produce a preliminary conceptual design to evaluate weight savings and potential cost of production and installation. Use Finite Element Analysis (FEA), as appropriate, to confirm design parameters. Provide the following required Phase I deliverables: a report on the results of modeling and simulation and an initial proposal for a Phase II effort.

PHASE II: Using results from Phase I, fabricate and validate prototypes. Demonstrate the prototypes' ability to meet requirements in the Description through lab testing. Evaluate the results of the demonstration and refine the design as necessary. Conduct on-vehicle testing in a relevant environment. Evaluate and compare the results to Marine Corps requirements. Prepare a Phase III development plan to transition the technology for Marine Corps use. Deliver the prototypes at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Provide support to the Marine Corps in transitioning the technology to the ACV through an Engineering Change Proposal (ECP) process. Refine the system for further evaluation and determine its effectiveness in an operationally relevant environment. Support the Marine Corps test and evaluation program to qualify the system for Marine Corps use.
Commercial applications include combat vehicles used by other services and other countries. The developed technology could also be used in the Commercial Truck Industry and Recreational Vehicle (RV) market.

REFERENCES:

1. "Combat Vehicle Weight Reduction by Materials Substitution." National Academies of Sciences, Engineering, and Medicine. 2018. Proceedings of a Workshop. Washington, DC: The National Academies Press. https://doi.org/10.17226/23562.
https://nap.nationalacademies.org/catalog/23562/combat-vehicle-weight-reduction-by-materials-substitution-proceedings-of-a
2. "Lightweight Materials for Cars and Trucks."
Office of Energy Efficiency & Renewable Energy, Vehicle Technologies Office.
https://www.energy.gov/eere/vehicles/lightweight-materials-cars-and-trucks

KEYWORDS: Amphibious Combat Vehicle; ACV; Weight Reduction; Advanced Materials; Composites; Corrosion Resistant; Armored Vehicle

N251-003 TITLE: Amphibious Combat Vehicle Improved Heating Ventilation and Cooling (HVAC) System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces

OBJECTIVE: Develop a heating, ventilation, and cooling (HVAC) system that meets the HVAC requirements for onboard personnel (Ref 1), functions within space, weight, and power (SWaP) limitations, has minimal impact on vehicle noise levels (Ref 2), and does not introduce a significant maintenance burden.

DESCRIPTION: The Amphibious Combat Vehicle (ACV) is an amphibious armored vehicle designed to transport Marines on land and in the water. The vehicle is closed during water and combat operations so outside air must be supplied from above the vehicle. There are several variants of the vehicle.

1. The Personnel variant (ACV-P) has a crew of 3, carries 13 Infantry Marines, and requires the most volume/quantity of fresh air from outside the vehicle.

2. The Command-and-Control variant (ACV-C) has a crew of 3 and accommodates, in the troop compartment, up to 7 command staff members who conduct command and control (C2) tasks that require computer, servers, and communication equipment that generate heat and must be kept within acceptable temperatures.

3. The 30mm gun variant (ACV-30) has a crew of 3, carries 8 Infantry Marines, and has a 30mm Mk. 44 Bushmaster II Automatic Cannon. The ACV-30 requires air filtration or other ways to avoid bringing noxious fumes into the vehicle.

4. The recovery variant (ACV-R) has a crew of 4, all of whom are from the Maintainer Military Occupational Specialty (MOS), and has craning, winching, and repair capabilities.

When operating, the ACV variants' noise levels can exceed single hearing protection levels. Noise level testing indicates that the current Environmental Control System (ECS) is one of the main culprits for excessive noise levels in the cabin. The system must not prevent the ACV from meeting MIL-STD-1474 guidelines for hearing protection and have minimal impact on weight.

The ACV-P is required to supply 20 cubic feet per minute of fresh air per person (320 cfm) and maintain an interior temperature below 90 degrees F in ambient conditions up to 110 degrees F, with a 1,120 W/m2 solar radiation load, doors and hatches closed, and engine running (estimated to require ~55,000 BTUs of cooling). The ACV-C requires 20 cubic feet per minute of fresh air per person (200 cfm) and ~55,000 BTUs of cooling. The ACV-30 needs a filtration system that will not introduce noxious fumes into the cabin and will provide 20 cubic feet per minute of fresh air per person (220 cfm).

The current HVAC system does not properly cool the space per requirements in MIL-STD 1472H. There is large variability across workstations within the vehicle and even within a given workstation (temperature variability between head and feet locations). The HVAC is located on the left side of the vehicle approximately 1/3 of the way back in the troop compartment and has no duct system or other means to distribute conditioned air evenly through the compartment, especially to locations in the far corners of the vehicle.

The current system requires its refrigerant lines to be emptied and the refrigerant captured when the vehicle engine is removed. Engine removal occurs frequently which causes significant maintenance delays. When the engine is re-installed, the lines must be reconnected, a vacuum pulled, and the refrigerant refilled. This greatly increases the time required to remove and reinstall the engine for maintenance.

PHASE I: Review the vehicle drawings or models and conduct a site visit to study an ACV to determine technical feasibility of a single system to meet the requirements of all four variants. Develop a concept for a new HVAC system or modification of the current system design. Demonstrate compliance through a combination of modeling, analyses, and bench top demonstration.

In addition to the Phase I deliverables described in the BAA, the awardee is expected to deliver at least 1 in-process design review with meeting minutes, report on results of modeling and simulation, and an initial Phase II proposal.

PHASE II: Using results from Phase I, fabricate and validate a prototype. Demonstrate the prototype's ability to meet the requirements in the Description. Evaluate the results of the demonstration and refine the design as necessary. Conduct on-vehicle testing in a relevant environment. Evaluate and compare the results to Marine Corps requirements. Prepare a Phase III development plan to transition the technology for Marine Corps use. Delivered a prototype at the end of Phase II.

PHASE III DUAL USE APPLICATIONS: On vehicle testing across different variants and refinement as a result of testing will be required. Production planning and partnerships should be created if necessary for production.

Other military applications potentially include use in combat vehicles used by other services and other countries. The developed technology could also potentially be used in commercial markets such as heavy construction and agricultural equipment, and possibly in the Recreational Vehicle (RV) market.

REFERENCES:
1. US MIL-STD 1472H, DESIGN CRITERIA STANDARD HUMAN ENGINEERING. https://www.dau.edu/cop/hsi/documents/milstd-1472h-design-criteria-standard-human-engineering
2. US MIL-STD 1474 MIL-STD-1474E, DEPARTMENT OF DEFENSE DESIGN CRITERIA STANDARD: NOISE LIMITS (15-APR-2015). http://everyspec.com/MIL-STD/MIL-STD-1400-1499/MIL-STD-1474E_52224/
3. “CO2 as a Refrigerant .” Mercedes Benz, June 2021. https://www.bing.com/ck/a?!&&p=129127754f9de7dbJmltdHM9MTcyNDk3NjAwMCZpZ3VpZD0xNDIwMGZiMC1iODY2LTZmNTUtMWMxYi0xYjY2Yjk5NzZlYTAmaW5zaWQ9NTIyNg&ptn=3&ver=2&hsh=3&fclid=14200fb0-b866-6f55-1c1b-1b66b9976ea0&psq=co2+air+conditioning+automotive&u=a1aHR0cHM6Ly9hdXRvbW90aXZldGVjaGluZm8uY29tL3dwLWNvbnRlbnQvdXBsb2Fkcy8yMDIxLzA2L0NPMi1hcy1hLVJlZnJpZ2VyYW50LWlzLUhhcHBlbmluZy5wZGY&ntb=1

KEYWORDS: Amphibious Combat Vehicle; ACV; Noise; Sound; Reduction; Heating, Ventilation and Cooling; HVAC; Climate; Maintainability

N251-004 TITLE: Kill Web Conceptual Modeling for Wargaming

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems;Integrated Sensing and Cyber

OBJECTIVE: Develop C4ISRT (Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance, and Targeting) Network and Kill Web models for wargaming that are sufficient to withstand review board scrutiny to support model verification, validation, and accreditation, as required. The focus is on developing and implementing the models referenced herein, not on the underlying mechanics of the PM WGC (Program Manager Wargaming Capability) materiel solution simulation framework.

DESCRIPTION: This SBIR topic addresses several parametrics of interest related to C4ISRT Networks and Kill Web models for future inclusion in the General Robert B. Neller Center for Wargaming and Analysis, formerly the Marine Corps Wargaming and Analysis Center (MCWAC). The parametrics address the procedural and physical information and decision flow through the C4ISRT networks to effectively model the coordination between the various warfighting functions to achieve effects on targets. The relevant processes include aspects of planning, directing, tasking, collecting, processing, producing, and disseminating information, including network transmission. Network transmission modeling should account for node locations and links, information size, data/error rates, bandwidth, and latency. Network nodes can be fixed sites or mobile and should be susceptible to damage states and degraded performance.

Previous efforts within the Neller Center simulation system development focused primarily on physics-based models of communication transmission. In typical kinetic-focused wargaming, the kill web sense-decide-effect process constraints and realities are not always highlighted. This effort involves a novel approach for including rigorous kill web considerations within wargames alongside the other types of typically employed models.

In the table linked below, the major parametrics considered are listed, along with a description of the parametric and the pertinent specific conceptual model requirements for each parametric topic.

https://navysbir.com/n25_1/N251-004-Kill_Web_Conceptual_Modeling.pdf

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 MCSC 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 concepts for an improved representation of C4ISRT Networks/Kill Webs in wargaming Modeling and Simulation (M&S) that meet the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs. Establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by evaluation of the plan of attack for the development effort including data availability. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I concepts and the Phase II development plan, the small business will develop prototype conceptual models. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for C4ISRT Network/Kill Web M&S. System performance will be demonstrated through prototype evaluation over the required range of parameters. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

It is anticipated that the Phase II prototype development may require the gathering, storing, and processing of classified data at the SECRET level or higher (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Integrate C4ISRT Network/Kill Web conceptual models into the Neller Center wargaming software to demonstrate their effectiveness in an operationally relevant environment within the Neller Center. Support the Marine Corps for M&S Verification, Validation, and Accreditation (VV&A) to certify and qualify the system for Marine Corps use.

The conceptual models described herein are not only a high priority within the Marine Corps [Refs 1,3], but are equally applicable across the Services, to support not only wargaming, but also analysis, training, and experimentation. Successfully developed conceptual models would likely be of great interest across these communities. DoD components and prime contractors are in need of accurate C4ISRT Network/Kill Web simulation representation to support gap analysis and solution assessment. Commercial game developers for DoD use cases would benefit from augmenting their software offerings with these kill web models, adding to the realism and real-world complexity afforded the wargame participants.

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2. “IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP), IEEE Standard 1730-2022.” C/SI - Simulation Interoperability Stds Organization/Stds Activity Committee. https://standards.ieee.org/ieee/1730/10715/
3. “Force Design 2030 Annual Update 38th Commandant of the Marine Corps, June 2023.”, https://www.marines.mil/Force-Design-2030/
4. “Marine wargames offer a look at the future — and fuel dissent.” Marine Corps Times, March 2024. https://www.marinecorpstimes.com/news/your-marine-corps/2024/03/21/marine-wargames-offer-a-look-at-the-future-and-fuel-dissent/
5. Kackley, Tyson C. “Future Force Modeling and Simulation: Innovation in Wargaming Capability Development.” , Marine Corps Gazette, May 2022. https://www.mca-marines.org/wp-content/uploads/Future-Force-Modeling-and-Simulation.pdf
6. “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: General Robert B. Neller Wargaming and Analysis Center; Marine Corps Wargaming and Analysis Center; MCWAC; United States Marine Corps; USMC; M&S; Modeling and Simulation; conceptual model; analysis; Neller Center; wargaming; Force Design; kill chain; kill web

N251-005 TITLE: Day/Night Crew Served Weapon Sight System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Microelectronics

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 day and night capable target acquisition and engagement sight system for crew-served small arms weapon systems.

DESCRIPTION: This SBIR effort is to develop a day/night crew-served weapon sight system that combines the functionality of multiple legacy sight systems while providing additional performance and capabilities. Marines require a replacement for technologically obsolete thermal weapon sights procured for medium (7.62mm) and heavy (12.7mm and 40mm) machine guns. These single-function devices do not provide fire control capabilities, such as target range determination with dynamically corrected aimpoints, nor do they provide the clarity and range of dedicated visible light sight systems utilized during daylight. The Marine Corps is also investigating capabilities to provide the range performance of heavy machine guns in form factors comparable to medium machine guns, with associated mobility advantages for dismounted Marines. Such a capability would require an associated day/night sight system and fire control to efficiently utilize the limited amount of ammunition carried by machine gun teams. Technical approaches may include modular or fully integrated capabilities (see technical parameters in Phase II) but should emphasize light weight for dismounted applications. Multiple approaches may be assessed in Phase I, but a prototype hardware solution (or multiple solutions) must be achievable within the time and funding scope of the base Phase II effort. In all phases of the effort, the proposer shall provide target and environmental modeling assumptions and sensor/optical parameters.

It is recommended that proposers utilize the U.S. Army Night Vision Integrated Performance Model (NVIPM) for sensor range predictions. A copy of NVIPM software can be provided as Government Furnished Information upon contract award, however proposers are expected to have prior proficiency in use as training will not be provided by the Government. Phase I proposals shall include, but are not limited to, discussion of the performer’s experience and knowledge of relevant technologies and their application to optical systems for small arms; the proposer’s ability to model the size, weight, power, cost, and range performance of optical systems for small arms applications; and the proposer’s capabilities for rapid prototyping and relevant prior examples. Supplementary material should include recent examples of the performer’s ability to develop, refine, and qualify relevant systems for use in military operational environments and produce systems in significant quantities, utilizing either internal resources or via teaming or licensing agreements. Phase I proposals may include preliminary concepts that demonstrate understanding of the relevant trade spaces.

The prototype system is not expected to be optimized for power consumption, nor to meet gunfire shock and full military operational environment requirements; however, it shall be suitably robust for use outdoors in temperate climates. The prototype shall include an external power capability to operate on

120VAC power via an adapter and any internal batteries shall be removable by the operator, allowing use on external power only.

The prototype system shall provide the operator a 70% probability of recognizing personnel targets at no less than 2,400 meters in overcast starlight conditions (~100 microlux), without the use of active illumination sources, through bright sunlight conditions (~100 kilolux) and under 7 kilometer clear air equivalent visibility. The prototype system shall include a color visible light capability (powered digital imager or unpowered direct view optic) for bright sunlight to civil twilight (3-400 lux) use, in clear air, at the stated distance. Solutions incorporating digital day imagers shall have dynamic range sufficient for observing objects in shadows across the stated ambient light levels. Viewable scene and/or symbology brightness shall be adjustable to minimize detectable emissions at night and bright enough to permit observation during daylight without the use of a light sealing eyecup. The prototype system shall be capable of performing the stated task in dirty battlefield and adverse weather conditions at no less than one-third the clear air range. Recognition shall be evaluated by the ability of the operator to detect and correctly count the number of upright personnel within a group with no more than 50% line of sight positional overlap between individuals presenting a frontal aspect.

For NVIPM modeling, the recommended relevant parameters are: 0.75 meter target characteristic dimension, V50 (recognition) = 2.2 cycles, 2 Kelvin target contrast for thermal band imaging, and 25% target contrast for reflectance band imaging.

The prototype system shall have a fire control capability with sufficient ranging and corrected aimpoint accuracy to permit first-round engagement of targets at the maximum effective range of the associated small arms system.

The prototype system shall have sufficient field of view to observe projectile impacts on target, rapidly search for and detect targets, and maintain situational awareness of friendly forces approaching perpendicularly to the target area before they enter the cone of fire. Specialized mounting solutions, including superelevation capabilities, are permissible for different weapons. Relevant USMC weapons include the M240B 7.62mm Medium Machine Gun, M2A1 12.7mm Heavy Machine Gun, and Mk19 40mm Heavy Machine Gun.

The prototype system should demonstrate the ability to receive target handoff from a secondary observer, such as a nearby machine gun team leader or a distant small unit leader (Objective).

The performer shall provide a plan for both low and full rate production, describing proposed fabrication capabilities and teaming or licensing agreements, if applicable. The performer shall provide a cost estimate for non-recurring initial resources and facilities as well as production of sight systems based on step ladder pricing.

PHASE I: Define and develop a concept for a day/night crew-served weapon sight system. Establish the feasibility of the concept. Prepare a Phase II plan.

PHASE II: Develop and deliver at least one hardware system prototype suitable for demonstrating the range performance, operator employment, and approximate size and weight of the preferred concept on relevant small arms systems. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Further refine the sight system for optimization of size, weight, power, and manufacturing cost and for survivability in the conditions associated with weapon firing shock and the military operational environment. Deliver sufficient representative sight systems to allow qualification and Marine user evaluation for refinement prior to full rate production. Dual use applications include law enforcement precision marksman and civilian hunting applications, subject to ITAR and local government restrictions. Related applications may include machine vision systems for remote inspection and autonomous vehicle long distance hazard/pedestrian avoidance.

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KEYWORDS: Sensors; Optics; Fire Control; Sights; Small Arms; Weapons; Targeting

N251-006 TITLE: Diagnostics, Prognostics, and Health Management for Non-Steady State, Rapid Acceleration/Deceleration, High-Load Bearings

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Integrated Sensing and Cyber;Sustainment

OBJECTIVE: Develop and demonstrate an empirically developed system for failure risk prediction, diagnostics, prognostics, and health management of rapid acceleration/deceleration, high-load bearings to increase operational availability (Ao) of carrier-based recovery systems.

DESCRIPTION: Arresting gear on aircraft carriers quickly decelerate aircraft over a short distance (hundreds of feet or meters) and time (2–3 s). Nimitz-class carriers utilize the MK-7 arresting engine, while the Ford-class utilizes the MK-15, Advanced Arresting Gear (AAG). In both instances, an aircraft tailhook engages the cross-deck pendant (CDP). The CDP attaches to the purchase cable (PC), which transfers energy to the arresting engines. Below deck, sheaves (i.e., pulleys) are used to change PC direction and wrap the cable around shock/energy absorbers. Due to the nature of the application, the sheave bearings on the MK-7 and the spherical roller thrust bearings on the MK-15 AAG experience high-loading, and rapid acceleration followed by rapid deceleration. This cycle repeats as aircraft are continuously arrested during flight operations. Arrestments are followed by retracts, which have a lower load and acceleration, where the cable is retracted back to its pre-arrestment position.

Bearing specifications differ between MK-7 and MK-15 (AAG); they also differ within MK-7 depending on location and use. The max RPM of the MK-7 bearings is in the range of 1000–1400 RPM; the max-RPM range of the MK-15 is between 600–900 RPM, with a few follower-bearings going up to 1,400 RPM. The bearings accelerate to and decelerate from this speed over a matter of 2–3 seconds. Load ratings vary depending on where the bearing is used. On the MK-7, the maximum load ratings range from approximately 335,000 lb–360,000 lb (151.95–163.29 MT) static (with one outlier rated for 560,000 lb [254.01 MT] static.) and 190,000 lb–268,800 lb (86.18–121.93 MT) dynamic. In operation, the max operating loads are 105,000 lb (47.63 MT) cable tension, 210,000 lb (95.25 MT) resultant load. However, there can be overload scenarios that load sheaves to an approximate theoretical load of 350,000 lb (158.76 MT). Thrust loads are minimal (a few hundred pounds) for the majority of the sheave bearings. One sheave bearing type is rated at 2,100 lb (.95 MT) of thrust. Examples of the MK-7 inner diameters, outer diameters, and widths include: 7.9 in (20.07 cm) ID x 12.6 in (32.004 cm) OD x 3.5 in (8.89 cm) W, 12.6 in (32.004 cm) ID x 19.7 in (50.034 cm) OD x 2.5 in (6.35 cm) W, 18.7 in (47.5 cm) ID x 24.3 in (61.72 cm) OD x 2.7 in (6.86 cm) W. The MK-15 uses 300 mm (Timken / SKF bearing model number 29360) and 360 mm (Timken / SKF bearing model number 29372) inner diameter spherical roller thrust bearings under high-dynamic loads, as well as a few follower bearings (both pillow-block and thrust bearings) that go up to 1,400 RPM; the long-term effects of thousands of arrestments on the risk of bearing failure has yet to be determined.

When selecting a roller bearing, a common practice is to estimate the bearing’s "L10" life, defined as the number of revolutions (sometimes listed as a time at a constant speed) before there is a 10 % chance of bearing failure. A bearing can have one of many different types of failure mechanisms, including a lubricant failure causing the bearings to seize; as well as a failure in fatigue, causing rollers to crack and potentially jam the bearing. These empirical equations are based on prior tests (mostly around the 1940s) of roller bearings being continually spun until failure. These tests predominantly used continuous speed tests, and these empirical equations assume a continuously spun bearing. When a roller bearing’s speed is varied, the only available approach to estimating the bearing’s L10 life is to extrapolate from a summation of continuous speed calculations; this is at best an educated guess, and one does not truly know the probability of a bearing failure for bearing applications with significant variability in speed. It is clear, however, that a rapid change in speed will impart more fatigue and alter the lubricant properties, and thus the true long-term risk of failure from hundreds of thousands of arrestments has yet to be truly determined.

In addition, maintenance practices, failure risk, and the life of steady state bearings are better defined, and diagnostics/prognostics technologies are more mature. The rapid acceleration and deceleration of bearings in arresting gear applications is atypical; there is significant variability when quantifying the risk of a bearing failure, and this unknown risk from this unique use case leads to potentially conservative maintenance practices. This includes high-frequency greasing of the sheaves on MK-7 (every 20 arrestments) and routine teardown for inspection. The inspections include taking apart the sheaves, wiping off grease, and visually inspecting the bearing. Repeated disassembly and reassembly of the sheaves increase the maintenance, and the frequent disassembly for inspection inherently increases the risk of damage. A reduction in maintenance requirements can reduce Operations and Support (O&S) costs by (a) decreasing hours spent on inspection, and (b) preventing excessive teardown from increasing the failure rate of the sheaves. Sheave inspections take anywhere from 6–14 hours of work (per sheave) depending on the type of sheave. A method of reducing the inspections and maintenance of the bearings that preserves safety and reliability would increase Operational Availability.

Mobil Mobilith SHC 460 grease is used on the MK-7 sheave bearings, and none of the bearings are sealed. Phenolic and steel spacers act as grease retainers, but grease still escapes from small gaps between the spacers and the housings. For the majority of sheaves, the grease ports are stationary and grease is fed through grooves in the spacers. One sheave type is greased from the inner diameter of the sheave shafts. On the MK-15 AAG, Mobil Mobilith SHC 629 and 634 bearing oil is used in the spherical roller thrust bearings; seals hold the liquid oil within the bearing cavity.

The Navy is seeking an innovative solution to setting up an apparatus to subject roller bearings under a high load (relative to the bearings' dynamic load limit). The apparatus will cyclically ramp up the bearings from stationary to a high speed (relative to the bearings' rated speed), and then immediately and rapidly decelerate the bearings to stationary; each cyclic event should last less than 5 seconds. This cyclic acceleration and deceleration would need to continue indefinitely until the bearings have failed. Undoubtedly, this process can take a long time, but it would be essential for such an apparatus to be scaled and/or replicated in such a way such that a trend of estimated failure rates versus the number of cycles can be determined with a reasonable statistical confidence.

From this experimental apparatus, the Navy is seeking an empirically derived solution to predict the risk of a bearing failure and to track the bearing health over time. This will involve the development of diagnostics/prognostics algorithms. Insight into appropriate greasing, inspection, and maintenance intervals is required to decrease maintenance hours, extend bearing life, and alert Sailors to required maintenance prior to bearing failure. It is expected that a fixed, scheduled greasing interval will remain. Research and data are required to determine if the current 20-arrestment interval is reasonable or too conservative. In regard to diagnostics and prognostics of the bearings, real-time health monitoring is preferred, but periodic, automated inspections are also acceptable, so long as they do not increase the maintenance burden on the Fleet and enable a move towards a condition-based maintenance (CBM) approach.

Approaches may include, but are not limited to, a combination of modeling and simulation (M&S), instrumentation, sensor fusion, prognostics and health management, and/or other methodologies for data collection and data analytics, based on the empirical data. From a software perspective, advances in artificial intelligence and machine learning, or other related innovations associated with prognostics and health management may be leveraged to achieve the goals as outlined. Prior research and literature surrounding reliability, availability, and maintainability, including associated failure distributions (e.g., normal, Weibull, etc.) and other probabilistic/statistical methods are also relevant. From a hardware perspective, existing sensors, such as accelerometers, temperature sensors, thermal imaging, torque sensors, nondestructive inspection equipment, and so forth, may be appropriate; however, proposers are in no way limited to these technologies or methodologies and may offer alternative means to monitor health. Designs must be minimally intrusive, and capacity/space for additional, bulky sensing equipment is limited.

PHASE I: Demonstrate feasibility of high-load, non-steady state bearing predictions and health monitoring. Design and develop a solution that utilizes hardware to collect data at representative bearings and utilizes software to accept data for evaluation via M&S, data analytics, AI/ML algorithms, or other methods. Awardee may develop a physical, subscale bearing test bed during Phase I; however, it is not a requirement if the awardee can achieve similar results by generating realistic datasets using computer resources. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design and build a full-scale prototype based on Phase I work. Demonstrate the technology in a lab environment using a bearing test bed that models the loading and acceleration profiles of the Navy's bearings. Consideration should also be given to cyclic operations (i.e., high-sortie rate testing), as this is expected to lead to the highest temperatures, wear, and potentially bearing failure.
Validate and verify that the approach meets needs and requirements of the application by showing that diagnostics/prognostics algorithm(s) can identify (a) a proper greasing interval, (b) current bearing health state, (c) when to visually inspect and/or perform maintenance, and (d) remaining useful life or mean time between failures (MTBF) as applicable.

Assuming iterative design is used, and a more capable solution is developed gradually throughout this phase, consideration will be given to packaging to meet military specifications, data storage/processing, the health monitoring user interface, and integration with existing equipment and infrastructure.

PHASE III DUAL USE APPLICATIONS: Use any algorithms, sensor systems, bearing monitoring systems, and life-cycle prediction tools developed during Phase II to both accurately predict the expected number of arrestments a set of bearings can handle prior to an expectation of failure, as well as predict when anomalies in the bearing performance (e.g., vibrations, increase in torque) is indicative of a developing problem. Transition the monitoring systems to the ships to alert the crew when anomalies are detected, or maintenance is needed.

There are countless examples of commercial applications, which use bearings that accelerate and decelerate rapidly, and that can benefit from this technology. Some examples likely include bearings with large braking requirements, such as landing gear on aircrafts, and brakes on trains.

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KEYWORDS: Bearings; Tribology; Lubricants; Failures; Monitoring; L10

N251-007 TITLE: Alternative Wireless Technologies for the Aircraft Carrier Flight Deck

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems

OBJECTIVE: Develop a wireless communication method that functions inside shipboard radio frequency (RF) limited environments to accommodate data links between mobile devices and computer systems.

DESCRIPTION: The aircraft carrier flight deck is not only a physically hazardous environment, but a highly contested electromagnetic environment. Allowing wireless communication between computers and mobile devices on a flight deck is a challenging problem. Various systems such as radar interfere with bands in the electromagnetic spectrum, ruling out technologies such as commercial Wi-Fi as a solution. The importance of managing Electromagnetic Interference (EMI) is especially important in the presence of ordnance where technologies must be tested under Hazard of Electromagnetic Radiation to Ordnance (HERO). Most importantly, there are RF restrictions due to Emissions Control (EMCON) during operations. Wireless communication on the flight deck is an enabler to many key technologies. This includes mobile devices used for providing naval aviation information to flight deck Sailors, audio communication devices, and autonomous systems relying on wireless links. Creating a flight deck compatible wireless solution would improve many aspects of Sailors' jobs during operations.

There have been many advancements in wireless links using technologies outside of the RF spectrum. Technologies based on free space optics use both the visible and nonvisible spectrum to transfer data. For example, Light Fidelity (LiFi) technologies have been created to provide a WiFi alternative in indoor environments. Ceiling mounted lights can be used to transfer data to receivers on laptop computers. Long distance data transfer has also been demonstrated to be able to send data in outdoor environments when directionality and power are adjusted. However, there are disadvantages in the light spectrum due to the need for direct line of sight and loss of effectiveness in degraded weather conditions. Alternatively, the sound spectrum outside of human audible frequencies can be used as a medium but has disadvantages in range and interference. There are difficulties in both mediums when implementing within a wireless network with multiple devices.

The U.S. Navy is seeking a solution to prototype a wireless communication network that is capable of being used in RF limited environments. It must provide bi-directional connectivity between mobile devices across the entirety of the aircraft carrier flight deck. While examples were given above with solutions outside of the RF spectrum, methods that make use of RF with low probability of intercept and detection is also acceptable. The proposed solution should include hardware designs for networking devices such as access points and peripherals to enable mobile device connectivity. A plan on how to implement connectivity across an area as large as a carrier flight deck should be included. The solution should accommodate data throughput of at least 100 kbit/s from device to device on a single channel to accommodate voice and intermittent data transfer. Technologies will be judged based on reliability, compatibility with shipboard emissions requirements, and anticipated data rates.

PHASE I: Define and develop a concept for wireless connectivity within an air capable shipboard environment that eliminates or reduces radio frequency emissions. Perform an initial assessment of the technology through modeling and simulation or in a lab setting where data is sent between a minimum of two devices using the wireless medium. Provide a plan to expand the technology to a local area network. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype wireless network of devices using a wireless medium that eliminates or reduces radio frequency emissions. Produce prototype network hardware such as transceivers and access points. Demonstrate the technology in an outdoor environment at ranges experienced on aircraft carriers.

Provide an assessment of probability of detection, as well as test results for latency, data rates, and reliability. Provide documentation on hardware architecture and device drivers.

PHASE III DUAL USE APPLICATIONS: Integrate the wireless network developed in Phase II into an air capable ship flight deck and validate system functionality. Test its compatibility within the environment (EMI and HERO requirements) and determine if the system has a low probability of detection.

The project has significant implications to the telecommunications industry. Wireless transmission outside of commonly used RF bands are vital to future generations of wireless networks (i.e., 6G) to use in conjunction with RF. It increases overall bandwidth by offloading data sent through RF bandwidth to other mediums. The technology can be used indoors within local area networks and outdoors through cell phone towers.

Technology developed in this effort can be implemented in locations where traditional RF or WiFi cannot be used. It has implications within areas where there is equipment sensitive to RF such as medical devices. It can be used in undersea communications systems where traditional WiFi will not work.

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KEYWORDS: Wireless Network; Radio Frequency; WiFi; Optical Communication; Local Area Network; Emissions Control

N251-008 TITLE: Autostereoscopic Flight Simulator Display System for Improved Depth Perception

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces

OBJECTIVE: Develop a novel flight simulator display system, which improves user depth and velocity perception greater than those, which can be perceived via traditional two-dimensional visual display systems.

DESCRIPTION: Current display systems for Navy flight simulators traditionally project two-dimensional (2D) imagery of a three-dimensional (3D) environment onto a display medium, but user depth perception is greatly decreased due to a loss of visual information about the 3D environment. The human vision system relies on stereoscopic views of the real world in order to accurately gauge depth, object location in space, and velocity. This information is interpreted by the visual system from the combined effects of monocular and binocular cues. Naval aircrews must reliably perform tasks in 3D space (e.g., AAR, formation flights, air-to-air engagement, and landing on aircraft carriers). Therefore, the goal of this SBIR topic is to develop a display system capable of providing stereoscopic views of a computer generated 3D environment specifically for flight simulator usage.

It is expected that this effort will produce an autostereoscopic display system capable of replacing current flight simulator display systems without the use/requirement of stereoscopic eyewear. The visual acuity and performance of the system will be equivalent to or better than current flight simulator display systems regarding resolution (i.e., minimum 20/20, objective 20/10), refresh rate (i.e., minimum 120 Hz, objective > 140 Hz), luminance (i.e., maximum 1,500 cd/m2 and minimum 0.00 cd/m2), and integration into high fidelity naval aircraft training systems. The display system will also allow a user to accurately gauge depth at least between 5–100 ft (1.52 m–30.48 m) to an equivalent stereoacuity between 40 to 20 arcsec (objective 20 arcsec). Any impacts on human performance will need to be minimized and/or eliminated and evaluated to prevent negatively impacting the pilot's normal flight operations and learning (e.g., strabismus, vergence-accommodation conflict, visual distortions, operator feedback, lateral/vertical head movements, etc.). Users should not have a significantly limited “head box” to maintain stereoscopic vision. Formal pilot evaluations and human factors studies should be developed with assistance from the TPOC’s and NAVAIR’s Human Research Protection Official.

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

PHASE I: Design an autostereoscopic display system that does not require the use of eyewear/glasses/headwear, which is able to meet or exceed the requirements outlined in the Description. Determine technical feasibility through experiments that address extended use from a human factors point of view. The Phase I effort will include prototype plans to be developed under Phase II. Prototype plans shall include methods for incorporation with high fidelity cockpit simulator systems currently in use by the Navy (e.g., tactical operational flight trainer “tub”). While the initial targeted simulation environment is for fighter jet platforms, integration should not be limited to fighter jet platforms as rotary-wing and large fixed-wing platforms also require stereoscopic simulation.

Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II.

PHASE II: Develop and demonstrate a functional prototype of the system. Perform pilot evaluations of the system's performance and capabilities, human factors analysis, and psychological assessment for simulator sickness and human performance. Determine if the display system can be used as a replacement to current flight simulator display systems. Identify, address, and document deficiencies and areas for improvement.

Note: Please refer to the statement in the Description above regarding human research protocol for Phase II.

PHASE III DUAL USE APPLICATIONS: Use pilot evaluations, human factors studies, and/or lessons learned from the Navy simulator integration (Phase II) to improve on the autostereoscopic display system design and transition from prototype to producible solution.

Autostereoscopic display technology is a new and growing field, which is getting a significant amount of attention inside and outside of the DoD. Testing this system as a simulation tool, and addressing human factors such as comfort for extended use, would allow this system to enter the market as a proven display system ready to be utilized in training systems. These training systems could extend beyond aircraft and military applications (e.g., gaming, entertainment, private sector training, etc.).

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KEYWORDS: Autostereoscopic; Stereoscopic; Display; Depth Perception; Simulator; Training

N251-009 TITLE: Network Enabled Weapons Settings Verification

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with 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: Possible rewrite: Develop and demonstrate the ability to verify the compatibility of cryptologic key material and radio initialization settings among weapons, sensors, and shooters and to permit required data exchanges.

DESCRIPTION: The U.S. Navy has, and continues to develop, a category of air-launched smart munitions known as Network Enabled Weapons (NEW). These weapons require target location updates during the weapon time of flight to ensure that the target is within the weapon's seeker field-of-view at weapon endgame. Remote sensor platforms transmit this updated target information via Weapon Data Link (WDL) radios. The WDL is currently Link-16 (L16) Line of Sight (LOS) datalink. Additional LOS and Beyond Line of Sight (BLOS) datalinks are currently in development for use in software programmable radios. These datalink radios require NSA-produced Black (encrypted) cryptologic key material (KEYMAT) and myriad specific initialization parameters to enable data exchange between the weapons, the launch aircraft, and the remote sensor platforms. The KEYMAT and initialization parameters are provided via entry into aviation mission planning systems by trained Naval Aviators and Naval Flight Officers, for subsequent digital transfer to the platforms and weapons. Current Fleet employment procedures generally have the launch aircraft provide the target updates, though they can also come from other targeting platforms. However, the Air Wing of the Future (AWOTF) will train and fight in a distributed environment, whereby NEW will regularly need to communicate with other nodes within the kill web besides the launch aircraft, to include other aircraft in the air wing and other Navy, Joint, and Coalition platforms. Assured communications is a critical enabler for this distributed environment.

The objective is to develop and demonstrate the ability to verify the compatibility of cryptologic key material and radio initialization settings among weapons, sensors, and shooters and to permit required data exchanges. End article must be ready for production, meet all requirements and specifications for National Security Agency (NSA) certification for handling of cryptographic key material, and supportable by current and future Fleet logistics.

The Fleet is struggling to improve the success rate of NEW employment in training and exercises due to the intolerance of any faults, errors, or omissions in the data entry and transfer process. To reduce the operational burden on aviators and to significantly raise the success rate of NEW employment, the Fleet requires a mission data verification capability to verify the aircraft and weapon dataloads are compatible and will result in successful data exchange after the weapon is launched. This verification must occur while aircrew are still near the mission planning system, to allow timely correction of errors. Waiting to verify correct initialization until the aircrew are in the aircraft with engines and systems online delays flight events and breaks aircraft carrier emissions control (EMCON) conditions required in wartime. In addition, not all NEW are capable of radio initialization verification before launch.

The flight test community at Naval Air Warfare Center Weapons Division, China Lake, CA, has developed a device that meets some of the Fleet requirements. However, it uses NSA Type 1 certified flight-worthy radios, has a user interface built for engineers instead of aircrew, and is of a size and weight unsuitable for deployed use aboard aircraft carriers and at remote operating locations ashore. This solution also requires a separate instantiation for each model of WDL radio currently in use.

The Fleet requires a solution that addresses the shortcomings of the device in use by the flight test community. A fieldable, sustainable, and usable solution must have a small footprint, easily stowable and transportable by aircrew and squadrons. In this regard, a software-only solution that can run on a laptop would be preferred, but not to the detriment of other requirements. It must be producible at a per-unit price below that of flight-worthy hardware, if possible. The solution must be capable of using the actual datalink initialization files from mission planning, including operational KEYMAT. The solution sought must work for every type of L16 terminal currently fielded in naval aircraft and weapons and must be architected to be easily and quickly updateable to work with new radios and new datalinks as they are fielded. Success is the ability to use NSA sourced Key Encryption Keys (KEKs) to decrypt Key Management Infrastructure (KMI) wrapped Traffic Encryption Keys (TEKs) in support of Navy missions. Key formats follow the NSA Cryptomodernized Key Specifications for L16 and vendor specific key splits that enable the radio operation. It must not produce any electronic emissions. It must be simple to use by trained aircrew and must take minimal time to produce a result. If the solution determines that the dataloads are not compatible, it should be able to inform the aircrew of exactly which parameter or data is causing the incompatibility. However, this feature is not required for fielding.

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: Identify and design a concept that, with minimal to no aircrew action (besides providing access to the dataload from the mission planning system), ingests the planned L16 radio KEYMAT and initialization parameters for multiple aircraft within the carrier air wing (CVW), multiple weapon types (all current deployed NEW), and multiple weapons (i.e., a single weapon type carried by multiple aircraft to be employed as a salvo), tests whether the combination of KEYMAT and radio initialization will allow the required data exchanges, and provide aircrew an indication of success or failure. Emphasis should be on currently fielded aircraft, weapons, and radios. Phase I deliverables include a detailed description of the proposed solution, a detailed plan for development of a proof-of-concept capability, and a proposed cost and schedule for Phase II. The plan should include a draft NSA certification plan (if required by the proposed solution). The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design, develop, and deliver a proof-of-concept solution as described in the Phase I deliverables. Produce an NSA reviewed certification plan and tailored Information Assurance Requirements (as required). Expand the design to accommodate emerging waveforms and WDLs. Assess

and report the utility/feasibility of adding BLOS radios. Provide cost and schedule estimate for transition to production and production of IOC quantities, as well as sparing and support plan.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Obtain final approved NSA certification (as required). Partner as necessary for transition to production and sustainment. Produce IOC quantities (approximately 10–32 units). These units will be deployed aboard U.S. Navy aircraft carriers and to Master Jet Bases for use by strike fighter squadrons for NEW training.

The capability will have dual-use/commercial application benefits supporting commercial sales of UAV/drones requiring data link mission systems software uploading in either a classified or non-classified environment. Having a key validation tool will provide the quality checks and balances required to assure mission success.

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KEYWORDS: Network Enabled Weapons; Link-16; Initialization Parameters; Assured Communications; Mission Data Verification; NSA Type 1 Encryption

N251-010 TITLE: Conformal Antennas for Unmanned Aerial Vehicles (UAV)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Integrated Sensing and Cyber;Microelectronics

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: Originate an additive manufacturing-based technology suitable for use in creating conformal antennas that also function as structural skins/air flow surfaces for airborne pods and wing-based Unmanned Aerial Vehicles (UAV). Also desired is the development of related techniques, which can be used for ground vehicles and drones.

DESCRIPTION: Conformal antennas became popular during the conflict in Afghanistan when their lack of visual signatures provided an operational stealth advantage. Since then, the increased maturity of electromagnetic simulation codes has allowed the impact of multiple feed points on nonplanar surfaces on the frequency dependence of antenna patterns to be controlled in the design process. The same codes now allow the frequency span of periodically spaced resonant element arrays to increase from 4:1 to as much as 50:1 by implementing electrical interconnections between actual phase centers for radiation. Conformal antennas lack the need to modify the design of antenna fins. Such changes impact air flow and hence flight performance and require expensive design verification costs for both pods and UAV. Ultra-wideband antennas are also inherently more attractive than narrow band ones since many techniques exist to reconfigure wideband systems into multiple narrow band ones for cases where frequency scanning or limited operation adaptation are acceptable. Moreover, functional specific antenna fins limit the maximum production volume of a given transceiver’s realization, raising per unit acquisition and logistics costs and increasing the likelihood of manufacturing delay. Thus, it is desired for wideband, conformal antennas to develop as generic packaging commodities. It is notable that additive manufacturing techniques have been used to construct complex periodic arrays, though the range may still be limited by structural and electrical properties of the “inks”.

It is known that the addition of carbon nanotubes to various polymers change their electrical properties from insulating to conductive, though how close to high purity copper in electrical properties can be achieved is unclear, especially in a material strong enough to be used as thin shells with good structural properties. Thus, it is unknown if conformal antennas for unmanned platforms, such as pods and UAV, should be constructed as single layers with local control of the electrical conductivity or multilayered prints and using standard additive conductor structures at each feed point or slot antenna concepts. 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 design for a 4:1, > 90° field of view (FOV) antenna for 6 to 24 GHz on a cylindrical volume 10 in. (25.4 cm) in outer diameter and having minimal internal stiffening structure, 5 ft (1.52 m) long and with two pairs of wings that can be realized using the simulation code and manufacturing process identified in the Description. During the base, both complete the design in simulation and produce prototype planar array coupons having more than four elements. Experimentally document the electrical and structural properties of the printed materials and the functionality of these coupons as directional emitters. Identify all the roadblocks to realizing the performance objective defined in the original proposal. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Work with the naval sponsors to refine the design into a target platform of specific operational class and functional requirements. Deliver a scaled first prototype in the Base period. An iteration thereof that addresses sponsor concerns should be completed in the Option period. This iteration is then to be flight tested during the Phase II Option with the internal volume occupied only by onboard signal emitters and any required batteries. This work is expected to be export controlled and could become classified secret.

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

PHASE III DUAL USE APPLICATIONS: Focus on integration of the design concept into a particular functional system. Work with program office staff to produce further improvements to shells loaded with more realistic internal transceivers and document their functionality under fielded conditions. These shells become a generic part wherein the RF antenna characteristics are determined by connections and hardware inside the volume.

Commercial applications could include hour to day-long deployments as reconfigurable extra/temporary replacement relay stations for wireless systems. Also, car collision avoidance systems use sparsely arrayed antennas on increasingly nonmetallic surfaces as active radars, while driver entertainment and assistance systems require multiple communications network capacity.

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KEYWORDS: Distributed Antenna Arrays; Slot Antennas; Carbon Nanotubes; Additive Manufacturing; Wideband Antennas; Reconfigurable Antennas

N251-011 TITLE: Extreme High Speed Laser Application (EHLA) for Titanium Cylinders Bores

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop Extreme High Speed Laser Cladding technology for the inner bore of titanium cylinders.

DESCRIPTION: Internal bore diameters of hydraulic cylinders and dampers experience excessive wear in extreme conditions and require replacement at high cost. Current titanium coating applications introduce a high heat-affected zone into titanium housings causing, delamination, reduced fatigue life, distortion, and surface cracking. Coating technologies available today are limited to select processes as to not affect the base titanium material but the processes still ultimately result in early failure of the component due to heat-affected zone penetration. Additionally, coating blind bores is not common in industry. This is due to fixturing and tooling available as discussed in the third paragraph.

Coating the bore of the cylinder with a hard, wear-resistant, and corrosion-resistant coating is desirable to extend the life of the component. The Extreme High Speed Laser Application (EHLA) technology is unique in that it melts the powder before it hits the substrate, which causes a very little heat-affected zone, by orders of magnitude less than common coating applications. For comparison purposes, EHLA may create heat-affected zone of ~0.001 in.–0.003 in. (0.025–0.076 mm), whereas traditional laser clad creates a heat-affected zone of 0.03 in. (0.076 mm), or more. With EHLA, the coating is metallurgical bonded via the fusion process to the base layers, so it does not chip, peel, or delaminate.

The EHLA process has mainly been used for line-of-sight applications, but the technology has progressed, and non-line-of-sight (NLOS) equipment is now available for use within the past year. The benefit of NLOS is that it allows the coating to get into smaller diameter bores, radii, and difficult transition areas of a part. A German company named the Fraunhofer-Gesellschaft originally developed this technology. China has heavily invested in this technology. The Fraunhofer-Gesellschaft is currently the only company in the world that has vast experience in extreme high-speed laser application technology. They have used this technology to coat external components. Small Internal bore application has been developed within the last year, which can now be applied down to 3.5 in. (8.89 cm) diameters. Successfully coating titanium bores with this technology will help future programs and future Original Equipment Manufacturers (OEMs) be less averse to selecting titanium as an actuator or cylinder material. By choosing titanium they can adhere weight savings on the aircraft because they get the added benefit of this novel wear coating's performance. This technology is not restricted to titanium cylinders, but the process can be adapted to coat aluminum and steel cylinders easily and have the same beneficial results. EHLA is cost-effective due to few required pre/post processing treatments, high repeatability and precisely controllable, and it can easily be removed and reapplied without the need of building another asset.

PHASE I: Identify potential wear coatings and application for use on Titanium cylinder substrates with NLOS applications using EHLA technology. Determine a coating material that can be applied to beta-STOA Ti-6Al-4V (Current supplier: Consolidated Industries) that has a high-Rockwell Hardness C (HRC) rating and high-wear resistance with small ductility in order to prevent wear and internal debris. Identify methods to ensure the surface has adequate texture for oil retention and lubricity. Determine and define the correct laser head and powder feeding rate to properly apply the coating onto the titanium cylinder that keeps the temperature at or below 350 °F (176.66 °C) with as little heat-affected zone as possible. Provide evidence of feasibility for developing the coating process in Phase II. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Prototype the EHLA NLOS process for application of wear coatings for Titanium cylinder substrates with minimum bore inside diameter of 3.5 in. (8.89 cm) and minimum length of 12 in. (30.48 cm) based on Phase I results. Develop and implement the coating method to ensure surface has adequate texture for oil retention. Complete necessary testing to validate the integrity of the substrate and the coating: metallurgical analysis, bond testing, wear testing, corrosion testing, and fatigue. Provide a report that outlines the prototype process, equipment, methodology and testing completed to verify integrity. Develop a plan to mature the technology in Phase III.

PHASE III DUAL USE APPLICATIONS: Using the matured EHLA NLOS process, coat a full-scale 53K titanium damper housing and complete a full-scale 1700 hr endurance test to demonstrate that the EHLA process provides minimal wear and corrosion resistance. Once complete, this technology can begin to integrate into the 53K fleet and become a route for OEMs to design hydraulic cylinders out of titanium to provide weight savings.

OEMs and the private sector will benefit from this technology by having the capability to coat titanium cylinders instead of typically going with steel in order to provide weight savings. Along with the added benefit of reducing internal wear, higher quality adhesion to the cylinder housing, and superior oil retention for a sliding seal. EHLA is available for use in multiple cylinder applications including aluminum and steel.

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KEYWORDS: Coatings; Titanium; Extreme High Speed Laser Cladding; Wear Resistant; Actuators; Dampers

N251-012 TITLE: Resource Manager Enhancements for Automated Maritime Mission Prosecution

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Trusted AI and Autonomy

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 decision making tools and processing techniques to dramatically reduce the time required to achieve maritime situational awareness in very dense contact environments.

DESCRIPTION: Distributed maritime operations in dense surface contact littoral environments is challenging and requires automated mission prosecution. The construction of surface picture heavily relies on the use of a sensor resource manager controlling a surveillance radar augmented by electro-optical/infra-red (EO/IR) and electronic support measures (ESM). The sensor resource manager enhancements would ideally demonstrate improved classification of dark surface contacts not transmitting automatic information systems (AIS). Surface contact physical attributes (e.g., length), behavioral characteristics, and in-theater location should be contributors to the automated decision processes. The aggregation and exploitation of historical information could utilize artificial intelligence/machine learning (AI/ML) methods as appropriate to facilitate in-mission decision processes.

In dense maritime environments typical of many areas of the western Pacific, an airborne surveillance platform with a capable radar, ESM and AIS may have several thousand or more vessels under track. Making sense of what is going on is extremely challenging. The automatic association of information from these independent sensors is certainly beneficial in gaining maritime situational awareness. However, in many instances AIS messages contain false coordinates, incorrect field entries or missing entries. In other cases, vessels stop transmitting AIS or AIS reception is jammed. Furthermore, during times of heightened tension or conflict many radio frequency transmissions from surface vessels are expected to curtail dramatically. Achieving a comprehensive wide-area maritime situational awareness in these dense environments is very challenging in the best of circumstances, but is more challenging when the role of AIS and ESM degrades. From a radar perspective, maritime situational awareness involves developing a surface track picture, and then using an inverse synthetic aperture radar (ISAR) mode to image individual vessels in order to classify them. Inverse synthetic-aperture radar (ISAR) dwells may last 15–30 s each, meaning it is impossible to image all vessels under track.

In order to address this sensor timeline issue, the Navy needs to gather more classification information from very short duration ISAR sessions. These short sessions or ISAR snap shots (ISARSS) would take approximately 1 s rather than the 15–30 s for a traditional ISAR. The construction of surface picture relies heavily on the use of a sensor resource manager controlling the radar’s operation. In this SBIR topic, the Navy seeks to develop the means to maximize the vessel classification information from an ISARSS with sensor resource management control. Minimally, the vessel’s length overall and the general topside profile is expected to be derived. This information may be sufficient to identify a vessel as a possible combatant. In order to make ISARSS truly valuable, much more classification information is required. Providing fine naval class-level identification using ISARSS, leveraging compressive sensing techniques would fundamentally change the time and resources needed to achieve wide-area maritime situational awareness.

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 an architecture for the automatic aggregation of this information into an exhaustive set of filtering discriminants that can be subsequently used to enhance sensor resource manager decision processes during mission prosecution. Complete an initial analysis of how ISARSS might support fine naval class-level identification with tight coupling between the ISARSS classification information and the sensor resource manager. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Mature the coupled resource management and ISARSS exploitation approach for a specific radar system identified by the Navy sponsor. The ISARSS exploitation approach will be matured using collected field data supplied by the Navy sponsor. Assess the performance of the ISARSS exploitation as a function of range, dwell time and illumination geometry. Assess the performance of the combined system in a high-fidelity mission level simulation. Prepare an integration plan for the integration on a platform identified by the Navy sponsor.

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

PHASE III DUAL USE APPLICATIONS: Complete the automated control approach and ISARSS exploitation and integrate into a Navy mission system.
The automated control and imaging exploitation capabilities could be utilized by agencies like the Coast Guard.

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KEYWORDS: Sensor Resource Management; Inverse Synthetic Aperture Radar; Automatic Target Recognition; Maritime Situational Awareness; Radar; Automation

N251-013 TITLE: Passive Cooling/Heating System for Thermal Regulation in Clothing

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop a novel a passive cooling capability that provides thermal regulation when operating in the aircraft and/or insulation during inwater survival with a minimal impact on bulk and weight.

DESCRIPTION: For Navy and Marine Corps aircrew, the need to wear an anti-exposure coverall is determined by the operational environment air and water temperatures in which they will be operating. Anti-exposure coveralls are required when flying over water temperatures of 60 °F (15.6 °C) or lower and the outside air temperature is 32 °F (0 °C) or below (when corrected for wind chill). Temperatures in the cockpit and aircraft at takeoff and during flight can be much higher as the aircraft departs from a warm environment and operate over cold water that requires wearing an anti-exposure coverall. Current Navy constant wear exposure suits, the CWU-86/P for men and CWU-87/P for women, are required to be worn by aircrew in rotary-wing, tilt-rotor, and ejection seat aircraft when operating in these environmental conditions. The CWU-86/P and CWU-87/P are dry suits and designed to prevent water intrusion into the suit, keeping the layers underneath dry in order to provide the insulation required for survival. The CWU-86/P and CWU-87/P were designed for a 2 hr inwater exposure time and 3–4 hr of wear time. The increasingly common practice of mid-air refueling extends the duration of wear time in flight and extends the potential inwater exposure due to a longer time before rescue. The design does not afford any thermal regulation for comfort during normal flight conditions, which leads to overheating and sweating, and which is distracting and can lead to dehydration and fatigue.

The Naval Air Warfare Center Aircraft Division (NAWCAD) is seeking novel solutions to improve personal thermal management in flight and maintain or improve inwater thermal protection from hypothermia. The solutions must provide aircrew the capability to actively regulate body temperature in flight without degrading in water survival. Increases in body temperature during flight and decreases in temperature during in water survival can impact strength, endurance, cognitive function, and mission effectiveness decrease [Refs 1-3].

More specifically the solution and technology must meet the following requirements. The requirements address both inflight and inwater scenarios. A solution that addresses one, but not both scenarios will be considered, as well as solutions that address both scenarios.

1. The solution must maintain or improve thermal regulation of aircrew when wearing the current inwater configuration of the CWU-86/P or CWU-87/P worn with two layers of long underwear (layer 1: mid-weight, layer 2: heavy weight).
2. This solution must manage moisture build up inside of the exposure suit to reduce the potential of hyperthermia.
3. The solution must insulate the body to reduce heat loss during inwater immersion and survival for 4 hr (threshold) 24 hr (objective).
4. Aircrew must be able to wear the solution for 12 hr, without interfering with operation of the aircraft or mission tasks.
5. The solution must be compatible with aircrew life-support equipment worn over the top of an anti-exposure coverall. For rotary-wing and tilt-rotor aircrew the configuration will include a survival vest with LPU-36/P or LPU-21E/P life preserver, HGU-56/P helmet, gloves, and boots. For fixed-wing, ejection seat aircrew the configuration will include the CSU-15/P anti-g garment, the PCU-58P parachute/restraint harness, the LPU-37/P or LPU-23/P life preserver, the HGU-68 helmet, gloves, and boots.
6. The body core temperature from body heat build-up during operational performance of aircraft must not exceed 101.3 °F (38.5 °C).

7. The body core temperature must fall no lower than 95 °F (35 °C).
8. The hand and foot skin temperature must be no lower than 60 °F (15.6 °C) when immersed in 45 °F (7.2 °C) water for a minimum of 2 hr, and 60 °F (15.6 °C) when immersed in 32 °F (0 °C) water environment for a minimum of 4 hr.
9. The garment must not interfere with bladder relief systems worn with the anti-exposure suit.
10. The solution, when worn as part of the anti-exposure suit configuration must not cause body burn greater than 25%.
11. The solution must follow MIL-STD-1472H (5.8.3.2). For systems and equipment that are life-critical (e.g., accessibility of safety interlocks, clearances for ejection seats, fit of gas masks), the design for all physical factors (size, shape, weight, reach, strength, and endurance) must accommodate the multivariate central 99 % of suitably clothed and equipped males of the target user population and the multivariate central 99 % of suitably clothed and equipped females of the target user population using dimensions applicable to the tasks.
12. The solutions must not require power (objective) and will utilize a portable power source (threshold) when used in the aircraft. Power is not preffered when in water.
13. The solution must not obstruct emergency egress from the aircraft.
14. If applicable, the solution must continue to function as designed after 25 launderings.
15. The solution must maintain functionality for a minimum of 1 deployment (9 months) with minimal maintenance support.
16. The solution must be easily donned by the individual without requiring additional help.
17. The solution must not cause hot spots or rash if in contact with the skin.
18. The solution must meet airworthiness standards (i.e., MIL-HDBK-516).

PHASE I: Design and develop a solution concept of a thermal regulation system for use with a constant wear anti-exposure coverall. Demonstrate technical feasibility of the solution through analysis and limited laboratory demonstrations. Provide cost and reliability estimates. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, demonstrate, and validate a working prototype for testing based upon the design concept created during Phase I. Conduct laboratory testing and demonstrate thermal regulation capability in a laboratory environment. Demonstration will be conducted in a simulated environmental environment with personnel representing the central 5th to 95th percentile male and female aircrew.

PHASE III DUAL USE APPLICATIONS: Perform final design updates based upon prototype testing in Phase II. Produce systems for flight testing and develop production capability for commercialization. Provide updated engineering drawings, detail specifications, cost and life cycle analysis, maintenance and repair procedures.

The technology developed under this effort can apply to commercial aircrew flying in helicopters over water, commercial fishing industry, commercial applications in which workers are wearing garments to protect from liquid contaminants.

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KEYWORDS: Exposure Suit; Heating; Cooling; Passive; Clothing; Thermal Regulation

N251-014 TITLE: Enhanced Submarine Mast Detection and Discrimination

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Trusted AI and Autonomy

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: Exploit the radar backscattering return from the wake produced by a submarine mast to enhance detection and discrimination beyond what is possible when relying solely on the return from the mast.

DESCRIPTION: The U.S. Navy requires an operational capability to detect submarine mast wakes from high altitudes using coherent radar waveforms that also reliably reject sea clutter detections. Submarine mast detection has always been one of the most challenging radar problems. Submarines deploy a variety of sensor masts including optical and electro-optical periscopes, electronic support, radio frequency direction finding, and radar. Maritime wide area surface search radars traditionally operate at low altitudes with non-coherent waveforms. At high and grazing angles coherent processing can add Doppler spectrum as a radar observable. If the Doppler spectrum of a mast’s return can be adequately separated from that of the sea, then improved detection performance is possible. However, the radar cross section of the mast itself may be very small. Therefore, if the wake generated by the mast can also be exploited, additional performance is possible.

Measurements of backscatter from real submarine masts is generally classified, although some measurements of masts have been published in the open literature [Refs 1 and 2]. Those measurements show that the backscatter is composed of the return from the mast, the wake generated by the mast moving through the water, and the clutter return from the surrounding ocean surface within the radar’s antenna beam. Analysis of those measurements show the return from the mast, in this case with a Doppler shift placing outside the clutter spectrum, and a significant return from a wake. The sea clutter spectrum is also visible. It appears that the Doppler spectrum for the wake extends over about –3 m/s to 3 m/s, equivalent to a Doppler spread of about 400 Hz in X-band. The clutter extends over about –0.5 m/s to 1.5 m/s, or about 125 Hz in X-band. The target has a narrow spectrum, mainly confined to a single Doppler bin having a resolution of about 0.1 m/s. The total power in the wake appears to be comparable to the power from the mast alone. These results are a function of the test conditions and in some other cases the mast may have the same Doppler shift as the sea clutter returns and a clear separation in Doppler space cannot always be relied upon.

In this SBIR topic, the Navy seeks to better understand the wake signature from the moving mast. More complex detection schemes might be considered; for example, those involving micro-Doppler signatures from the wake. An understanding of the wake magnitude and Doppler spread over the range of mast configurations, sea states, submarine speed, direction of movement relative to the prevailing seas and radar viewing geometry is needed to gain a comprehensive understanding of the feasibility of such schemes.

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: Complete comprehensive analytical and numerical assessments of how the wake generated by a moving submarine mast will supplement the hard body return for detection and discrimination performance improvements. Assume the grazing angle ranges from 5 to 20 degrees over a representative range of conditions. Consider probability of detection and false alarm rate as compared to those for the mast alone. Develop the basis for the discrimination approach which complements the hard body technique. Prepare an overall system architecture concept. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Work with the Navy to test and refine the approach developed in Phase I using experimental data provided by the Navy. Tune the approach to the data's specific conditions. The supplemental detection and discrimination approach should be sufficiently mature at the conclusion of Phase II that it could be integrated into a radar's submarine mast detection and discrimination system.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Complete the automated processing capability for enhanced submarine mast detection and discrimination and integrate with a Navy maritime surveillance radar system.

The techniques could be applied to a variety of small target detection capabilities in a maritime environment such as those needed by the Coast Guard.

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KEYWORDS: Submarine Masts and Periscopes; Wake Characterization; Electromagnetic Scattering; Doppler Processing; Radar; Maritime Surveillance

N251-015 TITLE: Predictive Lifing Tool for Coupled Corrosion, Pitting, and Fatigue Degradation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop and demonstrate predictive modeling and lifing capability for coupled corrosion, pitting, fracture, and fatigue mechanisms of naval aero-engine propulsion materials.

DESCRIPTION: Critical propulsion components are carefully lifed to uphold system safety and reliability in support of the warfighter's mission. Lifing analysis relies on an understanding of the fracture and fatigue mechanics of component materials to establish inspection, maintenance, and removal intervals throughout the life of the weapons system. Often, component lifing is based on empirically derived material properties, S-N curves, and Weibull analyses of inspection and failure events. However, the roles of the austere naval operational environment and environmental degradation of material properties are difficult to evaluate, and it becomes even more complicated to predict the resulting impact on fatigue and service life.

In naval aviation, the warfighter must operate within maritime atmospheric environments, and critical propulsion components are exposed to harsh cycles of high humidity, temperature, and salt exposure, which contribute to corrosion degradation and pitting. In recent years, there has been significant research into coupled corrosion, pitting, fracture, and fatigue mechanisms. This research has uncovered numerous contributing mechanisms, such as galvanic coupling, high temperature oxidation, saltwater corrosion, cyclic environmental corrosion, hydrogen embrittlement, coupled erosion/corrosion or impact/corrosion, among others. This interconnection of mechanisms has made the development of predictive corrosion modeling very difficult and very complex.

However, there is an ever-growing need for predictive lifing capabilities. The material, maintenance, and manpower costs of repairing or replacing components due to corrosion has become a significant hindrance to the affordability, availability, and safety of the warfighter. Currently, the U.S. Navy spends between $3 to 4 billion per year to combat corrosion. Part of this cost is driven by the undetermined effect corrosion degradation has on component life; out of an abundance of caution, components are repaired or replaced prematurely when there may be additional, safe operational life still available. Notably, this need exists not only across naval aviation but also across surface and undersea naval material applications, so predictive corrosion fatigue lifing capabilities may be disseminated across the Department of the Navy. Thus, the U.S. Navy seeks the development of a predictive modeling and lifing tool for coupled corrosion, fracture, and fatigue of naval aero-engine propulsion materials to support more accurate, reliable, and safe lifing of warfighter components. This lifing tool should address as many of the specific capabilities listed here as feasible. The proposed solution may be a self-contained tool encapsulating all the capabilities listed. It may be an add-on tool compatible with a commercial-off-the-shelf predictive model, such that the combination addresses the target capabilities. It may also be a series of independent tools that each address the different capability needs. The intent of this Description is to outline the desired capabilities of the final lifing tool but to allow the proposer flexibility for how to achieve and package these capabilities.

The tool should address the following capabilities:

1. Develop a Material Model with Customizable Loading Conditions. Any predictive lifing tool should be capable of reflecting realistic or structurally relevant loading conditions. For example, airworthiness considerations may require conventional tension and tension fatigue testing, steady and cyclic applied loading, flexural loading, and uniform and non-uniform loading conditions. Solutions are sought that are capable of modeling different mechanical loading scenarios and can be validated with common tensile, flexural, or other experimental method. Upon award, the Navy

technical point of contact (TPOC) can help identify the most crucial mechanical loading configurations to model.

1. Many different alloys, coatings, greases, and other materials are used in the U.S. Navy fleet. The material model should be developed and demonstrated with the material properties of (a) a representative aluminum alloy, and (b) a representative stainless steel. Upon award, the Navy TPOC can assist the team to identify the most appropriate material systems based on the required data inputs per the strategy described above and available property data. Common aluminum alloys used in the fleet are F357, AA 2024, and AA 7076, and common stainless steels are 17-4PH, A286, and M152.
2. Simplify Material Corrosion Degradation. Corrosion mechanisms are highly complex and interdependent. Thus, truly predictive modeling of those mechanisms is very challenging, likely involving coupled chemical and environmentally-driven reaction kinetics and likely beyond the scope of a single project. Solutions are sought, which propose a reasonable and achievable simplification of naval aero-engine corrosion mechanisms within the material model. For example, it may be reasonable to apply some environment-dependent scaling coefficient or stress riser to the stress intensity factor driving crack growth. It may also be possible to model material degradation due to corrosion by reducing the material to an effective, load-bearing geometry or by imposing a pre-existing defect, like a pit or crack, to the material model. Furthermore, aero-engine corrosion is highly cyclic, so models that incorporate some cyclic progression of corrosion degradation will be prioritized. Continuing from the previous examples, this cyclic degradation may take the form of periodic reduction of the load-bearing geometry or of pre-existing surface defects of the material model. These are just examples of simplifications and are not meant to constrain proposed corrosion degradation modeling. Upon project award, the Navy TPOC can provide experimental data on observed corrosion rates, pitting, and pre-existing defect features as well as some operational data, which may describe the frequency and magnitude of environmental cycles.
3. Correlate Impacts to Fatigue Life. Once a strategy to model the corrosion degradation is identified, that strategy should be implemented within the material model with customizable loading configurations to form the predictive lifing tool. This lifing tool should be capable of quantifying a predicted fatigue strength over a range of loading conditions in the form of an S-N curve. S-N curves are common graphical depictions of the load fatigue strength relationships of a material or component and provide an easy, visual means of comparing the strength properties of different materials. The key output of this predictive lifing tool should be the S-N curves of one representative aluminum alloy and one representative stainless-steel alloy across a realistic range of loads and cyclic content. Upon project award, the Navy TPOC can provide guidance about engine loading and cyclic content.
4. Predict the Fatigue Life Impacts of Pre-existing, Surface and Near-Surface Cracks and Pits. The predictive lifing tool should be capable of representing the effect of pre-existing, surface and near-surface cracks and pits. Many degradation mechanisms begin with the generation of surface and near-surface cracks and pits, and the predictive capability to model the fracture and fatigue performance of a material will inform allowable limits on pre-existing pits, cracks, and porosity within an as-manufactured material. The tool should be capable of modeling the impact of crack or pit size, depth, and density within the material. The resulting fatigue performance should be represented in S-N curves.
5. Validate the Fundamental Fatigue Life Predictions. The predictions of the corrosion fatigue lifing tool should be validated for both the representative aluminum alloy and the representative stainless-steel alloy in at least two disparate loading configurations (e.g., two different tensile loads, one tensile load and one torsion load, etc.). Tool predictions should be made for each material in an ideal, uncorroded state; a minor-to-moderately corroded state; and a moderate-to-heavily corroded state. The nature of the modeled corrosion state may depend on the proposed strategy to model corrosion degradation. Upon award, the Navy TPOC may help to identify the

appropriate model prediction and validation conditions, but these conditions should be producible in a laboratory environment. The proposer should identify the test facility capable of performing the validation experiments, mimicking the test conditions in the tool prediction to enable a direct comparison of results.

6. Package the Predictive Lifing Tool into a Testbed. The predictive corrosion fatigue lifing tool should be packaged into a testbed deliverable, integrating the required capabilities previously described. This testbed may take the form or forms most appropriate to deliver these capabilities to NAWCAD engineering personnel. For example, the testbed may consist of a single, standalone software package or model, or it may consist of a series of add-on packages for existing commercial software. If awarded funding, teams should work with the Navy TPOC early in the tool development to identify the form of the testbed deliverable to comply with any Navy software or computational tool restrictions. In addition to providing key benefits to the Navy, the lifing tool is anticipated to extend corrosion fatigue lifing capabilities to other ground, surface, and aerial commercial and military vehicles operating in highly corrosive environments, so the proposer should outline a commercialization pathway for the lifing tool.
7. Provide Workforce Training for the Tool. To facilitate the delivery of the testbed lifing tool, the proposer should plan for and conduct either an on-site or virtual training for NAWCAD engineering personnel. The objective of the training should be to provide NAWCAD personnel an understanding of the tool's function with respect to the required capabilities listed above, of how to use the tool, and of the application of the tool to other material and environmental conditions (including identifying necessary user inputs for such applications).

PHASE I: Demonstrate the feasibility and probability of success via the initial development of a tool framework.

1. Technical Challenges Assessment. Perform a review of the technical challenges facing a proposed solution and assess these challenges. Consider the availability of environmental and material data, the proposed strategy for corrosion modeling simplification, the difficulty and time required for the tool development, among other obstacles. This assessment should inform the Solution Feasibility Assessment, which capabilities will be addressed, and to what extent they will be addressed.
2. Strategic Work Plan. Based on the Technical Challenges Assessment, develop a strategic work plan for the development of a corrosion fatigue lifing tool to address the listed capabilities and to clearly identify the scope of work and tasking associated with development of each capability. This work plan should carefully consider and identify the assumptions, advantages, and limitations of the proposed strategy to model corrosion degradation described in the section "Simplify Material Corrosion Degradation." However, this work plan should also address the other capabilities, validation, testbed delivery, and training. The work plan should lay out a schedule of tasking and activities for Phase I and subsequent phases of work if awarded. Outline specific tasks, objectives, milestones, and go/no-go decision points to track the progress and feasibility of the proposed solution in context with the Technical Challenges Assessment and Risk Assessment.
3. Risk Assessment. Evaluate the Strategic Work Plan and Technical Challenges and identify potential sources of risk. Develop a risk mitigation plan that outlines specific strategies and/or go/no-go decision points in the outlined work plan.
4. Preliminary Feasibility Assessment. Begin execution of the Strategic Work Plan to demonstrate the initial feasibility and likelihood of success of the proposed solution. Phase I progress will be evaluated based on accomplishments made against the Strategic Work Plan and towards Capabilities 1, 2, 3, and 4.

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

PHASE II: Fully execute the Strategic Work Plan developed in Phase I and demonstrate a predictive corrosion fatigue lifing tool.

1. Testbed Development. The Strategic Work Plan should be fully executed to deliver a predictive corrosion lifing tool satisfying the listed capabilities.
2. Testbed Validation. Validation of the testbed should be completed as described in Capability 5.
3. Updated Risk Assessment. Upon completion of the testbed, the Risk Assessment from Phase I should be revisited and updated to reflect resolved or new risks, and to identify appropriate mitigation to sustain use of the lifing tool. Future risks or opportunities for future development should also be identified, which may bring added capability.

PHASE III DUAL USE APPLICATIONS: Complete delivery of the testbed corrosion fatigue lifing tool.

1. Testbed Delivery and Training. Delivery and training of the testbed with NAWCAD engineering personnel should be completed as described by Capabilities 6 and 7. A commercialization pathway beyond the Navy should also be identified.
2. Technical Challenges Re-Assessment. Perform a re-assessment of the technical challenges identified in Phase I. These challenges would have informed the proposed strategy for corrosion modeling simplification, such as for example the simplification to the effective load-bearing geometry. This re-assessment should consider how the lifing tool may require future development to meet the specific needs of commercial and military end users and how corrosion model simplifications may or may not be appropriate for different users. Identify a pathway to re-address those challenges and to feasibly avoid model simplifications. Continuing with the previous example, if the model was simplified to a load-bearing geometry, describe the future tasking required to introduce the reaction kinetics that may instead inform a more representative depiction of the material degradation. Identify what information or knowledge gaps need to be resolved to avoid such simplifications, what testing or analysis is needed to address those gaps, and assess how feasible it would be to incorporate updates to the lifing tool.

The solution is expected to be highly applicable to both military and commercial aviation propulsion systems and materials. Military operations, by their nature, are more strenuous than commercial, and involve operations in the harshest environments, which contribute to accelerated corrosion. However, commercial aviation is also experiencing significant degradation due to corrosion, particularly commercial operators who fly in and out of coastal and subtropical regions. As such, this corrosion fatigue lifing tool may benefit commercial operators to predict how that degradation will affect component lifecycles and to use the tool to provide informed engineering judgement for component maintenance and sustainment activities. While the tool targets naval aviation applications, the basic function of the tool may also be extended to ground and surface vehicles operating in highly corrosive environments. Air-breathing propulsion systems, like gas turbines, are used for power generation in surface vehicles and use equivalent designs and materials to aviation systems. Lightweight and structural materials (i.e., stainless steels and aluminums), are also common across ground, surface, and aerial vehicles, meaning that material-customizable configurations of the tool may be readily transferred among applications.

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KEYWORDS: Naval Aviation Propulsion; Corrosion; Fatigue; Cyclic Environment; Corrosion Fatigue Modeling; Lifing Tool

N251-016 TITLE: Expendable Sonobuoy-Launched Unmanned Aerial Vehicle for ASW Cued Search, Detection, Tracking, and Classification

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 expendable Tier 1 Sonobuoy Launched Unmanned Aerial Vehicle (SL UAV) that can be launched from a P-8A's sonobuoy launcher system from high altitude, with a sensitive magnetometer, and capable of deploying an in-water passive acoustic sensor(s) for Anti-Submarine Warfare (ASW) target cued search, detection, localization, tracking, and classification.

DESCRIPTION: The metrics of this development are:
Overall Sonobuoy Launched UAV for ASW Re-Acquire, Tracking, and Classification System Objectives:

1. Packaging: LAU-126A Sonobuoy Launch Container (SLC) or equivalent,
2. SLUAV Weight: Max 39 lb (17.7 kg) (bare, not including the SLC),
3. SLUAV Stowed Dimensions: 4.875 in. (12.38 cm) diameter x 36 in. (91.44 cm) length,
4. Storage: 9 years shelf life,
5. Launch Envelope: Full Sonobuoy production specification,
6. Speed: 70 kts Cruise Air Speed (Threshold),
7. Endurance: 70 min (Threshold),
8. Operational Altitude: 500–2,000 ft (15.24 m–609.6 m),
9. Range: 20 nm LOS (extending to 50 nm),
10. Payload Volume: Greater than 94.4 in.^{3} (1546.94 cm^3),
11. Environment:
    a. Temperature – must be able to operate in -20 °C–50 °C,
    b. Light Rain such that visibility is greater than 1 nm,
12. Autonomy: Threshold: Fly pre-programmed waypoint tracks and orbits, Objective: Transition to autonomous target tracking as cued by MAD system,
13. On board Processing:
    a. AI performance: Not less than 275 TOPS (INT8),
    b. Max GPU frequency: Not less than 1.3 GHz,
    c. Number of GPU cores: Not less than 2048 CUDA cores and 64 Tensor cores,
    d. Number of CPU cores: Not less than 12,
    e. CPU frequency: 2.2 GHz,
    f. Memory (RAM): Not less than 64 GB.
14. Command and control:
    a. Phase I and II: Any,
    b. Phase III: UAS Control Segment (UCS) Architecture, and
15. Cost: In final form, < $10,000 in quantities of 100.

Magnetic Anomaly Detection (MAD) System Specific Objectives:
The SL UAV must support MAD with the requirement that the inherent platform motion coupled with the SL UAV & acoustic sensor payload magnetic signature shall not prevent the following performance:

1. Platform magnetic field components will exhibit an amplitude noise spectral density of less than 1 pT/rtHz from DC to 100 Hz.
2. Magnetometer should work in real-world conditions including a dynamic range of +/- 100 µT on each axis, no dead zones, and an accuracy of 1 nT over the temperature range of -0 °C–50 °C.
3. MAD in-air noise level: Threshold: 20 pT/rtHz in 0.01–100 Hz with a raw heading error of <3nT uncompensated.

In-Water Passive Acoustic Sensor Specific Objectives:

1. Operating Life: Threshold 60 min; Objective 70 min,
2. Max Operating Depth: Threshold 200 ft (60.96 m); Objective 400 ft (121.92 m),
3. Deployment time: Threshold 120 s; Objective 60 s,
4. Scuttle: Threshold: Automatic based battery life remaining; Objective: Automatic and on-command,
5. Sensor DI: Threshold: omni; Objective: higher gain and/or direction-finding capability,
6. Sensor(s) Frequency Coverage: Threshold: 0.01 Hz–2.5 kHz; Objective: 0.001Hz–25 kHz,
7. Sensor Noise Equivalent: dependent on proposed topology; intent would be to extend contact time (detection range) commensurate with DI and ambient conditions,
8. Data shaping: whitened to environment for reduced uplink bandwidth,
9. Sensor Calibration Accuracy: Threshold: +/-2dB; Objective: +/-1dB,
10. Range: 20 nm LOS (extending to 50 nm).

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 concept for an expendable SL UAV supplied with an Area of Uncertainty (AOU) conduct a cued search, detection, localization and classification using MAD and an in-water passive acoustic sensing capability to meet the above requirements. Explicitly state, theoretical, physical, numerical and computational methods employed. Approach for aircraft design and MAD/acoustic operation should be back up with simulated results and proved experimentally on a laboratory environment before proceeding to Phase II. If developing a new aircraft, compare to performance of similar SL UAVS previously developed. Clearly label artificial intelligence/machine learning (AI/ML) methods employed on SL UAV computer. Compare performance with non-linear correlation methods often employed on weak ML neural-networks. MAD detection and classification methods should not be limited to dipole models and must include, but not limited to, harmonic fields. Computational methods should be able to implement data fusion algorithms incorporating different sensor types. Encryption methods for data transmission should also be addressed.

A prototype of the aircraft should be completed by Phase I. This includes structural analysis and flight clearances. Magnetic characterization at magnetometer location should also be completed at different engine speeds. Failure to meet the magnetic noise threshold at the magnetometer location will result on a rejection for a Phase II.

A successful Phase I will be defined on meeting the threshold on the above-mentioned parameters in the structural analysis, simulation, and laboratory testing. Results from the previous should be confirmed by the TPOC, and more analysis/test may be requested by the TPOC as needed. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Based upon the Phase I effort, construct SLUAV MAD + Acoustic ASW System and demonstrate the feasibility of meeting the above requirements on a relevant and operation environment. A successful Phase II effort will culminate with a full-system demonstration of the combined MAD and acoustic capabilities on multiple SL UAVs. The SL UAVs, during this demonstration, should be air launched from a surrogate platform to demonstrate they can unfold, transition into stable flight and communicate. Additionally, the SL UAVs should be subjected to shock loads prior to air launch, these shock loads should replicate the loads the prototype would see from a Cartridge Activated Device (CAD) launcher or pneumatic sono-launcher as close as possible.

A successful Phase II will also measure the ability of the SL UAVs to operate in Swarm, classify and localize targets, and meet the in-flight thresholds defined on the Description.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Based upon the Phase II effort, on a relevant environment, conduct a Swarm search with SL UAV's, which includes relevant targets. Effort should detect, track, and classify targets using a combination of both magnetic sensors and acoustic sensors. The SL UAV's should be air launched from a relevant platform, which satisfy sponsors' demands.

SL UAV technology, combined with data fusion and processing capabilities, would improve product innovation in the deliverable of products meeting reckoning and detection demand while airborne both in the sea and earth landscape.

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KEYWORDS: Unmanned; Air Vehicle; UAV; UAS; Magnetic; MAD; Acoustic; Infrasound; Machine Learning; Artificial Intelligence

N251-017 TITLE: Small Type-1 Encryption for Aircraft, Littoral, and Terrestrial Higher-than-Secret (STEALTH) Applications

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber

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 very small modular NSA Type-1 High Assurance Internet Protocol Encryptor (HAIPE) Internet Protocol Security (IPSEC) encryption modules that support multi-frequency, carrier-hopping, spread spectrum features with removable crypto modules.

DESCRIPTION: Type-1 Encryption “device” for Aircraft, Littoral, and Terrestrial Higher-than-Secret (STEALTH) requires physically separated Red and Black dual processors as part of the architecture. STEALTH must have provisions for a modular Radio Frequency (RF) System on Chip (SoC) to support L and S Band Transmission Security (TRANSEC) Waveform (WF) Encryption. STEALTH will support Multi-Frequency, Carrier-Hopping, Spread Spectrum features in modern WFs. Target applications are for smaller embedded systems, such as 3U VPX, SOSA VPX, and other systems requiring removable plug-and-play crypto. Encryption data rates need to be able to support low to medium encrypted transmissions. The system is intended for tactical-relevant aircraft, ships, vehicles, dismounted users, SIPR, and JWICS government users that need removable crypto modules and that can be easily removed and stored in secure spaces (i.e., safes, etc.), or removed from military platforms to facilitate Secret and Top Secret handling procedures.

The Navy requires very small modular NSA Type-1 High Assurance Internet Protocol Encryptor (HAIPE) Internet Protocol Security (IPSEC) encryption modules along with physically separated Red & Black dedicated, processors, memory, and storage that can be easily removed from computers, radios, electronic warfare systems, and can also be embedded into antennas that have Software Defined Radios (SDRs) integrated into the antennas. Current crypto solutions are entire stand-alone large avionics boxes and cannot be easily integrated into emergent Software Defined Radios (SDRs) or mission computers requiring greater Size, Weight, Power, and cooling (SWAPc) and higher integration costs. The DoD requires a crypto solution that allows the users to easily remove these crypto units without having to de-install the crypto system from an aircraft, ship, ground control station, or secure classified facility. The lack of carriage/sled docking architectures or socket type connector design architecture is a contributing factor to the current constrained architecture. Multi-domain platforms and Sensitive, Compartmented, Information Facilities (SCIFs) require a removable “credit card”—sized crypto card (rough dimensions) that can operate with the following requirements:

1. Data Rate: 10 Mbps (threshold) up to 100 Mbps (objective) for Secret and TS/SCI when operating Type-1 NSA encryption algorithms.
2. Size: .75 in. X 3 in. X .25 in. (1.905 cm X 7.62 cm X 63.5 cm) thick (Thumb Drive Sized) that can plug-and-play in tactical embedded systems or through external connection devices (removable architecture approach without disassembly or deinstallation of the system).
3. Ability to code and zeroize over a USB and PCI-E minibus.
4. Processing: 4-Core (3 GHz, 8 x Peripheral Component Interconnect express (PCIe) Lane (Threshold), 16 x PCIe Lane (Objective)) per enclave.

5. Memory: 32 GB of RAM (Double Data Rate (DDR) 4, 3200 MHz data speed (or higher)) per enclave.
6. Storage: Persistent storage capability of 2 TB per enclave.
7. Telecommunication Electronics Material Protected from Emanating Spurious Transmissions (TEMPEST).
8. Embedded Cryptological Unit (ECU) shall support the Joint Communication Architecture for Unmanned Systems (JCAUS).
9. Power: Host power provided by 5VDC Bus.
10. Cooling: Convection cooled (No external fan).
11. Thermal: Operate 50–80 °Celsius.
12. Security level: Secret, TSI, NATO – (Guidance: See CUI NSA PICO Brief).
13. Open Standards: Configuration 1: 2X (RED & Black) multi-lane, mini-PCI interface with USB, Thunderbolt 4 (Embedded daughter card or stand alone for MOSA, SOSA, FACE, etc.).
    Note: Enclave is defined as separate Red and Black sub-systems.

Work produced in Phase II will 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. § 2004.2 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 and demonstrate the feasibility of a conceptual design/architecture that will support a STEALTH plug-and-play NSA Type-1 crypto module approach. Present a Red and Black cypher text core isolation approach that shows how the architecture meets TEMPEST requirements for data bus and power layout, memory and processing architecture, and compliance with NSA design standards (to be provided after contract award). The design should also show the mounting options for various applications and the plug-and-play approach to accommodate multiple SDRs, computer processors, and small device applications. The design approach should address the incorporation of a modular Radio Frequency (RF) System on Chip (SoC) that has Red and Black separation, supports L and S Band, TRANSEC Waveform (WF) Encryption. Embedded Cryptological Unit (ECU) shall support the Joint Communication Architecture for Unmanned Systems (JCAUS). Additionally, a high-level unclassified Anti-Tamper (AT) design approach should be addressed in Phase I. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: A lab-based proof of concept brass board design and Red and Black (Physically separated) RF SoC (L and S Band) that will be submitted to NSA for consideration and approval that can be removed without disassembly/de-install of the host system. Demonstrate full encryption using NSA algorithms with RED and BLACK rule sets applied to parsing classified (secret data) and unclassified data in a controlled lab environment.

The work under this effort will be classified at SECRET under Phase II (see the Description section for details).

PHASE III DUAL USE APPLICATIONS: Transition to PMA/PMW-101 Program of Record (PoR) for Multi-Information Distribution System (MIDS) Program Office (MPO). Full Qualification and Test (FQT) to include TEMPEST and Authority to Operate (ATO).

Continue the development of the STEALTH Type-1 encryption devices while developing an NSA approval path to operate at SECRET, TS/SCI, Special Access Programs (SAP), to support Federal and Foreign Governments, Five Eyes (FVEY), and for NATO secret.

Small removable HAIPE devices have commercial transition applications for protecting bank information, company proprietary information, as well as, for government classified operations developed during Phase II. Open Standards compliant (i.e., SOSA, JCAUS, etc.) for integration with other commercial products (i.e., SDRs, Servers, Desktop Computers, etc.).

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KEYWORDS: System on Chip; SoC; High Assurance Internet Protocol Encryptor; HAIPE; ECU; Joint Communication Architecture for Unmanned Systems; JCAUS; National Security Agency; NSA; Telecommunication Electronics Material Protected from Emanating Spurious Transmissions; TEMPEST; Small Type-1 Encryption for Aircraft, Littoral, and Terrestrial Higher-than-Secret; STEALTH

N251-018 TITLE: Compact Electric Fuel Pump for Extreme Viscosity Fuels and Slurries

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics

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 and demonstrate an electric metering fuel pump capable of pumping highly viscous liquid and slurry fuels with SWaP sufficient for a flight vehicle.

DESCRIPTION: Fuels with higher energy density than JP-10 are being explored to improve system range. Unfortunately, many of these candidates (including metal particle slurries) are significantly more viscous than standard jet fuel. Enabling the use of the more viscous fuels would offer new platforms increased range potential over conventional fuels. Based on Navy defined parameters (viscosity, particle size, run time, flowrate, power draw, etc.) the proposer should design and demonstrate an electric pump minimizing total pump weight/volume/power draw. Metrics of success include fluid metering accuracy and repeatability of throttle authority.
Pump requirements:

1. Capable of moving neat liquids of 1.5 St or greater,
2. Capable of moving slurry fuels that use a hydrocarbon liquid fuel as a base and:
   i – contain maximum of 50 wt. % of solids,
   ii – where the particles are between 50 nm and 60 µ in diameter, and
   iii –the particles are 9. 0 Mohs or harder
3. Maximum controllable flowrate of at least 5 gallons/min (18.9 L/min),
4. Minimum controllable flowrate of no more than 0.3 gallons/min (1.14 L/min),
5. Repeatable flowrate control of +/- 0.1 gallons/min (+/- 0.38 L/min),
6. Sustained pumping of viscous and slurry simulants for minimum 45 min at minimum 90% flowrate without failure,
7. Capable of starting and continuous operation from -40 °C to 50 °C,
8. Weigh no more than 15 lb (6.8 kg), and
9. Take up no more than 130 in.^3 volume.

PHASE I: Design and simulation of electric fuel pump meeting or exceeding Navy defined requirements. Pump design must incorporate high-accuracy metering capability and throttle authority with high-viscosity fluids and slurries. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Production and testing of middle-weight pump. Pump does not have to be at final flight-weight or compact packaging, but must have clear pathway towards being so. Testing of the pump will include endurance runs using simulant fluids and slurries. Metering accuracy and throttle authority of the design to be evaluated.

PHASE III DUAL USE APPLICATIONS: Refine design of pump using Phase II test results. Produce and evaluate a flight-weight and compact pump capable of meeting Navy defined specifications with representative working fluid.

Technology developed for a compact, high-viscosity pump can be used as upgrades to larger industrial pumps to extend life and/or capabilities.

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KEYWORDS: Pump; Fuel; Compact; Slurry; Viscosity; Metering;

N251-019 TITLE: Neuro-Symbolic Artificial Intelligence (AI) Agents for Cybersecurity Authority To Operate (ATO) Development

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems;Integrated Sensing and Cyber;Sustainment

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, design, and develop an innovative automated software toolset to assist the Cybersecurity workforce personnel in developing and maintaining Authority to Operate (ATO) packages under the Risk Management Framework (RMF) process.

DESCRIPTION: The DoD leverages the RMF to guide cybersecurity processes and requirements [Refs 3, 5, 7, and 9]. Further, program offices have experienced a dramatic increase in the man-hours required to produce a cybersecurity ATO package and maintain that package throughout the lifecycle of the system or systems supported. This increase has put a strain on budgets and increased schedules.

One outcome from Deep Neural Network (DNN) experiments into what are called large language models (LLMs; e.g., GPT3 or Lambda) is the ability for analysis of large data sets and the capability of system composed documents based on user requests [Refs 1 and 2]. For example, one might say, “Write me a paper about ‘Logistics issues in Africa’”, and the system can then automatically produce a document that may sound reasonable. It has classified or categorized information about both logistics and Africa. It may even have found areas of overlap. The system is trained to understand, identify, and replicate patterns of what a paper should look like, how it might be organized, and the structure of paragraphs and sentences. There is a chance, therefore, that the paper actually conveys real information. There is, however, a significant chance that the paper is utter nonsense (i.e., a pattern borne out of mimicry rather than substance). The use of the LLM approach may be less viable as one moves towards novelty. That is, if a paper that describes a new concept, device, method, process, or strategy is desired, LLMs are unable to provide much help. In one sense they are merely sophisticated search algorithms that can find existing patterns and sometimes combine those patterns to useful effect.

An ATO is by its very nature a novel problem. So, one might argue that the LLMs are not going to add much value. This, however, is only true if they are used in isolation. This SBIR topic seeks a technical approach that leverages one or more technology type, such as LLMs, and capabilities offered by Artificial Intelligence (AI) and/or Machine Learning (ML) [Refs 4 and 8]. For example, approaching this challenge as an applied engineering discipline, focusing on applying a myriad of AI Techniques such as DNN to identified AI reasoning tasks with an understanding that most expertise is found in the heads of subject matter experts (SMEs) rather than in large data repositories, is expected to maximize the efficiency and effectiveness of the capability and maximize return on investment. The desired outcome of this SBIR topic is to develop technology and a methodology to work with SMEs to capture their expertise and mental models on the RMF and ATO process. From here, the technical approach should leverage these mental models to generate bias DNN classifiers and provide a way to represent an organization’s specific expertise and content.

Expected outcomes include:

- Efficiency Gains: Significant reduction in time and manpower required for ATO drafting.
- Consistency and Compliance: Standardized ATOs that adhere to Department of Defense (DoD) Cybersecurity regulations and policies.
- Scalability: Potential application across various DoD acquisition entities, enhancing overall efficiency of the Cybersecurity workforce.

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 and develop a system that captures and organizes cybersecurity hardware/software configuration information and can automatically write an ATO for a given system leveraging that information. Develop a hybrid solution that integrates the capabilities of large language models, leveraging the mental models of experts and past ATOs into the ATO creation process. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, test, and validate prototype software toolset proof of concept. Recognizing that initial generated ATOs will lack quality, develop and engage in an iterative test cycle, design and development software refinement, and document proposed concept of operations for employing technology. The goal is to capture and adapt knowledge over time, which incrementally improves the process through feedback from experts.

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

PHASE III DUAL USE APPLICATIONS: Mature technology and seek approvals for deployment on DoD systems. Extend capability to more advanced capabilities for higher level security documentation. Investigate solutions to automated sustainment of underlying knowledge models. Consider additional modular capabilities to extend utility and use throughout the ATO process.
Cybersecurity is an issue for commercial sector organizations beyond DoD such as banking, medical, and civil infrastructure (e.g., power, water, GPS, and internet). As technology use has continued to increase, individual considerations for protections increase as well. The commercial sector will likely benefit from similar technology within these industries, as well as means for commercial products used within households to increase certification/guarantees to consumers.

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KEYWORDS: Automated Software; Cybersecurity; Authority to Operate (ATO); Risk Management Framework (RMF); Deep Neural Network (DNN); Generative Artificial Intelligence

N251-020 TITLE: Computational Tools for the Prediction of Galvanic and Crevice Corrosion of Advanced Materials Relevant to Sea-Based Aviation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Sustainment

OBJECTIVE: Develop computational tools that can be used for aerospace design, to minimize galvanic corrosion risk of mixed-material couples for component geometries with occluded areas exposed to atmospheric conditions relevant to sea-based aviation.

DESCRIPTION: The recent revision of MIL-STD-889D provides a starting point for comprehensive galvanic compatibility comparison of aerospace-relevant materials in immersion conditions. However, galvanic corrosion is known to be dependent on specific atmospheric factors associated with the usage environment. Due to the interactions of electrochemical processes and atmospheric conditions, the rank ordering of galvanic compatibility in immersion may not be fully representative of the degradation rates and damage distribution experienced in service. Furthermore, significant progress has been made in modeling galvanic couples openly exposed to aggressive atmospheres, but model development is needed to capture the influence of concentration polarization and mixed materials within crevices that occur at fasteners and faying surface of structural joints. Crevice corrosion at fasteners and joints presents the greatest corrosion risk for the structural integrity of airframes.

Determining a high-level approximation of relative galvanic compatibility risk under different environments on exposed surfaces and within crevices through a user-friendly computational tool for rapid analysis would enable increased accessibility and transferability of corrosion performance information between corrosion experts, aircraft designers, and engineers. If acceptable levels of galvanic compatibility are exceeded, military standards/handbooks and technical manuals/orders for corrosion prevention and mitigation strategies could be updated to aid the Cognizant Engineering Authority and computational tool user to address these issues early in the design and deployment phases.

To account for complex geometries, galvanic corrosion rate prediction across a 3D and/or 2D geometry can provide spatial resolution of relative corrosion risk, helping to inform corrosion mitigation through both design and long-term maintenance planning (inspection guidance) of aerospace structures. Corrosion prediction across a 3D and/or 2D geometry can be difficult, due to both substructure and superstructure contributions (i.e., inner and outer mold-line material combinations), creviced geometries (fastener assemblies, lap joints, etc.), and dynamic atmospheric environments. Incorporating systematic iterations of these factors to characterize their relative contribution to the galvanic corrosion risk assessment (both in magnitude and spatial distribution) through computational tools will help inform future design efforts and sustainment programs. Identifying component-level predictions of corrosion “hot spots” under specific conditions would inform specification of corrosion protection systems and determine areas of particular importance for inspection as part of an aircraft maintenance program.

PHASE I: Design and develop an approach and initial demonstration for rapidly assessing galvanic compatibility of multiple aerospace-relevant materials and three-dimensional geometries in atmospheric conditions. Develop a computational tool framework to provide a rapid and user-friendly assessment of the galvanic compatibility in atmospheric conditions, and detail methods to address atmospheric conditions relative to assumptions and inputs based on immersion testing. Describe the formal structure for all relevant metadata and assumptions used to achieve an approach suitable of naval aircraft and operating environments. Draft an approach to couple corrosion prevention and mitigation strategies with galvanic compatibility risk from existing military standards/handbooks and technical manuals/orders. Develop a computational prediction model to assess galvanic corrosion rate prediction across a 3D and/or 2D geometry, including occluded geometries, with a subset of geometries and materials, incorporating both thin-film atmospheric and crevice corrosion conditions. Demonstrate the feasibility of the model through a limited set of tests articles using galvanic couples to obtain both current responses and physical damage distribution. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Increase the assessment of material combinations, relevant geometries, and atmospheric environments in the galvanic compatibility testing for the purposes of optimization, validation, and verification. Establish the tiered computational tool framework, with modular open system architecture, and populate it with necessary property measurements, geometric models, and environment inputs to demonstrate functionality. Provide large-scale parameter-space corrosion rate prediction across a 3D and/or 2D geometry can, highlighting conditions with the most risk (highest galvanic corrosion) or most variability (change in galvanic compatibility). Clearly identify all requirements, limitations, and assumptions of the framework and computational tools. Demonstrate the capability and user-friendly accessibility through beta-testing with naval aviation stakeholders. Conduct an operational assessment for atmospheric corrosion using test articles designed to simulate structural component exposed at a marine test site. Draft methods for implementing new materials, assessing environments, and adding new geometries for use within the tiered framework. Develop the implementation plan for delivery of capabilities to the Navy and other DoD components through U.S. Government enterprise systems and assess commercialization viability for dual-use applications.

PHASE III DUAL USE APPLICATIONS: Incorporate beta-testing results from Phase II testing to address user needs. Finalize software design and make an initial software package available for purchase to the DoD.

All marine-based industries (ships, oil and natural gas platforms, and aviation) have common risks stemming from galvanic and crevice corrosion. By developing these models, engineers in these fields can develop more resilient and safer systems more quickly to accomplish the industry specific goals.

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KEYWORDS: Crevice Corrosion; Galvanic Corrosion; Corrosion Modeling; MIL-STD-889D; Digital Engineering; Environmental Severity

N251-021 TITLE: Open Architecture Solution for Data Transfer on Naval Aviation Platforms

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber

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 hardware, firmware, and software enhancements to existing legacy Mission Computers and associated data busses allowing rapid integration of modern software capabilities within in service aircraft (e.g. F/A-18, E-2D, SH-60, M/V-22) and their native data sources (e.g. MIL-STD-1553).

DESCRIPTION: Despite significant investments by the Department of Defense in the next generation of open architecture for military aircraft platforms; the truth remains that the bulk of the U.S. military aircraft fleet is still heavily reliant on proprietary, prime vendor supplied mission computers, and tactical data bus technologies. This reliance results in exorbitant costs imposed by the original equipment manufacturer (OEM) for any maintenance or upgrades of existing platforms; dramatically slowing NAVAIR's ability to introduce capability into a highly dynamic battle space. Further, by maintaining a tight grip on mission computer, flight program, and data bus access prime vendors effectively box out any competition that could otherwise add significant value to these aircraft.

In order to maximize combat effectiveness and maintain U.S. technological superiority amongst global threats, there exists a need to develop airborne system architectures, hardware, and software solutions capable of securely exposing aircraft and mission data to third party hardware and software applications. These new capabilities must successfully interact with legacy mission computers and data busses without adversely impacting existing platform DO-254 and DO-178C certifications. Once in place, these capabilities will provide the necessary connectivity to in-service platforms allowing for rapid introduction of new capability without incurring the high cost of prime vendor-based integration and deployment. Solutions should identify critical components for interfacing with NAE platforms such as F/A-18, E-2D, SH-60 and M/V-22. Perform feasibility analysis of hardware and software options for implementing the selected approach, including the Tactical Mobility Integrated Project Team (TacMo IPT)/PMA-272-developed Multiple Obstructed Brokered Hub (MOB Hub) embedded computer.

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 and develop an approach to sense, synthesize, and provide aircraft unique data to a modern software application suite. Solutions should identify critical components for interfacing with Naval Aviation Enterprise (NAE) platforms such as F/A-18, E-2D, SH-60, and M/V-22. Perform feasibility analysis of hardware and software options for implementing the selected approach, including the TacMo IPT/PMA-272-developed MOB Hub-embedded computer. Finally, identify an approach to disseminate the collected data to third party hardware and software components without impacting the existing aircraft certifications. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype system using the results found in Phase I and evaluate against a representative test system using Government furnished simulation/stimulation equipment. Utilize MOB Hub Circuit Card Assembly (CCA) and/or Jet in a Box hardware to validate prototype with real or representative aircraft data. Potentially use a MOB Hub CCA as an embedded computer to evaluate prototype.

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

PHASE III DUAL USE APPLICATIONS: Further refine the system developed in Phase II and integrate into a designated aircraft. Demonstrate the system's ability to disseminate aircraft unique data to third party hardware and software components without impacting the existing aircraft certifications or assist with aircraft certification process.

Commercially this technology could be used for any legacy hardware/software platform where replacing legacy equipment is cost prohibitive. Commercial satellites, civilian aircraft, and older automotive platforms could all implement this technology to introduce modern computing capabilities without impacting the existing hardware/software suites while enhancing cyber security and extending future capability.

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KEYWORDS: Cyber Security; Open Architecture; Embedded Computers; Human Machine Interface; Naval Aviation Platforms; Data Busses

N251-022 TITLE: High Energy Density Synthetic Fuel Development

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Hypersonics;Renewable Energy Generation and Storage

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: Synthesize a novel liquid hydrocarbon fuel or generate a synthetic fuel blend with a higher volumetric energy density than JP-10, which maintains a flashpoint above 60 °C and viscosity below 200cSt at -40 °C.

DESCRIPTION: There is a mission critical need for increased range in gas turbine powered cruise missiles. The proposer should develop a scalable process for high energy density fuel synthesis and provide a cost analysis for commercial scale production. The fuel properties must be characterized to demonstrate net heat of combustion exceeding that of JP-10. High energy density fuel will improve the range of current and future airbreathing propulsion systems.

To minimize environmental impact, renewable solutions are highly encouraged and potential toxicology issues should be considered for maritime use.

PHASE I: Design and develop a proof of concept, production, and delivery of 250 mL of fuel to Navy lab. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Produce and deliver of 100 gallons (378.54 L) of fuel to a Navy lab. Perform a cost analysis of fuel production at designated production levels.

PHASE III DUAL USE APPLICATIONS: Design and cost a large-scale production facility capable of meeting yearly Department of Defense needs.

Fuels developed through this SBIR topic may have utility for rocket propulsion. Chemical byproducts may have utility as lubricants and polymer precursors.

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KEYWORDS: High Density Fuels; Synthesis; Propulsion; JP-10; Hydrocarbons; Jet Fuel

N251-023 TITLE: Live, Virtual, Constructive (LVC) Afloat: Automated Scenario Generation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces;Trusted AI and Autonomy

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 the capability to automate the creation of training scenarios for aviation platforms underway using the Next Generation Threat System (NGTS). This capability should include a framework and accompanying architecture in which specific performance parameters can be varied based on Machine Learning (ML) algorithms and Artificial Intelligence (AI).

DESCRIPTION: As the Navy prepares the carrier airwing of the future (AWOTF) for the high-end fight, the training paradigm will shift to almost exclusively Live, Virtual, Constructive (LVC) environments due to expanded range capabilities of the peer threat competitors and Operational Security (OPSEC) considerations. As a result, warfighters will be able to train as they fight with higher fidelity scenarios that more accurately represent red kill chains. This high-fidelity, data-rich environment provides unique opportunities for instructional strategies to better support end-to-end training and improve readiness. Specifically, LVC environments increase the amount of—and access to—data that can support improved scenario generation, performance assessment, and debrief when utilized appropriately. However, LVC training is not without its challenges. These challenges include resource requirements to develop these high-fidelity scenarios as they can be cumbersome and labor intensive. Moreover, scenarios that do not contain significant variations may lose utility very quickly as operators can begin to anticipate scenario outcomes after a few exposures. Consequently, a need exists for rapid generation of real-time, adaptive, high-fidelity scenarios.

Additional challenges lie in the assessment of performance. The carrier airwing of the future will rely on integrated tactics that require a level of coordination and information exchange across platforms that have not been required in past tactics. The complexity of coordination associated with integrated tactics necessitates a significant amount of voice communications across the different platforms to provide Situation Awareness (SA) and elicit decision-making. While communication is critical to cross platform coordination and overall tactical execution, it remains one of the most challenging training objectives to meet during Air Defense events.

As such, the present effort seeks to alleviate identified challenges with scenario generation and performance assessment through the investigation of generative AI (e.g., DALL-E and ChatGPT) or other forms of AI to support scenario generation and communications assessment. This SBIR effort shall focus on utilizing AI to learn from pilot-in-the-loop red threat behavior to rapidly generate constructive threat presentations that adapt to trainee behavior in a tactically feasible manner. Additionally, AI shall be applied to further the state-of-the-science in communications analysis [Ref 5]. Specifically, AI shall support analysis of blue recorded communications and provide an initial assessment in terms of accuracy of the words said (relative to ground truth) and speed at which they are said. This will include digesting communication recordings, assessing quality of communications-based accuracy and speed, then providing these results via automated debrief.

These capabilities will improve the quality of training and readiness via end-to-end training enhancements. First, high-fidelity Air Defense scenarios that can be rapidly generated and are adaptive will yield greater training utility and provide cost avoidance associated with scenario development manpower and human-in-the-loop (HITL) threat support manpower. Next, development of a communications analysis and debrief capability will improve SA, and decision making will benefit the Fleet by decreasing instructor workload, reducing human error and manpower time requirements, and automatically provide instructors with information on communication protocol adherence and timeliness to improve SA and increase debriefing capabilities.

This effort will specifically look at Air Defense training scenarios within LVC environments to increase speed at which high-fidelity, adaptive scenarios can be generated and assessed to enhance operator performance. This capability will be developed with the intention of a transition path to the NGTS. 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 and develop a development plan for a proof-of-concept solution to rapidly automate the creation of training scenarios for aviation platforms at sea. This will include identifying the most appropriate methodology for developing the scenario generation framework and architecture, enhancing red threat presentation, and developing a graphical user interface (GUI) for instructors that align with current NGTS GUI. An unclassified sample dataset will be provided to help support this investigation. The Phase I development plan will be used to demonstrate feasibility of application into the larger, integrated training system. The plan shall detail integration into NGTS to allow for transition into an operational LVC environment. Additionally, the plan shall include a Subject Matter Expert (SME) evaluation of capabilities and how to conduct an Analysis of Alternatives to identify best practice method moving forward for training delivery. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Research, develop, design, and deliver a proof-of-concept scenario generation capability and intelligent mechanism for modifying threat models based on evolving threat presentations and test in NGTS through execution of the integration plan developed in Phase I. During Phase II, the sample data provided will be more tactically and operationally relevant and classified at the SECRET level. Awardees can expect the scenarios to be more tactically complex. Design and tool development shall include tactically appropriate presentation of evolving red threats utilizing the NGTS behavior structure, usability documentation, and technology evaluation. Demonstration of the tool, along with documentation of usability of the training software is critical. Risk Management Framework guidelines should be considered and adhered to during the development to support information assurance compliance. Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Introduce additional data from NGTS, as well as other live and virtual entities within the scenario. Scenario generation shall be enhanced to include external (live and/or virtual) entities. Integration testing and demonstration of capabilities will be conducted in a distributed simulation via Distributed Interactive Simulation (DIS) protocol at the SECRET level. Software shall be integrated with NGTS to facilitate transition into operational LVC environment. Documentation and any supporting materials shall be delivered to NGTS team for maintenance and future enhancements.

The scenario generation tool can be leveraged in the private sector as an aviation training aid in environments with limited network access. Tailorable aviation scenarios can be used for commercial or private pilot training devices to expose trainees to a wider variety of simulated high-risk events.

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KEYWORDS: Scenario Generation; Live, Virtual, Constructive; Training Underway; Artificial Intelligence (AI); Tailorable Scenarios; Next Generation Threat Systems (NGTS); Adaptive Threat Models

N251-024 TITLE: Self-Hosted Certificate-Key Management Server

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber

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: Provide a Self-Hosted Certificate-Key Management Server (CKMS) hosted on Gigabit Ethernet Data Multiplex System (GEDMS) to allow for individual systems to communicate over encrypted channels.

DESCRIPTION: A CKMS is a specialized server or system designed for the management of digital certificates and cryptographic keys in a secure and organized manner. Digital certificates are used in public key infrastructure (PKI) systems to verify the identity of entities and secure communications over the internet. A CKMS focuses on the management of cryptographic keys that are associated with these certificates, ensuring they are generated, stored, and distributed securely. The Self-Hosted CKMS will provide a secure and (de)centralized way to manage certificates and keys for devices within a closed network. The CKMS will be designed to be scalable, extensible, and easy to use and administer. CKMS is especially important in environments where digital certificates are widely used for authentication and data encryption, such as securing web communications with Secure Sockets Layer and Transport Layer Security (SSL/TLS), code signing, secure email, and many other applications. It ensures that the cryptographic keys and certificates are managed in a way that maintains their security and reliability.

Device certificates are digital certificates that enable mutual authentication and secure connections between two devices (i.e., machine-to-machine [M2M] communications) and is achieved using PKI. A device certificate is typically issued by an organization’s internal certificate authority, known as a private CA. The private CA will be internal to the organization (meaning, an organization issues its own certificates for use on its network).

GEDMS is a mission-critical system that provides IP-based network transport and the collection, processing and distribution of data across DDG 51 class destroyers. GEDMS is designed to provide high-speed data communication and networking capabilities to support a wide range of shipboard systems and applications, including command and control, radar, navigation, weapons systems, communications, damage control, and other mission-critical functions. It allows for the efficient and secure exchange of data among various shipboard systems and subsystems.

Key features and characteristics of GEDMS in a Navy context may include:

- High Data Rates: GEDMS operates at gigabit Ethernet speeds, providing fast and reliable data transmission for shipboard systems.
- Redundancy: GEDMS often incorporates redundancy and fault tolerance to ensure the reliability of data communication even in the presence of hardware failures or battle damage.

- Security: Given the sensitive nature of Navy operations, GEDMS includes security measures to protect data and network integrity.
- Scalability: The system can accommodate various types of shipboard equipment and systems, making it adaptable for different classes of Navy vessels.
- Interoperability: GEDMS ensures that various shipboard systems can communicate and exchange data effectively, improving overall operational efficiency.
- Maintenance and Support: The Navy conducts regular maintenance and updates to ensure GEDMS remains operational and secure.

GEDMS is an integral part of DDG 51 class destroyers, helping to ensure the efficient operation and coordination of various Platforms and Enclaves on board. It plays a crucial role in supporting the Navy's mission and enhancing its capabilities in a network-centric warfare environment.
Given the critical nature, and the crucial role GEDMS provides in supporting the Navy's mission, it's imperative to ensure the integrity, confidentiality, and availability of the data transmitted across the network. The lack of secure device communication can provide attack vectors that make the GEDMS environment susceptible to Man-In-The-Middle (MITM) attacks, spoofed commands, and status message spoofing.

The Navy seeks a closed-network CKMS to provide a secure and centralized way to manage certificates and keys for devices within the closed network. The CKMS shall run on a single board computer with the following minimum specifications, Quad-Core X86 1.5Ghz CPU, 16GB RAM, 256GB internal storage, and two (2) network interfaces supporting the following types: 10/100/1000BASE-TX, 1000BaseLX, and 100BaseFX. The single board computer shall support Linux and Win10 Operating systems. The CKMS will be responsible for generating, distributing, renewing, and revoking certificates and keys, as well as auditing and logging all activity. To enhance security, mitigate vulnerabilities and protect the confidentiality and integrity of the GEDMS environment, the following steps should be considered to build, configure, and implement the CKMS solution:

To establish a secure and well-maintained CKMS for a closed network, it is imperative to systematically address various aspects.

Navy needs a Key Management server that is superior to what is commercially available, is able to operate in a self-contained environment, and is decentralized, so combat damage to the server will not disable ship network access. Currently, we are not aware of any Key Management Servers that meet these requirements. PMS 400D investigated this in the past and rejected the available candidates because they presented a single point of failure that is unacceptable in combat. Innovation will be needed to produce a robust cybersecurity solution.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 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 an improved device for a Self-Hosted CKMS that meets the requirements above. 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 computer 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 a CKMS prototype, to include designing the CKMS architecture, database schema, user interface, APIs, and other software. The prototype will be tested to demonstrate its core functionality, such as certificate and key generation, distribution, renewal, and revocation. Additionally, the prototype will be tested at a Land Based Test Facility to ensure its suitability to shipboard use. The results of these tests will be used to refine the prototype into a design that will meet Navy requirements. Prepare a Phase III manufacturing and development plan to transition the CKMS to Navy use.

Begin by clearly defining the network's specific needs, encompassing device types, security levels, compliance standards, and scalability requirements. Select robust cryptographic algorithms that adhere to industry best practices for key generation and certificate signing. Establish a Certificate Authority (CA) responsible for validating device identities and signing certificates. Implement secure key storage mechanisms, such as Hardware Security Modules (HSMs), to safeguard cryptographic keys from unauthorized access. Enforce a robust access control mechanism, preferably Role-Based Access Control (RBAC), to restrict key and certificate management to authorized personnel. Develop functionality for the entire certificate lifecycle, including automated processes for generation, distribution, renewal, and revocation. Implement comprehensive logging and auditing features to ensure accountability and security in CKMS activities. Secure communication by encrypting data in transit using protocols like TLS. Employ monitoring tools and alerts to promptly identify and respond to suspicious activities. Establish regular backup procedures and a disaster recovery plan for quick restoration in case of failures or data loss. Ensure compliance with relevant industry standards and regulations such as X.509, PCI DSS, or HIPAA. Maintain comprehensive documentation for the CKMS, covering configuration details and guidelines for ongoing maintenance and troubleshooting. Conduct thorough testing in a controlled environment, encompassing functional, security, and performance aspects before deploying in the production environment. Keep the CKMS software and underlying systems up to date with the latest security patches to address emerging threats. Finally, provide training to administrators and users on proper key and certificate management practices to prevent inadvertent security issues. This holistic approach ensures the CKMS aligns with the specific requirements and compliance standards of the closed network, fostering a robust and secure key management infrastructure.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the CKMS to Navy use. Commercial uses may be limited due to the security posture inherent in these types of Navy systems. Other military applications would include use on any network that requires an added level of security between the systems communications and interfaces with minimal disruption to the design of existing user.

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KEYWORDS: Control System Network; Multimedia Communication; Digital Key Management; Cryptographic keys; Access Control; Key Management Server

N251-025 TITLE: Automated Writing of Problem Reports

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 software solution that utilizes artificial intelligence (AI) and machine learning (ML) to automate the generation of accurate and consistent problem reports for surface navy platforms.

DESCRIPTION: The Navy's Aegis Combat System (ACS) currently relies on manually generated problem reports using testing, analysis, and operator feedback. These problem reports are currently populated by personnel with varying degrees of experience. Information is provided by personnel attempting to identify issues that may or may not agree with the written performance specifications for their systems. This produces a lack of details needed to reproduce the issues. The process is time consuming, prone to human error, and lacks consistency across platforms and personnel. The Navy seeks an innovative software solution that is capable of automatically generating accurate and reliable problem reports for surface navy platforms, replacing manual processes used in the current ACS. This can be accomplished either through merging, removing, or automatically generating problem reports to reduce operator workload and improve efficiency. Added capability would provide more accurate problem reports written against specifications for human understanding and improvement of human system integration (HSI). Currently there are no commercially available remedies found to solve this situation. The observation of anomalous behaviors or unexpected testing and analysis results will drive generation of problem reports. The software solution needs to provide a system that can perceive, recognize, learn, decide, and act on their own. The solution will need to consolidate and interpret data. The software solution will utilize ML systems with the ability to explain their rationale, characterize their strengths and weaknesses, and convey understanding of how they will behave in the future. The software application will also need to be capable of analyzing existing reports to understand format and content requirements. It will need to accept input from the test community and operators, automatically generate problem reports that are accurate and reliable based on various data sources, including sensor data, test observations, and operational experiences, and integrate seamlessly with all elements of the ACS. Because of the planned implementation for both operational and testing environments, the software application should permit realistic testing of evolving threat types and configurations in a dynamic test environment. This will enable the proficiency of testing and certification problem reporting timelines for new Aegis program timelines. This will also help in maintaining or improving product quality through the early detection of deficiencies in the product. The speed and accuracy of the solution must exceed existing ACS performance attributes by 10% or better.

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 problem report solution that demonstrates it can feasibly meet the parameters in the Description. Feasibility will be demonstrated through modeling and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype problem report solution based on the results of Phase I that meets the parameters described in the Description. Demonstration will take place at a government provided facility. The government subject matter expert will evaluate the prototype to ensure it improves situational visualization and situational understanding within a varied problem reporting context.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use within the Aegis Weapon System (AWS in Advanced Capability Build (ACB) 20 or higher) as part of an Integrated AWS database. Refine the prototype for integration into the current AWS operational planning tools. Test and refine the prototype design for the appropriate interfaces with other Navy systems and to comply with information security requirements.

The developed technology should be broadly applicable to live testing of manned and unmanned systems and simulations in which users need Course of Action (COA) planning and updates to the plan as time progresses. Dual use applications are numerous, almost any analyst seeking to combine spatial and temporal data in a single display could use this technology including the Federal Aviation Administration or civilian air controllers.

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KEYWORDS: Anomalous Behaviors; unexpected testing and analysis results; automatically generate problem reports; Machine Learning to automate; testing and certification problem reporting timelines; consistency across platforms

N251-026 TITLE: Passive Position Sensing and Navigation for Small Crafts and Unmanned Surface Vehicles (USVs) in Global Positioning System (GPS) Denied Environments

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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OBJECTIVE: Develop a passive device or system that allows a Small Unmanned Surface Vehicle (sUSV) or other small craft to develop and maintain awareness of its location on the earth's surface in a Global Positioning System (GPS)-degraded or -denied maritime environment.

DESCRIPTION: Current naval navigation systems are heavily reliant on GPS, which is a highly accurate all-weather source of positioning, navigation, and timing (PNT). However, GPS utilizes weak radio frequency (RF) signals from distant satellites that may be subjected to intentional and unintentional interference. GPS signals may not be available or reliable in a degraded/Anti-Access/Area Denial (A2/AD) environment. In recent years, the ability to compromise GPS has been demonstrated by adversaries using jamming techniques that interfere with military mission execution. Additionally, RF transmissions, including use of a surface search or navigation radar, can disclose a vessel's location, as can use of a fathometer or depth finder. To mitigate these challenges, the Navy is seeking affordable passive navigation technologies for improved PNT on sUSVs or small craft when GPS is degraded and/or unavailable.

Inertial navigation systems (INS) and precision clocks may extend the PNT solution for short periods, but both are subject to drift errors. An alternative real-time PNT solution—utilizing complimentary PNT sensor data and networks—is required to maintain an accurate and reliable navigation solution by bounding the drift errors without GPS dependency.

The proposed system footprint should be no larger than 4 inches by 4 inches and no taller than 4 inches. The system should weigh less than 10 lbs. and total system power consumption should be less than 100W. Objective performance requirements are a positioning accuracy requirement of less than 10 meters, less than 3 meters/second velocity error, and better than 20 nanosecond time transfer. With respect to affordability, each system should cost less than $125,000.

Older electronic navigation systems such as Long-Range Navigation (LORAN) and Omega have been retired, and other satellite-based systems such as Russia's Global Navigation Satellite System (GLONASS) and the European Union's Galileo have the same disadvantages as GPS. This SBIR topic does not seek optical line-of-sight algorithms (e.g., visual positioning systems [or camera-based positioning solutions] or sextant-based solutions). Optical line-of-sight algorithms can be utilized to assist in bounding the solution from other PNT sensor solutions. The PNT sensor solution should be an "all-weather solution" not dependent upon cloud cover. This topic seeks a novel system, an improvement over existing methods, and/or a combination of methods to achieve the stated accuracy goals. Systems may use visual, gravity, magnetic, bathymetric, relative navigation, signal of opportunity, and/or other technological applications. Use of a fathometer is discouraged but not prohibited. The final product should be a fully integrated system that interfaces with the sUSV's autonomy or craft's electronic display panel by passing a stream of latitude, longitude, time, and confidence fields. The final product should be able to take an input from an onboard inertial navigation system that provides a “dead reckoning” solution to previous fixes and in turn, provides heading information to the ship.

This system will meet critical Navy needs by allowing sUSVs and other small craft to safely navigate without revealing their locations to adversary forces. The product will be validated and tested ashore for compliance with the Navy-provided Interface Control Document (ICD). Once validated ashore by the Navy, it will be qualified and certified during Navy Sea trials in at least three different geographical locations, e.g., Atlantic Ocean, Gulf of Mexico, and Pacific Ocean, and in a variety of conditions. These conditions will include near-shore and all open ocean conditions, daytime and nighttime, and all-weather conditions including clear visibility and foggy. Depending on the technology used, tests will be selected that provide results from a diversity of conditions having an impact on the solution.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 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 conceptual design for a Passive Position Sensing and Navigation system that meets the requirements in the Description. The concept design must define a system that can consistently operate within the established navigational rules, and include any modeling and simulation, studies, or prototypes in support of concept risk reduction. Demonstrate the feasibility of the proposed concept through modeling, simulation data analysis, and concept demonstrations.

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 system based on the requirements in the Description. The prototype systems will be evaluated at sea in both near-shore, and open-ocean and all-weather conditions to verify and validate the performance regarding position and navigation accuracy.
Participate in a Critical Design Review (CDR) during which the system’s necessary interfaces, dependencies, and risks are identified and presented. After a successful CDR, refine and build a prototype system. prototypes will be integrated into Navy-provided systems ashore as described in the Navy-specified ICD. After integration, the prototype will be tested ashore in a laboratory environment to verify that it meets the ICD requirements.

Final Testing and certification of the prototype system will consist of performance Verification and Validation (V&V) tests for both ashore and at-sea tests on a vessel of opportunity. The overall performance V&V tests of the system will also include hardware-in-the-loop testing on a vessel of opportunity provided by the Navy. 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: Long-term accuracy has been a challenge for all Navigation sensors and technologies due to bias instability (going from hours to days). The final product from this effort will be a Navigation system, for use at all open sea and weather conditions, which provides an accurate position with minimal bias drift when GPS is degraded or denied during operation. Ultimately, it will be validated, tested, qualified, and certified for Navy use.

Support the Navy in transitioning the technology to Navy sUSVs or other small craft in order to maintain awareness of their locations on the earth's surface. The technology can also be transitioned for use in commercial small craft or boats.

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KEYWORDS: Global Positioning System (GPS); Small Unmanned Surface Vessel (sUSV); Small Craft; Navigation Sensor; Position, Navigation and Time (PNT), Bias Drift

N251-027 TITLE: Acoustically Transparent Underwater Curing Adhesive

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

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: Development of an underwater applicable, curable, and acoustically transparent adhesive for the mitigation of defects in submarine sonar conformal flow surfaces.

DESCRIPTION: Current and developing sonar technologies rely on conformal structures that serve dual purpose as a fastening component and as an acoustically enhancing material. These structures may suffer damage and degradation over time and decrease acoustic performance of the sensors due to flow obstructions which may cause unwanted noise. Current repair methods require the submarine to be dry-docked, with high time and cost expenditures. This SBIR topic seeks to repair these flaws using a material with properties which allow it to be applied, cured, and used underwater and make it acoustically compatible with array sensing capabilities.

Existing consumer gap fill material is used for bonding to metals for pipe repairs, ceramics, and some rigid plastics. In the naval environment, currently approved materials per S0600-AA-PRO-200 include HYCOTE 461 and HYCOTE 151, which are an underwater curing epoxy and paint, respectively. These materials are used mostly on metal surfaces, with their focus on functioning as an anti-corrosion coating and contouring smooth surfaces after repair work has been performed. Another material in use has been PR-944F, which is a two-part, elastomeric, chemically curing adhesive for metals, plastics, woods, and ceramic surfaces. This adhesive has been shown to be used underwater as a seam filling material when performing sonar structure repairs.

Sonar sensors embedded in conformal polymeric materials (NGD-09) are being incorporated in existing and future submarine hulls. These structures interact with incoming sound waves to assist in detection. Current adhesives and fill epoxies do not contain the full set of properties that would allow them to effectively function as an underwater repair solution for emerging structural imperfections in acoustic embedding material. A product with the strength properties of existing adhesives, underwater curability, and acoustic transmissibility under system working frequencies which is compatible with the undersea environment would simplify efforts to maintain conformal sonar systems without affecting their acoustic performance. A non-toxic compound would be desirable.

To produce such a material, several research requirements must be addressed:

- Material must be able to be applied, cured, and faired underwater under expected pier side working environments.
- Material will also be evaluated based on ease of application and use by working personnel in typical shipyard conditions.
- Once set, material must demonstrate acoustic transparency and produce no altering or detrimental effects on the acoustic performance of the sensors under broadband frequencies under use conditions.

- Once set, the material must maintain its adhesive strength to bonded material (i.e., metals, urethane, glass-reinforced plastic (GRP), NGD-09, and rubber) under expected environmental conditions experienced throughout the submarine's lifetime (i.e., salinity, pressure, and temperature fluctuations).
- Mechanical properties must be compatible with and equivalent to those of existing conformal acoustic material.
- Material should not have toxic effects on the environment or user during application, curing, and use.
- Anti-fouling capabilities must be equivalent to or improve upon that of current array coatings.
- Material must be able to be applied on a sufficiently large flaw area determined by an analysis of current and expected flaw sizes.

Additional uses exist which fall outside the requirement of acoustic transmissibility for underwater curing adhesives. An adhesive could effectively function to repair, fill, or seal any non-acoustic structure that would benefit from underwater repair. A specific application is repair of damage to the surface of polymer-based fairing structures that surround the main sonar system to ensure they effectively contour the hull, and no turbulent flow develops which can hinder sonar performance.
Contending material solutions will be evaluated against standards for applicability in repairs, and physical, chemical, and mechanical properties similar to those used on PR-944F and existing sensor conformal material. As for acoustic transmissibility, the standards to be used will fall within those of sensor conformal material.

The development of this technology can provide the Navy with an alternative to perform repairs which would remove the labor, cost, and time associated with the dry-docking process. This technology will have use in existing and future hulls due to the increasing amount of sonar systems which rely on conformal sensor embedding structures. Advanced developments in future materials may eventually produce a product that is incompatible with this technology, however this is unlikely during the short-term due to the current state of conformal structures as being newly introduced into the fleet.
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: Define and develop a concept for an underwater acoustically transparent adhesive that can meet the performance constraints listed in the Description. Feasibility for the material is expected to be theoretically demonstrated, however any further preliminary physical artifacts may be produced to support its validation (e.g., any preliminary lab samples that demonstrate fulfillment of the previously stated capabilities). Outline an approach to validate the proposed solution. Describe a production and test plan geared toward generating a prototype for Phase II.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II. Verify contending solutions for feasibility and fulfillment with the main requirements and capabilities stated under the identified problem in the Description.

PHASE II: Determine if the solution can meet Navy requirements. Due to the physical nature of an underwater adhesive, these developments will take the form of a prototype material to be applied in a series of simulated environments and conditions. Perform a series of prototype evaluations. Develop a plan to transition the technology into a system that can be acquired by the Navy. A prototype should be delivered at the end of the Phase II.

Conduct tests that involve a facet for non-acoustic, physical material performance and another for testing of acoustic transmissibility. The setup to simulate the working environment will likely contain sensors embedded in conformal material as well as other structures to which the adhesive may want to be tested on. This mockup will also have manufactured or induced flaws on the surface of the conformal material for repair. These evaluations specific to the prototype will be performed to determine if the adhesive material at a minimum meet the performance constraints stated under the identified problem in the Description.

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: A successful demonstration of the prototype in Phase II will concretize the process of transitioning the solution into a technology for Navy use. This process is expected to be supported by the Phase III awardee. Building on test results and further discussions on final performance requirements, develop a production plan to meet the needs of the specific application. This plan will consider the compatibility of the solution for use on legacy, existing, and future platforms. It will also consider the manufacturability of the product given current and future resources and lifecycle requirements. Support will be expected for the transition of the technology into use on Navy submarines under existing schemes for maintenance and repair processes. Further validation of the product for Navy use will take place using identified material property and performance standards as a guide to any further testing and qualification processes that must take place. Depending on the material developed, it may need to be presented to the Navy non-metallic Technical Warrant Holder for the military standard it would be evaluated against and approval.

The final adhesive material will be used in platforms which contain conformal acoustic structures. Given the final performance of the adhesive underwater, it may be used to repair non-conformal structures whose underwater repair would bring cost and schedule reductions to the Navy. These are most of the submarine platforms under the VA and OHIO programs, as well as the upcoming CLB class sonar systems. This technology will meet needs for allowing a continuous performance across a wide range of submarine sonar systems with a reduction on the cost and schedule to perform repairs. Outside of the Navy, and dependent on potential classification of material properties, this product may be streamlined to commercial and recreational boating applications which would require underwater repair of the hull.

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KEYWORDS: Underwater Curing Adhesive; Acoustically Transparent Material; Flow Surface Repair; In Water Repair; Anti-fouling; Sonar Material Repair.

N251-028 TITLE: Alternative Means of Deploying Shot Line

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop an accurate, reliable methodology of deploying shot line between two ships for underway replenishment (UNREP) operations.

DESCRIPTION: The U.S. Navy's DDG-51 Class Destroyers are typically at sea for extended periods. To sustain the ships, they are frequently resupplied at sea via UNREP. During UNREPs, shot lines are deployed to start the process of deploying a service line to pull the fuel hose to the receiving ship. The current method for deploying shot line has changed little since the Age of Sail. The shot line is a lightweight line attached to a projectile that is fired from a rifle powered by chemical propellant. Once the shot line is received on the other ship, it is hand-pulled by two to three sailors to bring a larger rope across and eventually the span line wire rope. Since the shot line is manually fired, it is an inaccurate process that sometimes requires multiple attempts before the connection can be established. If the shot line connection does not occur, the ship's UNREP evolution may be at risk. The current process of deploying shot line is time consuming, inaccurate, and presents a potential hazard to personnel on the receiving ship. Shot line is deployed to the receiving ship via a manually fired gun. The equipment used has been improved over time, but still has the basic drawbacks of using a shoulder fired gun. Manually aiming shot line is difficult, particularly at high sea states, and prone to error. The development of an alternative means of deploying shot line to meet Navy needs must overcome several technical challenges. First, the ships are approximately 200 feet apart. The line must be shot from one moving platform to another moving platform, relying on the proficiency of the gunner's mate in sometimes challenging environmental conditions. Next, the device must be able to function during conditions up to Sea State 5 on the Beaufort scale. Environmental conditions include such hazards as rain, sea spray, and fog, all of which affect visibility and thus the ability to accurately deploy the shot line. While the legacy process has been safe under optimal conditions, it still has some risk.

Recent technological advancements in smart targeting systems have potential to improve the deployment of shot line. However, such systems have not been adequately demonstrated in the commercial sector to meet Navy requirements. Especially since the system must be compact, but also able to operate in rough weather. R&D is needed to improve and innovate these technologies, so they are fit for Navy use.
An alternative means of deploying shot line must be inherently safe under all conditions that underway ships would attempt UNREP. Any device utilized in a developed methodology should be man-portable and compact for storage and transport.

PHASE I: Develop a concept for an improved method for deploying shot line that meets the requirements above. 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 computer 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 shot line deployment system. The prototype 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 evaluation, modeling, and demonstration over the required range of parameters. An extended test in a maritime environment 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 alternative means of deploying shot line to Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the alternative method of deploying shot line to Navy use. Develop installation, maintenance, and operations manuals for shot line deployment to support the transition to the fleet. There are many potential commercial applications for an alternate means of deploying shot line in inimical conditions. Notable examples include such varied fields as bridge construction, rapid deployment of bear bags, and, launching rescue lines for people in the water. The service industry supporting off shore platforms will benefit from developments under this topics.

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KEYWORDS: Shot Line; Span Line Deployment; Underway Replenishment; UNREP; Projectile Deployment; Service Line

N251-029 TITLE: Dual Band, Color Visible (VIS) and Short-Wave Infrared (SWIR) Camera

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): FutureG

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 single sensor/camera that captures visible (VIS) color and short-wave infrared (SWIR) bands in daylight, haze, and low light conditions with real time video output.

DESCRIPTION: Future submarine periscopes or future submarine off board systems will employ multiple imaging sensors with different imaging modalities and bands. The size of new masts will be similar in size to existing traditional submarine periscopes or smaller and similar for off board systems. The need to add additional capabilities drives the design toward reducing the size, weight, and power (SWaP) of sensors and internal components. Imaging sensors are needed for situational awareness and navigation. Visible band sensors are employed to differentiate navigation lights to quickly determine a ship's aspect at night and identify navigation markers and buoys.

Short wave infrared cameras are a low-cost alternative to costly thermal sensors for low light leveling situational awareness and navigation. To reduce SWaP while maintaining the benefits of both imaging bands, the Navy desires the development of a single sensor to capture imagery in the VIS color and SWIR bands. Combining both imaging bands into one compact sensor while maintaining the performance of each is challenging. Silicon based complementary metal-oxide semiconductors (CMOS) are the most available visible band focal plan arrays photodetectors, while indium gallium arsenide (InGaAs), Germanium (Ge), and more recently colloidal quantum dot (CQD) are common for SWIR focal plane array photodetectors. Two focal plane array approaches have been explored utilizing a beam splitter along with the deposition of CQDs onto silicon for simultaneous imaging of visible and SWIR light. Existing visible to SWIR dual band imagers are commercially available but are monochromatic and fail to provide the user the required situational awareness provided by a color screen. Development is needed to achieve a VIS color to SWIR solution. The final single sensor should also provide three outputs: visible, SWIR, and a fused visible-SWIR image. The fused image can be implemented separately from the sensor via post processing.

The following capabilities are desired for the dual band color VIS and SWIR sensor:

- Pixel pitch: VIS 5 microns, SWIR 12 microns
- Pixel Density: VIS 1920x1080, SWIR 1920x1080
- Frames per seconds: 30-60
- Spectral Range: VIS 0.4-0.7 microns, SWIR 0.9-1.7 microns
- Noise Equivalent Illumination/Irradiance: VIS 0.144m Lux·s, SWIR 2x10^9 photons/cm^2·s
- Bad pixels: SWIR dark or light response better than +/- 25% of array response
- Read noise: SWIR 60e
- Dark Current: SWIR 5nA/cm2 at 25°C
- Quantum Efficiency: VIS 80%, SWIR 60%
- Spatial Alignment: VIS-SWIR co-bore sighted
- Temporal Alignment: Within one or two frames

The Navy requires the technology to enable the insertion of a dual band VIS-SWIR sensor into submarine mast systems to reduce space requirements where a mast must be smaller.

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

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 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: Define and develop a conceptual design for an extended range or dual band color VIS/SWIR sensor/camera that meets the requirements described above. Demonstrate the feasibility of achieving daylight through low light color imagery and show that the concepts can be feasibly developed into a useful product for the Navy. Material testing and analytical modeling will be analyzed to establish design feasibility. The Phase I Option, if exercised, will include a design layout and capabilities for the Phase II prototype.

PHASE II: Develop an extended range or dual band color VIS/SWIR sensor/camera prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II Statement of Work (SOW) and the Navy requirements for nighttime navigation. System performance will be demonstrated through prototype evaluation and modeling over the required range of environmental parameters including lighting conditions and maritime navigational cues. Evaluation results will be used to refine the prototype into an initial design that meets Navy requirements and will be delivered at the end of Phase II. Prepare a Phase III development plan to transition the technology for Navy use.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use for the Submarine Electromagnetic Systems program. Develop an extended range color VIS/SWIR sensor for evaluation to determine its effectiveness in an operationally relevant environment. Support integration and testing aboard operational platforms.

Commercial use of this technology includes surveillance systems, commercial navigation systems, and imaging for search-and-rescue. These are examples of a few systems that must operate in a variety of lighting and sometimes hazy conditions, and which may also require distinction between specific colors.

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3. Tang, Xin et al. "Colloidal Quantum-Dots/Graphene/Silicon Dual-Channel Detection of Visible Light and Short-Wave Infrared." ACS Photonics, July 2020, pp. 1117-1121. https://pubs.acs.org/doi/10.1021/acsphotonics.0c00247
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KEYWORDS: Low light; color imager; high dynamic range; Short-Wave Infrared; SWIR; dual band; maritime navigation; Electro-Optical/Infrared; EO/IR

N251-030 TITLE: Artificial Intelligence (AI)-Generated Domain Specific Model and Ontology

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 concept for a comprehensive assessment methodology to automatically generate a surface Domain Specific Model (DSM) and a model of concepts and their relationships (i.e., ontology) from domain-related technical documentation and generate machine readable interface documentation (e.g., JSON, XML).

DESCRIPTION: The Integrated Combat System (ICS) operates independently and as part of a netted integrated force with shared sensors, Command and Control (C2), weapons, and communications. A surface ship can have over forty (40) system elements that have unique data models. This data must be normalized through a common ontology to ensure a common understanding that is useable for machine processing (e.g., Artificial Intelligence and Machine Learning [AI/ML]). Manual generation of this DSM is a daunting task that has yet to be successfully accomplished. Once a DSM is established, new sensors, weapons, and communications elements can be integrated with little to no changes to the integration software, thus reducing time and required acquisition funding.

In contemporary military operations, the synergy and interoperability of diverse combat systems are critical for mission success. However, achieving seamless integration remains a formidable challenge due to the disparate data formats and structures employed by various platforms. This SBIR topic proposes harnessing the power of AI to devise a unified common data model (CDM) tailored specifically for combat systems (i.e., DSM). By employing advanced ML algorithms, natural language processing (NLP) techniques, and ontological analysis, the Navy seeks a capability to automatically extract, analyze, and harmonize data schemas from multiple sources. The envisioned AI-driven CDM will serve as a foundational framework for standardizing data representation, facilitating real-time data exchange, and enhancing decision-making processes across heterogeneous combat environments. There is no commercial technology that can generate a combat system CDM from Navy technical documentation sources.

The solution will employ a comprehensive assessment methodology comprised of simulation-based testing, real-world data integration trials, and user feedback analysis to evaluate the effectiveness, efficiency, AI trustworthiness, and usability of the proposed AI-driven CDM in enhancing combat system interoperability. The results of this assessment will provide valuable insights into the practical implications and potential limitations of implementing AI technologies for combat system integration, thereby informing future research directions and operational strategies in military contexts.
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 the AI-based DSM that meets the parameters of the Description. Demonstrate the feasibility of the concept in meeting the Navy's need by a combination of analysis, modeling, and simulation. The Phase I Option, if exercised, will include initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype AI-based DSM based upon the results of Phase I. Demonstrate the prototype's functionality through ingesting of data from various representative simulated combat system sensor, weapon, and/or communication elements provided by the government. Demonstrate the ability to modify resource settings and send controls.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. The final product will be a set of containerized applications that transform sensor, weapon, and communications data into the DSM and back into element unique interface specifications to send element unique settings and controls. Provide necessary product-level objective quality evidence to support product certification for use. It is anticipated that DSM can become a standard for future element developments, thus minimizing future data transformations.

Automated generation of a DSM using AI has application beyond military systems. Any industry where there are differences in terminology can use this technology to achieve commonality.

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1. Murphy, A. and Moreland, J. "Integrating AI Microservices into Hard-Real-Time SoS to Ensure Trustworthiness of Digital Enterprise Using Mission Engineering." JIDPS, 25(1), 2021, pp. 38-54. https://dl.acm.org/doi/10.3233/JID-210013
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KEYWORDS: Power of Artificial Intelligence; Diverse Combat System; Unique Interfaces; Domain Specific Model; DSM; Combat Management System; Natural Language Processing; Integrated Combat System; ICS

N251-031 TITLE: Advanced Beam Control and Wave Slap Mitigation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE);Microelectronics

OBJECTIVE: Develop an advanced beam control system on a mast mounted single 12-inch aperture beam director that mitigates wave slap and controls laser emissions, by accurately pointing to and tracking targets.

DESCRIPTION: The Navy is seeking an advanced beam control system for free space optical (FSO) communication, light (laser) detection and ranging (LIDAR), laser systems, and imaging, while maintaining a stable line-of-sight with passive and active compensation of optical beam and imaging jitters. A beam control system must also mitigate environmental effects such as wave slap on the beam director and safely control the firing of laser beam when encountering wave slaps in a timely manner. Currently, there is no government or commercial beam control system for detecting incoming rogue wave and safely controlling the emission of the laser while reliably maintaining a beam control loop for accurate imaging, tracking, or pointing of a laser beam on targets. Typical disturbance sources contributing to optical jitter include platform vibration, structural flexibility, dynamic loading, and acoustics. The beam control system should be designed to minimize and compensate for optical jitter from those various disturbance sources. A well-designed optical jitter control system not only increases the effectiveness of the laser pointing system on targets, but also enhances the imaging and tracking capabilities that will share the same optical path. In order to have a very accurate beam control system, the conventional alignment, which is based on mechanical system alignment between beam director and target line of sight, needs to be very accurate under mechanical jitter, atmospheric turbulence, target motion, etc. However, this method is relatively low speed and requires a very stable platform. To avoid such problems, in this SBIR topic the Navy seeks an innovative high speed and high precision beam steering technology to compensate for any of the above disturbances from mechanical jitters, atmospheric turbulence, phase correction errors, etc.

Detailed requirements for the beam control system:

- Laser Power: > 100 kW average
- Elevation Range: -10 degrees to +85 degrees
- Azimuth Range: 360 degrees
- Target Acquisition Course Field of View (FOV): Wide (50 degree), Medium (8 degree FOV), Narrow (2 degree FOV)
- Target Acquisition Fine: < 1 degree FOV (with zooming capability)
- Target Acquisition Sensors: Visible (VIS), Short Wavelength Infrared (SWIR) and Medium Wavelength Infrared (MWIR) sensors with common FOV
- Target Feedback Control System with Target/Track Illumination Laser (TIL): As a probe laser and BIL (beacon illumination laser)
- Target Tracking: Demonstrate accurate and stable target tracking with positive feedback target lock-in, short acquisition time, and multiple target selection
- Wave Slap: Detection and mitigation within 10 milli seconds or less and closed loop with fire control
- Pointing Accuracy: 1 microradian (relative to inertial reference) closed loop using pulse probe laser
- Shock Tolerance: Structures and components must remain operable through 20G shock acceleration
- Beam Control System Housing: Pressurized 1 atm N2 gas for reduced condensation along the beam control optical path
- Beam Control System: Shall have Athermalization of the optical system

• Beam Director/Periscope Housing: Withstand fluid pressure of greater than 500 psi without leakage; and isolate components at maritime environment
• Volume: Compatible with existing/future Navy platform mast configurations (17” x 17” x 45”)
• Target illumination pulse laser with Deformable Mirror (DM): Include in design for adaptive wave-front, phase correction of laser beam due to atmospheric turbulence; Polarized pulse laser (as probe laser, LIDAR, TIL) can be used for the advanced beam control target detection and laser beam control on target of interest.
• Co-bore sighting: shared by imaging, TIL and laser
• Fast Steering Mirror: Include in design for correction of jitter from on-board vibrations and base motion compensation.
• LIDAR: Target ranging to provide information to beam control system for FOV and target tracking for beam delivery onto target.
• Imaging band: Vis, SWIR and MWIR; Use of Artificial Intelligence technique and multiband imaging for improving target detection, tracking, and pointing of the laser beam under different atmospheric condition is recommended.
• Optical path beam scattering detection system: to monitor beam path inside the beam control system in real time with laser fire control for safety.

Many technical challenges need to be solved before a laser system can be integrated onto a platform mast configuration. One of these issues involves building and demonstrating a compact and agile beam control system. Beam Control systems developed so far for land-based or airborne use are too large for to integrate them for Navy platform mast configuration use and are not submersible. Adapting beam control system designs for the Navy platform mast configurations requires greatly reduced space, weight, and volume while the overall system continues to maintain extremely accurate movement of the optical elements so that the laser intensity is maintained on target for the application of free space optical communication, imaging and tracking, LIDAR, and other laser system. Furthermore, system affordability must be addressed upfront as a major design consideration.

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 and demonstrate the feasibility of the advanced beam control system and identify the risk associated for mast mounted configuration to include integration of both TIL and laser beams. Modeling and simulation shall be used to determine feasibility and to assist with providing an initial assessment of performance under marine environment. Parameters that will demonstrate feasibility are identified in the Description section. The Phase I Option, if exercised, would include the initial layout and design to build the prototype in Phase II.

PHASE II: Develop and deliver the full-scale prototype beam control system with wave slap detection closed loop with beam fire control, target acquisition, target detection, stable optical communication, and power delivery on target with high precision based on the requirements outlined in the Description. If the

Phase II Base is successful and is able to meet all initial objectives as outlined, the Phase II Option I and Option II will be exercised for the full mast mounted beam control system delivered to NAVY for test and evaluation.

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 advanced beam control system into submarine laser and imaging programs for target tracking, and laser beam delivery on target. Validate, test, qualify, and certify the system for Navy use at the Navy facility.

Free-space optical (FSO) communications is an area of dual use for this technology.

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2. Kim, Jae Jun; Nagashima, Masaki and Agrawal, Brij. N. “Optical Beam Jitter Control for the NPS HEL Beam Control Testbed.” Naval Postgraduate School, Monterey, CA. https://nps.edu/documents/106865520/106917544/Optical+Beam+Jitter+Control+-DEPS+Paper.pdf/9b787113-9c99-4827-ac88-08496dc498e1?t=1458153910000
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KEYWORDS: Beam control system; Wave slap detection; Free Space Optical; FSO; Adaptive optics; imaging and periscope system; target illumination laser (TIL)

N251-032 TITLE: Autonomous Unmanned Surface Vehicle Fueling at Sea

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

OBJECTIVE: Develop a capability that will enable Large Unmanned Surface Vehicles (LUSVs) to conduct astern refueling operations from an auxiliary ship or platform while underway.

DESCRIPTION: LUSVs are intended to operate autonomously, including fueling at sea operations. Currently there is no technology, military or commercial, to facilitate autonomous FAS operations with Unmanned Surface Vehicles (USVs) . Manned astern FAS operations involve the refueling ship trailing a hose in the water that the receiving ship retrieves from the water and connects to a fuel riser on the bow of the vessel. This operation requires personnel to hook the hose in the water, operate a gypsy winch to pull the hose up on the deck of the vessel, and finally connect/disconnect the hose to the fuel riser. The Navy seeks to automate this process to eliminate the requirement for personnel aboard the receive ship.
The proposed solution should deploy from the bow of the LUSV and be capable of autonomously identifying, locating, and connecting to a 6 inch astern refueling hose in the water. Solutions could include a simple adapter to the standard hose interface on the refueling platform. The Navy values a solution that minimizes the equipment that needs to be developed. Proposed solutions should incorporate the entire process and must not include temporary manning of the LUSV.

The autonomous FAS system shall conduct and complete refueling evolutions while underway in sea state condition three from a logistics support platform without requiring any onboard/manned support on the receiving vessel. The system shall have emergency break-away capability to facilitate rapid and/or unplanned disconnection of the fuel line without any fuel spillage in the event of potential equipment malfunction, potential vessel collision, or other unanticipated emergency. The system must also prevent fuel contamination.

The FAS system shall be designed to optimize maintenance requirements and enhance safety, including ensuring access to equipment to facilitate safe and effective performance of maintenance actions. Safety considerations include human (human/system interface), toxic/hazardous materials and substances, production/manufacturing, and testing.

Proposers should develop a solution that is Mobile Open Systems Approach (MOSA) compliant to allow for compatibility with future USVs. To ensure interoperability with planned and future USVs, solutions must also comply with PMS 406’s Unmanned Maritime Autonomy Architecture (UMAA). UMAA establishes a standard for common interfaces and software reuse among the mission autonomy and the various vehicle controllers, payloads, and Command and Control (C2) services in the PMS 406 portfolio of unmanned system (UxS) vehicles. The UMAA common standard for Interface Control Documents (ICDs) mitigates the risk of unique autonomy solutions applicable to just a few vehicles allowing flexibility to incorporate vendor improvements as they are identified; affects cross-domain interoperability of UxS vehicles; and allows for open architecture (OA) modularity of autonomy solutions, control systems, C2, and payloads. UMAA standards and additional ICDs will be provided during the Phase I effort.

PHASE I: Develop a concept design for an autonomous LUSV FAS system that meets the requirements in the Description. The concept design must define a system that can consistently operate within the established constraints and include any modeling and simulation, studies, or prototypes in support of concept risk reduction. Demonstrate the feasibility of the proposed concept through modeling, analysis, and concept demonstrations.

The Phase I Option, if exercised, will deliver a preliminary design of the concept, identifying the baseline design (hardware, software, support systems) and underlying architectures to ensure that the concept has a reasonable expectation of satisfying the requirements.

PHASE II: Develop and deliver a prototype system based on the requirements in the Description. The prototype systems will be evaluated at sea in both near-shore and open-ocean conditions.

Identify the necessary interfaces, dependencies, and risks. After a successful Critical Design Review (CDR), the company will develop a prototype system. Testing and certification of the system will consist of simulation with a vessel of opportunity. The testing and certification of the overall performance of the system will consist of hardware-in-the-loop testing on a vessel of opportunity provided by the government.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Successful FAS systems will transition to the LUSV program and will be evaluated for transition to the Medium Unmanned Surface Vessel (MUSV) program and other USV programs. Technology developed for Autonomous Fueling at Sea may also have applicability to other allied nations and commercial users.

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KEYWORDS: Fueling at Sea; FAS; Autonomous FAS System; Medium Unmanned Surface Vehicle; MUSV; Large Unmanned Surface Vehicle; LUSV; Underway Replenishment; UNREP; autonomy; unmanned operations

N251-033 TITLE: Mixed Reality Point Cloud Manipulation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop a capability to visualize and modify 3-D point cloud models generated by Light Detection and Ranging (LiDAR) and photogrammetry with mixed reality hardware to improve the ability for engineers and technicians to perform virtual ship checks to support design, installation, and modernization to deliver ships on time at lower costs.

DESCRIPTION: Program Executive Offices (PEOs), shipyards, Original Equipment Manufacturers (OEMs), Alteration Installation Teams (AITs), Regional Maintenance Centers (RMCs), and others perform countless ship checks and inspections throughout a ship's lifecycle. Investments are currently being made into creating dimensional digital twins with LiDAR, photogrammetry, and other 3-D scanning technologies. These technologies have proven invaluable for generating 3-D models that aid in various maintenance and sustainment functions throughout an asset's lifecycle, but the Navy does not have an effective environment for visualizing and collaborating in the review of ship models.
3-D model generators and consumers visit ships, submarines, or other physical objects of interest, 3-D scan the physical asset leveraging LiDAR or Photogrammetry technologies, generate a 3-D data model with point cloud software, and then view the 3-D model in a 2-D environment (typically a computer monitor) to support future 3-D work (example: installation and modernization). This approach limits user performance and fidelity relative to what fully 3-D models offer, and results in lower effectiveness in the use of this technology.

Immersive 3-D native environments such as augmented reality (AR), virtual reality (VR), or holographic displays provide the opportunity to experience 3-D models in their native dimensions by allowing users to explore and visualize structures and components with every aspect of the model in a familiar and lifelike environment. This will allow naval architects, engineers, technicians, logisticians, shipyard workers, and others across the NAVSEA enterprise to gain significantly more value out of 3-D models with the ability to collaborate in real-time as if physically visiting the ship as a team.

While specific use cases differ in application, the general improvements to visualization are of scale, proportions, special relationships, interferences, and overlays of technical data and annotations from previous inspection and work crews. All these factors will be invaluable to maintenance planning and coordination. Direct return on investments will be seen by improved detection and resolution of physical interferences, design flaws or conflicts, physical damage to equipment or platforms, or other issues with material condition over traditional 2-D renderings on computer screens. Finally, mixed reality will offer the ability for collaborative touring, viewing, diagnosis, and resolution if the aforementioned issues to help diverse teams resolve challenges significantly faster, but currently these tools are not yet mature enough for wide adoption.

To improve the application, execution, and use of 3-D scanning technologies for shipyard applications, NAVSEA would greatly benefit from research, development, and transitioning of software tools that allow the exploration of models in full 3-D views. This concept of employment would be directly applicable to two primary user communities for design purposes:

A) Ship-level inspections, issue documentation, and tagging which occurs on the deck plates of ships and are reviewed by both local and distributed engineering teams. Teams specifically inspect equipment for work and maintenance discrepancies (paint issues, corrosion, loose nuts, bolts, fittings, et al), which should be annotated, documented, and reported via Navy IT systems. In a 3-D environment those annotations can be made directly in a 3-D model environment to better correlate issue status with the specific physical location and piece of equipment of concern, and then models can be shared across multiple teams to maintain a single maintenance operations and maintenance picture.

B) Long-term (multi-year) and short term (single year) modernization planning design work which occurs at the shipyard, at contractor offices, or at distributed engineering Navy laboratories. Engineers, architects, and technicians will take existing 3-D models and drawings, import CAD models for future installations and redesign, and look for interferences, poor condition of existing structures and materials, and will annotate corrections that need to be performed by other teams. A collaborative environment where these models can be viewed and toured by diverse teams to collaborate and rapidly resolve issues is critical, as is the ability to compare as-designed drawings to as-built and current condition models and take measurements inside of those models.

PHASE I: Provide detailed workflows for ingesting 3-D point clouds into vendor software and hardware. Demonstrate similar capability using contractor provided data to assess feasibility. To support this, the government will provide detailed requirements for interaction functionality, data specifications and standards for government models (provided at contract award). The Phase I Option, if exercised, will include the initial design specifications, capabilities description, a preliminary timetable, and a budget to build a scaled prototype solution in Phase II.

PHASE II: Demonstrate the ability to ingest, manipulate, and mark up 3D models of Navy-representative ships generated by the government, with annotations that can be shared across team-mates. Develop a full-scale prototype and complete a successful demonstration of the prototype’s capabilities.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning this technology in the form of a fully operational system (premised on the Phase II prototype) to government use initially on DDG 51 class ships. The final product delivered at the end of Phase III will be an integrated hardware and software solution that can be used by any industry, academia, or government engineering or operations teams that can benefit from collaboration in 3-D space. This includes operations planning, construction and construction management, surveying, and any other use case with similar requirements.

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KEYWORDS: LiDAR; Photogrammetry; Point-Cloud; Mixed-Reality; Annotation; Virtual Ship Check

N251-034 TITLE: Maritime Expeditionary Response Crawler

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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, multi-mission capable, minefield suitable undersea crawler platform to operate in complex seabed environments.

DESCRIPTION: The Navy seeks an expeditionary-sized bottom crawler system to detect, acquire, and neutralize or render safe threat objects in the seabed environment. Currently there is no commercial capability available. The expeditionary-size bottom crawler system shall be a remotely operated platform that must be capable of conducting operations in water depths over 600 meters while also capable of transit on the ocean surface for a distance of at least two nautical miles to a georeferenced point where it can autonomously submerge to the seabed. The crawler platform should not exceed 150 lbs. (not including payloads) and must be designed to accommodate the addition of alternative, end-effector specialized payloads including disruptors, short-range diagnostic sensors, and manipulators. The crawler system must be capable of integration with alternative specialized payloads in the field, which range from neutrally buoyant up to 100 pounds, including additional power adequate for both the baseline platform and payloads without degrading crawler stability and mobility on the seabed. The system must be capable of at least 6 hours of continuous operation including power required for platform, navigation, sensors, and communications.

The system must incorporate navigation, camera, and high frequency sonar sensors and a tethered buoy subsystem with active tether management for Radio Frequency (RF) communications. When submerged, the system shall release the tethered buoy to enable RF command and control by operators at a safe standoff distance. The tethered buoy subsystem shall provide operators supervisory control and situational awareness for detection, reacquisition, and render safe or neutralization tasks to enable clearance of naval mines and other underwater explosive-laden threats. It shall also be capable of allowing operators to take full manual control of the platform when necessary. Supervisory autonomy to reduce cognitive burden to the operator is desired. The system's tether shall be capable of very low latency, reliable communications at varying depths and standoff ranges to enable precision operations.

The system must be capable of effectively conducting operations in different sediment and seabed types (e.g., rocky, flat sand, silt, etc.) and must be stable on the seabed in dynamic sea states and currents. Additionally, it must be designed to achieve, maintain, and/or restore itself to the proper orientation for maneuver to and from the target, and for employment of payloads when at or near the target.
It is desired that the system be designed for operations in close proximity to influence actuated threat mines and have a magnetic signature of three times non-contact specification at a range of 3-4 feet from the closest point of the platform and appendages as specified in MIL-DTL-19595.

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 Maritime Expeditionary Response Crawler System that meets the requirements described above. Demonstrate through modeling and simulation, benchtop tests or other supporting documentation the efficacy of the proposed system design for satisfying prototype system requirements. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II, and plans to assist the Navy in refining system level requirements for transition to operational systems as a component of the Maritime Expeditionary Standoff Response (MESR) Family of Systems.

PHASE II: Develop and deliver a prototype for evaluation to determine its capability in meeting the performance goals defined in the Phase II SOW and the Navy requirements as stated above and to incorporate a diagnostic sensor payload. (Information on the payload will be provided as government furnished information (GFI) during the Phase I Option period). Demonstrate the prototype's performance in a relevant undersea environment against Government-furnished threat representative surrogate targets. Prepare a Phase III development plan to transition the technology to Navy use.

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

PHASE III DUAL USE APPLICATIONS: Provide technical and transition support for the incorporation of the solution into Navy program(s). Provide support for additional testing depending on the particular program (if needed). Explore the potential to transfer the system or technology to other military and commercial systems, including the scientific community. For example, implementation in the US Navy, United States Marine Corps (USMC) and Army Explosive Ordinance Disposal (EOD) Workspace for littoral ordnance neutralization activities in the surf zone. In addition, this technology can provide support within other federal agencies (e.g., Federal Bureau of Investigation (FBI), Department of Homeland Security (DHS)) and civilian first responders and law enforcement agencies to provide a broad range of EOD related support services.

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KEYWORDS: small unmanned surface vessel; sUSV; bottom crawler; mine countermeasures; MCM; Navy expeditionary; underwater improvised explosive device; unexploded explosive ordnance

N251-035 TITLE: Integrated Air & Missile Defense (IAMD) Adaptive Trainer (IAT)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 Artificial Intelligence (AI) and Machine Learning (ML) (AI/ML) based immersive adaptive training approach that continuously improves an operator's performance in evolving threat landscapes including Integrated Air & Missile Defense (IAMD).

DESCRIPTION: The Navy's IAMD systems are crucial for protecting ships and assets from air and missile threats. However, the rapidly evolving nature of these threats necessitates continuous improvement in training methods to ensure personnel are prepared for the latest challenges. Traditional methods like classroom lectures and simulations often present predefined scenarios that may not reflect the ever-changing tactics and capabilities of adversaries. This repetitive nature can lead to complacency and hinder the development of critical thinking and adaptation skills needed in real-world situations. By addressing the limitations of traditional methods, improved training can equip Navy personnel with the adaptable skills and knowledge needed to counter sophisticated and evolving threats. Immersive adaptive training (IAT) can lead to significant cost savings through reduced training time, improved resource utilization, and increased operational efficiency.

The Navy seeks a next-generation, AI/ML based IAT system that can adapt to individual trainee needs, incorporate real-time data and feedback, provide immersive and engaging training experiences, and measure and track training effectiveness. There are currently no known commercial solutions to meet this technology need.

The technology should leverage AI/ML to assess individual trainee strengths and weaknesses, and tailor training content and exercises accordingly. This personalized approach can significantly improve learning outcomes compared to the one-size-fits-all methods currently being utilized.
It should integrate real-time data from simulations, exercises, and operational deployments to continuously update training scenarios and challenges. This approach ensures trainees are exposed to the most relevant and up-to-date threats.

It should utilize Virtual Reality (VR), Augmented Reality (AR), or other immersive technologies to create realistic and engaging training environments that enhance learning and retention. The technology should incorporate comprehensive performance metrics and feedback mechanisms to track individual and group progress, identify areas for improvement, and demonstrate the effectiveness of the adaptive training, improving an IAMD course of action (COA) by at least 10 percent.

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 an AI/ML-based IAT system for IAMD systems that meets the objectives stated in the Description. Demonstrate the feasibility of the concept in meeting the Navy's need through a combination of analysis, modeling, and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and demonstrate a prototype AI/ML-based IAT system for IAMD based on the results of Phase I. Demonstrate the prototype's functionality based on pilot testing with representative groups of IAMD personnel to evaluate the system's effectiveness, usability, and impact on training outcomes. Develop a comprehensive training plan and supporting materials for the AI/ML-based adaptive training system.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. The final product will be an effective AI/ML-based IAT system for IAMD systems. Continued development will occur through testing with representative groups of IAMD personnel to evaluate the system's effectiveness, usability, and impact on training outcomes. Final system use will be analyzed by the Navy to determine effectiveness and utilization in IAMD systems. This system will provide state of the art training for IAMD by giving personalized, adaptable, and immersive learning experiences that significantly improve personnel readiness and combat effectiveness.

This technology could be utilized to support operator training in other mission areas. The AI/ML could additionally benefit commercial applications within the Federal Aviation Administration applications utilizing intensive motion to improve personnel experience benefiting proficiency.

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KEYWORDS: Artificial Intelligence for training; Machine Learning for training; Adaptive Training; Integrated Air and Missile Defense; engaging training environments; Next-Generation Training; VR/AR

N251-036 TITLE: Unmanned Aircraft Systems (UAS) Advanced Networking Interoperability

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with 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 tools that seamlessly integrate Unmanned Aircraft Systems (UAS) platforms with AEGIS Combat System (ACS) to optimize mission effectiveness and situational awareness.

DESCRIPTION: The ACS currently does not fully take advantage of recent upgrades in technical advancements and lacks full utilization of UAS capabilities, due to a lack of integrated routing protocols, controllers, and security. Resulting inefficiencies in speed and quality of information limit fast and accurate understanding of the battlespace from the "unmanned" perspective. Providing speed and quality information is necessary for modern surface Navy operations.

The Navy is seeking an innovative software tool to improve the "unmanned" battlespace and provide the needed integration and interoperability improvements to align existing UAS communication platforms within the broader ACS. This will also provide improved cost benefits to the Navy through improved maintenance and reduced manning. A commercial solution does not currently exist for these improvements.

Potential gaps with interoperability and integration of UAS platforms into the ACS that may be specifically targeted for improvement include adherence to communication standards, sensor fusion and data integration, and command and control interfaces. Development of software-defined networking (SDN) solutions, unified communication gateways, and secure protocol translators tailored specifically to UAS communications are needed to facilitate seamless communication and coordination between UAS and other components within the ACS. Through dynamic configuration and flexible routing capabilities, SDN controllers and agents will optimize network resources based on mission requirements (i.e. real-time situational awareness, mission flexibility, interoperability with Allied Forces, etc.) and operational conditions (i.e. electromagnetic interference, harsh weather conditions, mission-critical data security, etc.), providing real-time adaptability and scalability within complex combat environments. The optimized network will efficiently allocate and manage network resources, such as bandwidth, latency, and routing paths, to meet mission requirements and adapt to operational conditions effectively and can also involve dynamically adjusting network configurations in real-time to maximize performance, reliability, and scalability. The creation of unified communication gateways that serve as centralized hubs for integrating diverse UAS communication protocols with standard combat system interfaces will also be needed. These gateways will bridge the gap between UAS-specific protocols (i.e. MAVLink, STANAG 4586, etc.) and legacy communication standards (i.e. Link-16, Cooperative Engagement Capability, Link 11/22, etc.), facilitating seamless interoperability and data exchange across the entire combat system architecture. The development of secure protocol translators and adapters must ensure the integrity and confidentiality of data transmitted between UAS and combat system nodes. By implementing encryption, authentication, and access control mechanisms, these modules will mitigate potential security vulnerabilities and safeguard sensitive information in transit. Interoperability and integration performance improvements of 10% or higher should be targeted.

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 software tool that meets the Description requirements. Demonstrate feasibility through comparative evaluation and integration capability into the ACS. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Develop and deliver a prototype software tool based on the results of Phase I. Demonstrate the prototype meets the requirements in the Description. The prototype will be tested by government Subject Matter Experts in a government environment.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the prototype application to ACS use in the baseline testing modernization process. Integrate the prototype into a baseline definition, incorporate the baselines' existing and new sensor capabilities, conduct validation testing, and obtain combat system certification.

In the commercial world, this technology can be utilized to enhance the coordination and connectivity of autonomous vehicles within smart transportation systems, improving traffic management and safety. This technology can be applied by professionals specializing in transportation engineering or autonomous vehicle development, particularly in roles focused on software development, system integration, and traffic optimization.

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KEYWORDS: Unmanned Aircraft Systems; UAS; AEGIS Combat System; ACS; Software-defined networking; Unified communication gateways; Secure protocol translators; communication standards; UAS communications

N251-037 TITLE: Underwater Launch and Recovery of Unmanned Underwater Vehicles (UUV's)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces

OBJECTIVE: Improve Unmanned Underwater Vehicle (UUV) launch and recovery capabilities across the fleet by developing a universal approach that can be readily adapted to the existing T-AGS 67 Moon Pool Launch and Recovery System (MLARS) being installed for use by the U.S. Navy.

DESCRIPTION: The Navy seeks to develop a system to recover submerged UUVs so they can be brought aboard using an existing T-AGS 67 MLARS. System development will initially focus on PMS 325 craft, starting with Naval Oceanographic (NAVO) Survey Ship (T-AGS) vessels. Locating and connecting to unmanned vessels below the surface is challenging due to the environmental conditions at depth such as temperature, pressure, visibility, and currents as well as very different surface zone challenges.

The Navy seeks improvement of its UUV recovery capability across the fleet by implementing technology that is deployable from a variety of handling configurations, including ships cranes. Additionally, this SBIR topic aims to reduce the proliferation of specialized UUV recovery systems. A new approach is intended to reduce the need for multiple specialized UUV launch and recovery systems. The proposed system should enable UUV recovery at or below the water's surface, up to 200 feet below the surface. The technology developed under this topic addresses the critical problem of safety while recovering unmanned vessels back aboard their mother ships in a timely manner.

Many different types of hardware interfaces on UUVs exist. The government is seeking a UUV launch and recovery system that is highly adaptable to various configurations. All UUVs may be outfitted with hardware that provides a connection point to the MLARS strongback. The prototype demonstration should be capable of using a model of the REMUS at 19 feet long and 26 inches in diameter. The moon pool on T-AGS 67 measures 18 feet long x 18 feet wide. Wave tank testing is desired at a recognized test facility. Validate the prototype system during at sea or similar environment testing using the existing MLARS installed on a T-AGS vessel. The transition target would include all Navy ships outfitted with moon pool or over the side handling equipment large enough to carry, launch, and recover UUVs and Unmanned Surface Vessels (USVs).

PHASE I: Develop a proof-of-concept design to address the Objective and the details and requirements provided in the Description. Feasibility will be determined through a computer simulation of the solution and provide analyses of system features and a concept of operations to assess overall feasibility and risks. The Phase I Option, if exercised, will include initial design specifications and capabilities description adequate to build a scaled prototype solution in Phase II.

PHASE II: Develop the Phase I design further and provide additional analyses of key subsystems and components. Build a prototype, including supporting test fixtures, at a scale attainable in Phase II, while still sufficient to validate the system design. Prototype demonstration should be capable of using the model of a Remote Environmental Monitoring UnitS (REMUS) UUV as specified by the Navy. Wave tank testing is desired at a recognized test facility. It is also intended that the design of the UUV launch, and recovery system developed under this SBIR topic will be validated during at sea or similar environment testing using the existing MLARS installed on a T-AGS vessel. Develop a preliminary timetable and budget to advance a successful Phase II demonstration of a full-scale prototype.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology for Navy use. UUVs are proliferating throughout the fleet and may be used to minimize risks to civilians, naval personnel, and surface ships engaging in high-risk operations. In addition to application through a moon pool, the technology would have application for over the side operations and operations from USV mother ships, Expeditionary Fast Transport (EPF), and other ships that host USVs. The technology developed under this SBIR topic would also have application to civilian ocean industries such as offshore oil and gas exploration, fisheries, and environmental monitoring.

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KEYWORDS: Unmanned Underwater Vehicle; UUV; Strongback; Mother Ship; Oceanographic Survey Ship; Moon Pool; Launch and Recovery

N251-038 TITLE: Energy Conserving Power Control Module System for Unmanned Underwater Vehicle (UUV)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

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 compact, configurable power control module system for 28 Volt Direct Current (VDC) battery systems for small Unmanned Undersea Vehicles (UUV) to enable power conservation and extend mission duration.

DESCRIPTION: Current small UUV systems are often limited by the capacity of the battery that provides power to the vehicle and its onboard electronics. The Navy seeks a power control module system that has advanced control, optimization, and management capabilities to conserve power and enable longer duration missions.

The Navy seeks an innovative compact, configurable power control module system that can optimize power consumption of up to 28 VDC batteries in battery-powered small UUV systems to maximize energy utilization and extend operational capability. The module shall provide effective power management of all onboard electronics, including sensors, control, and navigation systems to conserve power and achieve a 10% or greater energy savings. Additionally, the module shall provide real-time monitoring and control of power distribution.

The power control system shall be capable of autonomously regulating/optimizing power system components while maintaining a low power impact on the system itself. The module may consist of advanced power management algorithms, software, hardware, or a combination; however, due to limited available Size, Weight, and Power (SWaP), there is a preference for minimal hardware integrated into the UUV. The module must be compact enough to be incorporated within the SWaP envelope, as well as the computing environment and power supply and distribution environment, of existing systems and systems in development. The allowable space for hardware should be no larger than 8 cubic inches, with no single component larger than 1 cubic inch and weighing less than 16 ounces.

The solution must work with existing Navy systems' power buses. However, the Navy is also interested in innovative systems that could involve new power bus schemes which can be included in proposed solutions as a potential for future systems or upgrades.

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 an Energy Conserving Power Control Module System that meets the requirements described above. Establish feasibility by developing system diagrams, as well as Computer-Aided Design (CAD) models that illustrate the power control module concept and provide the estimated weight and dimensions of the conceptual system. Feasibility will also be established; and by computer-based simulations that show the module's performance is suitable for the Navy's needs.

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 system for in-water testing and measurement/validation of the Phase I performance attributes. Perform detailed analysis and live demonstration in a test environment as part of the evaluation. Provide detailed technical documentation of the design, including an interface control drawing and interface specification, to allow successful transition of the product.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use.

Although a fully operational power control module is initially targeted for use in small UUVs, it should have the ability to support additional Navy applications and be suitable for shipboard use. Application of this product would provide commercial UUVs a longer duration to explore, map, survey (pipelines, cables, piers, bridges), and perform work (repair, salvage) in underwater.

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KEYWORDS: Energy Conserving; Power Control Module System; Mine Warfare; DC Voltage Systems up to 28 VDC; Configurable; Extend Mission Profile

N251-039 TITLE: Physics-based Data Augmentation for Machine Learning (ML) Models

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Trusted AI and Autonomy

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 tool to synthesize realistic physics-based sonar data for use in training Artificial Intelligence/Machine Learning (AI/ML) algorithms to enable rapid approaches to fielding sonar-oriented AI/ML capabilities.

DESCRIPTION: For imagery and vocal audio, tools exist to allow individuals to generate realistic audio and video clips for speeches, also known as deep fakes. These tools use a variety of AI/ML tools and limited exemplars of training data.

For sonar, there are tools to compute representative acoustics on sonar arrays to support sailor training objectives. Recording data at sea is currently used to obtain training data for sonar signal processing and it is cost prohibitive to obtain the quantity of data required to train AI/ML algorithms. The complex, physics-based models used in current simulations require a fundamental understanding of the entire phenomenon in question and requires extreme computational power. Data-generation tools exist in industry. However, these tools are not oriented toward sonar and existing tools are not sufficient to develop dynamic scene content covering 360 degrees at extended ranges to support mid-frequency sonar (1 kHz to 10 kHz) across the worldwide range of bathymetric, weather, volume scattering, and contact density conditions. Innovation is required to support the generation of phenomenologically representative data sets. The Navy seeks a tool to synthesize realistic physics-based sonar data for use in training AI/ML algorithms to enable rapid approaches to fielding sonar-oriented AI/ML capabilities. Currently, there are no commercial tools that can do this.

Success with video and vocal audio generation using AI/ML tools suggests that it may be possible to combine recorded exemplars obtained during exercises such as Rim of the Pacific (RIMPAC) with physics-based contact attributes to generate high quality sonar data. The primary use for this generated data would be to train emerging AI/ML algorithms.

AI/ML synthesis tools can enable development of realistic synthetic sonar data for use in training AI/ML algorithms. A limiting factor is the availability of recorded training data and the absence of recorded data from real-world conflict situations involving realistic numbers of enemy contacts. High-quality synthesis approaches that utilize AI/ML would provide an alternate means to creating the large volumes of data needed to train detection and classification algorithms.

The solution must include using generative adversarial models and deep predictive coding models. It must be capable of producing large volumes of diverse high-fidelity data to train ML algorithms that will improve target detection, classification, and tracking systems. Metrics for the solution includes computational performance, “image” similarity metrics, and user assessments.

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 tool to produce realistic synthetic sonar sequences suitable for training signal processing algorithms that meet the feasibility of parameters in the Description. Feasibility will be established through modeling and analysis of the design.

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 tool of the realistic synthetic sonar sequences. Demonstrate the tool’s ability to meet the parameters in the Description through testing. Testing will include benchmarking computational performance, “image” similarity metrics compared to recorded sonar exemplars (which will be provided by the government), and user assessments. Validate the prototype through application of the approach for use in a simulation environment. Provide a detailed test plan to demonstrate that the simulation achieves the metrics defined in the Description.

Due to the nature of recorded sonar data, it is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the tool to Navy use in training current Navy sonar signal processing algorithms as well as with training systems or simulators. Work with the IWS 5.0 Undersea Systems program working groups for ML and training to increase the fidelity of the sonar sensor data used for training AI/ML algorithms and used within high fidelity sonar trainers.

The technology developed under this SBIR topic could provide an improved approach to creating dynamic scene content for other DoD programs. If this AI/ML-generated sonar data can be generated with less computational power than current physics-based models, this technology may also be of use in trainers for sailors.

Complex, physics-based models are often used in current simulations. This requires a fundamental understanding of the entire phenomenon in question and requires extreme computational power.
The innovation sought would reduce reliance processing capacity while retaining traceability to physical attributes of sonar returns. This new approach could be used for sensor data prediction and interpolation for scenarios where it is not possible to record data (e.g., wartime conflict situations) or to produce sonar data to train for salvage operations, oil and gas exploration, and border protection.

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KEYWORDS: Train emerging AI/ML algorithms; AI/ML synthesis tools; High-quality synthesis approaches that utilize AI/ML; mid-frequency sonar; deep predictive coding models; physics-based contact attributes

N251-040 TITLE: Algorithms for 3 Axis Magnetometer in the Water Column

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

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 innovative real-time signal processing algorithms to optimize sensor performance and detect objects in water using commercial low-power 3-axis magnetometers.

DESCRIPTION: Recent developments in smaller and more sensitive 3-axis magnetometer sensing devices, coupled with ever smaller signal processing target detecting devices, has opened up the possibility for the development of algorithms for object detection based on magnetic sensing. However, the magnetic background of data collected is compromised due to the inherent motion induced noise of conventional scalar magnetic sensors.

Utilizing a 3-axis magnetometer in the water column of the earth’s large magnetic field is difficult because 3 axis magnetometer production is imperfect. Commercial fluxgate axis sensitivity mismatches and axis misalignment create noise issues when computing the total magnetic field while the sensor experiences yaw, pitch, and roll associated with being in the water column. Calibration can reduce these effects, but an attitude, and heading reference sensor (AHRS) compensation scheme will likely be required for effective object detection performance. Limitations on the ability to suppress noise in realistic environments versus manufacturing imperfections (sensitivities and alignments) must be minimized and characterized to maximize and understand moored underwater persistent system performance. To mitigate these limitations, the Navy seeks advanced signal processing object detection algorithms with calibration and noise cancelation schemes for commercial, low power, 3-axis magnetometers to optimize sensor performance and improve detection, localization and classification of underwater threat objects.

The algorithms will be integrated into the software module of a low-power commercial magnetometer system and will not be part of a towed magnetometer. The commercial magnetometer can be either a fluxgate or a total field magnetometer. However, the threshold power requirement must be under 0.45 watts.

The algorithms should be modular, configurable, and able to be recalibrated for mission or sensor housing type to be used in various magnetometer systems. Algorithms must be capable of processing magnetic sensor data in real time and support high probability of detection with low false alarm rate as well as prevention of false positives created by geomagnetic noise and motion induced noise. Algorithms should be capable of detecting and identifying object features.

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 to facilitate object identification, detection, and localization using 3-axis magnetometers that meets the requirements described above. Demonstrate the feasibility of the concept in meeting Navy needs and establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling.

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

PHASE II: Develop and deliver a prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II SOW and the Navy requirements for the algorithms. Demonstrate performance across a broad set of Government Furnished Information (GFI) data. Performance will be validated against Government-provided object truth. Prepare a Phase III development plan to transition the technology to Navy use. The company will prepare a Phase III development plan to transition the technology to Navy use.

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

PHASE III DUAL USE APPLICATIONS: Provide technical and transition support for the incorporation of the solution into Navy program(s). Depending on the particular program, support for additional testing may be needed. Explore the potential to transfer the system or technology to other military and commercial systems, including the scientific community for geological exploration of deep structures of the Earth and altitude control on satellites.

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KEYWORDS: Algorithms; Magnetometer; Water Column; Object Detection; Compensate for Noise and Changes to the Magnetic Field; Triaxial; Magnetic Calibration

N251-041 TITLE: Generalizable Artificial Intelligence/Machine Learning (AI/ML) Undersea Warfare (USW) Quick-Look Tool

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 configurable Artificial Intelligence/Machine Learning (AI/ML) tool that generates USW quick-look reports for laboratory testing and at-sea tests data collection events.

DESCRIPTION: Documenting the outcome of laboratory testing and at-sea tests procedures involves including time-consuming manual processes, variability in expertise, and subjectivity in interpretation. Manual interpretation of test results incurs potential for human error and requires substantial time. The potential for error and delay increases with the complexity and volume of data. Delay may also occur when multiple professionals must come to consensus on the interpretation of the data.
Not all test engineers have the same level of experience or knowledge when interpreting test results, leading to unnecessary inconsistencies in reported outcomes. This variability can result in unnecessary variation in management decisions based on test results that are not consistent due to interpretation of the data by various individuals.

Further, engineers may draw contrasting conclusions from the same test data, contributing further to the variability in outcomes, as may occur when the test is simple (e.g., calibration of a sensor array). These challenges are compounded by other factors, such as quality of results, factors related to the purpose of the test procedure, and the reliability of test measurements.

The Navy seeks a Generalizable USW Quick-Look Tool that reduces variability in outcomes and facilitates an advanced state of expertise among inexperienced test and manufacturing personnel. There is currently no commercial tool that can accomplish this.

The initial target of the technology would be relatively simple and repeatable tests, such as towed receive array calibration and inspection. The solution must be extensible to more complex test procedures, with the tool being evaluated based on accuracy of results in the report, useability of provided information, and latency reduction in the time it currently takes. The solution must show a range of quick-look test summaries to include representative tests, from simple calibrations to complex test series across multiple days, test objectives, and environmental conditions to demonstrate its abilities. It must also do pre-test quality assurance check that could detect mechanical inconsistencies between the planned test setup and the actual hardware configuration.

The concept will be evaluated based on feasibility, range of extensibility across test complexity (calibration test to multi-day multi-objective testing) and type (in-lab testing to at-sea testing), ease of use for test engineers, and clarity of test result presentation.

The minimum viable product (MVP) version of the end result will undergo independent testing by the IWS 5.0 Machine Learning Working Group. This independent testing will include using the prototype with classified data sets.

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 an AI/ML USW Quick-Look tool and demonstrate that it will feasibly meet the parameters of the Description. Demonstrate feasibility through modelling and testing.

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 AI/ML USW Quick-Look tool based on the results of Phase I. Demonstrate the technology through performing independent evaluation of the MVP prototype with the government Machine Learning Working Group. The government Machine Learning Working Group will test the prototype using classified data sets.

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

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to Navy use. It is anticipated the final product will eventually be used across PEO Integrated Warfare Systems (IWS) and USW to develop quick-look reports for both laboratory testing and at-sea tests. The Space, Weight, Power, and Cooling (SWAP-C) associated with the final product will determine details of how test engineers may utilize the resultant product in cases where cloud-based test infrastructure may not be available.

The Generalizable Quick-Look Tool will be of use in numerous applications where engineering tests must be rapidly summarized to support product decisions or provide insight to customers. Given the anticipated domestic reshoring of product manufacturing, the Generalizable Quick-Look Tool could become a major help to future manufacturers who will often lack sufficient seasoned personnel to mentor the rising workforce using traditional master-apprentice techniques.

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KEYWORDS: Quick-look test summaries; calibration of a sensor array; independent quality assurance check; complex test procedures; inexperienced test and manufacturing personnel; reduces variability in outcomes

N251-042 TITLE: Resilience against Supply Chain Cyber Vulnerabilities

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

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 technology that ensures computing hardware technologies integrated into future combat systems are trustworthy and cyber secure.

DESCRIPTION: Shipboard computing infrastructure has evolved to over 3,000 Central Processor Unit (CPU) Cores that are distributed across multiple military grade cabinets. The cabinets can be in multiple spaces within a ship to ensure survivability if a set of cabinets are disabled or destroyed. Current CPUs within the cabinets are on Advanced Telecommunications Computing Architecture (ATCA) standard single board computer (i.e., blades).

The distributed nature of shipboard computing poses significant challenges in ensuring security, robustness, trustworthiness, and performance of computing infrastructure. Infrastructure resilience is the ability of a computer infrastructure to adapt, mitigate, and respond to stresses within the Information Technology (IT) environment via the integration of software and applications. The IT system can transform itself to ensure that essential business functions and processes are maintained. In today's environment, cyber security is managed using a security information and event management (SIEM) embedded within the computing infrastructure (i.e., NIST SP 800-145 Infrastructure as a Service (IaaS)) or application services (e.g., NIST SP 800-145 Platform as a Service (PaaS)).

Computer research in the area of advanced multi-die systems is achieving previously unheard-of levels of performance. Instead of one-size-fits-all monolithic silicon, multi-die systems are comprised of an array of heterogeneous dies (or "chiplets"), optimized for each functional component. Given the increase in performance and evolutionary trend of shipboard computing hardware over the past 30 years, it's fair to predict that eventually chiplets will find their way onto surface ships to meet evolving surface ship warfighting requirements (e.g., AI/ML, decision support, weapons coordination). While multi-die systems offer new levels of flexibility and achievement in system power and performance, they also introduce a high degree of design complexity and new security challenges.

The Universal Chiplet Interconnect Express (UCIe) standard was introduced in March of 2022 to help standardize die-to-die connectivity in multi-die systems. UCIe can streamline interoperability between dies on different process technologies from various suppliers. But while a UCIe-compliant multi-die system may work great through development, testing, and manufacturing, can the system's die-to-die connectivity be ensured to continue—robust, secure, and tested— even while it's operating in the field? Having a mix of suppliers in a supply chain from various countries introduces security challenges within a chiplet-based architecture. Solving these challenges is of utmost importance for stakeholders. A comprehensive, multi-layered approach to address computing infrastructure resilience (CIR) and enhance the overall reliability and efficiency of edge computing environments is sought. There is no current commercial solution to address the approach needed.

A solution needs to protect all surfaces beyond the trusted computing base (e.g., processor chip) as data moves around the system. It must ensure zero trust by always verifying data and sources within the computing infrastructure (attestation). It must also ensure least privilege by software and hardware components only having access to what they need to complete work (access control). This research needs to demonstrate the ability to modify settings and controls to ensure CIR under various 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 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 CIR that meets the requirements stated in the Description. Demonstrate the feasibility of the concept in meeting the Navy's need through a combination of analysis, modeling, and simulation. The Phase I Option, if exercised, will include initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype CIR based upon the results of Phase I. Demonstrate the prototype's functionality through various cybersecurity use cases that demonstrate that it meets the requirements of the Description.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Provide a final CIR product that includes a set of design patterns, code examples, and compliance tests that provide guidance for CIR compliant implementations. Provide necessary product-level objective quality evidence to support product certification for use.

It is anticipated that this CIR can become a standard industry and DoD computing infrastructure implementation. Commercial cloud environments (e.g., Amazon, Microsoft Azure) can benefit from this CIR as well as computing environments located within industry facilities.

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KEYWORDS: Chiplet Architecture; Universal Chiplet Interconnect Express; UCIe; Infrastructure Resilience; Computing Infrastructure; Zero Trust; Supply Chain

N251-043 TITLE: Development of Toroidal Propellers for Torpedo and Unmanned Underwater Vehicles (UUV) Applications

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): FutureG

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 toroidal propellers for the MK54 Lightweight Torpedo (LWT) with focus on the metrics of speed, efficiency, and quieting.

DESCRIPTION: A toroidal propeller design consists of a hub supporting multiple elongated elements. The novelty lies in the tips of these elements curving to contact with one another to form a closed structure. This design encloses the huge open space usually seen in conventional propellers, increasing the stiffness of the entire propeller, and providing enhanced strength. The configuration of the propeller also reduces the noise that these mechanical devices usually generate, translating to a reduced acoustic signature. This technology is differentiated by these two innovative aspects: increased stiffness and reduced acoustic signature, unlike conventional propeller designs whose open structure both for aeronautical and marine environments makes them less rigid and noisier. This propeller design offers a unique adaptation that makes the propeller tougher, quieter, and more effective.

The Mk54 LWT Design of Record (DOR) utilizes a torque balanced inner/outer shaft design to propel the torpedo with a set of counter rotating propellers. These propellers operate at similar RPM with the forwards propeller operating at an RPM of ~0.5-3% greater than the aft propeller.

Any newly designed propeller set will need to meet the current system capabilities in fuel efficiency, top speed, and transmission of noise to environment. Ideally this upgraded design would be able to improve upon all aspects of the system and provide a better all-around propeller for the LWT. The Navy priorities for design, in order are: top speed, fuel efficiency, cavitation mitigation. These three topics will be the primary benchmarks for modeling and will be compared against the current system abilities. The secondary goals will be to look at maneuverability, system quieting, and survivability due to damage. The LWT torpedo is a long cylindrical body that tapers in a streamline fashion in the aft section. This section contains the control fins and the two rotors. The rotors maintain the streamline taper for the hub designs and then uses specifically designed blades for minimizing noise and increasing the thrust capability of the device.

As can be seen in Figure 1 (https://navysbir.com/n25_1/N251-043-Figures-1-and-2.pdf), the system normally uses two counter-rotating shafts on an inner/outer installation. The overall streamline dimensions for the shape are detailed in Figures 1 and 2.

A closer look at an Initial Capabilities Document (ICD) of the Mk54 torpedo shows the dimensions allowed for creation of a new set of propellers. The internal design is a spline, which is detailed in Figure 4, while the dimensions of the available space for propeller design is detailed in Figure 3.

The LWT operates from the surface down to LWT Depth and from RPM's from 600 to 3000 RPM. This produces a torque balanced system with the two propellers balancing each other's torque load. The Forwards propeller operates at a maximum of 3% less RPM at 600 RPM and 0.5% less at 3000 RPM. The speed range is between Low and High operation; with RPM Forwards being 300 and 2500, RPM Aft being 315 and 2690 low/high respectively. Associated Speeds and Depths are classified and may be shared after award.

Only direct drop in replacement designs will be considered. There is no design envelop for hardware modifications to the LWT. RPM ranges for different operating modes can be modified. The propeller hardware may be designed with any material and any manufacturing process so long as the design can conform to current DOR shock and vibration requirements. The Navy is seeking +10% improvement on top speed and fuel efficiency, meaningful noise reduction, and significant acquisition cost savings. Current DOR LWT propellers are approximately $22K per set.

The awardee will demonstrate new propeller design performance in a representative environment. The prototype design should provide no less than 8% improvement to top speed and fuel efficiency, and reduced cavitation compared to the DOR. The awardee will deliver a minimum of five of these prototypes to the Navy for evaluation. The awardee will perform detailed analysis to ensure materials are rugged and appropriate for Navy application. The proposer will provide a manufacturability and cost analysis in support of Navy Business Case Analysis for upgrading to the new propeller design. Environmental, shock, and vibration analysis will also be performed.

The awardee will conduct computational fluid dynamics (CFD) analysis of the design, which the Navy will measure against the current DOR propellers. The proof of design analysis will inform as to the anticipated improvements to the priority topics of top speed, fuel efficiency, and cavitation. The awardee will also include a projected manufacturability and cost analysis.

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 to meet the needs for an innovative propeller design. Design a proof-of-concept propeller set for the MK54 LWT using the provided design parameters in the Description. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver Phase II prototypes for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II Statement of Work (SoW) and the Navy's need for improved top speed, fuel efficiency, and cavitation mitigation.
It is probable that portions of the work under this effort will be classified under Phase II (see the Description section for details).

PHASE III DUAL USE APPLICATIONS: Apply the knowledge gained in Phase II to refine and finalize the propeller design and characterize performance as defined by Navy requirements. Working with the Navy and applicable industry partners, demonstrate the final propeller design with a series of in-water runs equipped on a MK54 LWT. Support the Navy for test and validation to certify and qualify the system for Navy use. Explore the potential to transfer the propeller design to other military and commercial systems (e.g., other torpedoes, UUVs). Market research and analysis shall identify the most promising technology areas and develop manufacturing plans to facilitate a smooth transition to the Navy.

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KEYWORDS: Toroidal Propeller; Closed Loop Propeller; Cavitation Reduction; Noise Reduction; Increased Thrust; Fuel Efficiency; Tip-Vortices

N251-044 TITLE: Data Converter Cabinet for the AEGIS Weapon System MK99 Fire Control System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with 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 a solid-state data converter cabinet that maintains or exceeds existing functionality and performance to replace wire wrapped plane cabinets.

DESCRIPTION: The Navy's MK99 Data Converter Cabinets (DCC) rely on a wire wrap backplane which relays power and logic to Circuit Card Assemblies (CCAs) via analog signals to process the necessary data to feed the many information systems of the AEGIS Weapon System (AWS) MK99 Fire Control System (FCS). A wire wrap system consists of individually wrapping wire around metal posts, collectively known as a bed of nails, to create logic and/or power circuit paths. Maintenance for these backplanes becomes time consuming should the bed of nails suffer damage, need repair, or for even simplest of wiring. The skill of wire wrapping is fast falling out of favor in the technical community and there is a need to find solutions such as Printed Circuit Board (PCB), surface mountable technologies, or other industry concepts and approaches that are adaptable innovations that can enable retrofit to existing MK99 FCS installations aboard DDG 51 Class ships, development and tactical sites, and international ships. The Navy is seeking a solution that minimizes requirements for wholesale cabinet rip-out and installation to include man-portable modular electronic components, hatchable equipment enclosure architectures, and mechanical/electrical compatibility with existing ship services and cables. Currently there are no commercial solutions that can meet the desired capability.

Design of this below-deck equipment solution seeks to maintain existing interfaces to the SPG-62/MK82 topside antenna and director as well as digitizing the FCS loop from the current antiquated analog MK200 system (largely unchanged since 1992). The solution for the below-deck equipment will retrofit to the existing AEGIS fleet with minimal interface changes and minimal impacts to existing cables and ship services (i.e., power, cooling, electrical, etc.), and equipment will comply with new construction DDG 51 shipbuilding delivery dates.

The solution will be a modular cabinet with system configurations with extensible future upgrades toward hatchable and readily upgradable electronic systems in the future. It must address mitigating supply chain issues through form-fit-function component selection and qualification. It will identify data converter cabinets, sensors, data acquisition hardware, technologies, and design. A solution will show advancements in contrast to existing devices. The solutions must be functionally equivalent to the current design and meet qualifications for shipboard equipment shock, vibration as specified in MIL-STD-810, airborne noise, and electromagnetic interference as specified in MIL-STD-461. The solution must meet testing requirements of the government in relevant environments. Define and demonstrate how to compare new solid-state data to legacy data. The design must be capable of integration with current cabinetry.

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 solid-state DCC and show it can feasibly meet the requirements of the Description. Feasibility will be demonstrated through modeling and analysis. Define and demonstrate how to compare new solid-state data to legacy data. 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 of the DCC based on the results of Phase I that meets the capabilities listed in the Description. Demonstrate the prototype meets the required parameters in the Description. Testing will be accomplished by the government in a relevant environment provided by the government.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the prototype to Navy systems. The prototype will be integrated into the MK99 FCS. Assist in testing and integration. Potential commercial applications involve the conversion of wire wrap backplanes to surface mounted technologies capable of providing power and logic to Circuit Card Assemblies (CCA).

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KEYWORDS: Address mitigating supply chain; Data Converter Cabinets; Solid-state CCA; man-portable modular electronic components; hatchable; minimal interface changes

N251-045 TITLE: Water Mist Pipe Repair Kit

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop a methodology for a high integrity repair of the DDG 1000 High Pressure Water Mist Fire Fighting System while deployed underway.

DESCRIPTION: Current piping system repairs are done through building pipe sections onboard, welding, or soft patches with sealant materials. Temporary piping repairs must be reliable, effective, and quickly implemented allowing for continued operations. While one can expect there is enough good pipe wall for the mastic and patch to adhere, the challenge is knowing the integrity of the pipe wall surrounding the leak in order to have confidence in the quality of a pipe repair method in a high energy system. Even a successful hydro of such a patch doesn't guarantee that the patch won't give way when next exposed to operating pressure.

Recently, a ship could not get underway due to water mist pipe header and branch line leaks that reduced system pressure in machinery spaces. The machinery spaces were shut down and created redline impacts for getting underway due to the level of defined risk. Ships Force and support activities have utilized epoxy and soft patches, with long cure times, and limited success. Regional maintenance centers evaluated the repairs and provided guidance for acceptable operations. However, further repairs were required which led to a one-month delay in test and trials. Current piping system repairs are done through building pipe sections onboard, welding, or soft patches with sealant materials. A new repair methodology must be quickly implemented to allow for continued operations and testing. The repair method should be suitable for emergent underway repair for a variety of fluid types and system pressures with primary concern being the DDG 1000 High Pressure Water mist firefighting system.

PHASE I: Develop a concept for an improved method for underway repair of the DDG 1000 High Pressure Water Mist Firefighting System. 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 computer 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 a prototype to be tested to demonstrate its core functionality. Test the prototype at a Land Based Test Facility to ensure its suitability to shipboard use. The results of these tests 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 CKMS to Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the repair system to Navy use. As High-Pressure Water Mist systems become more prevalent across the fleet and industry, quick high integrity repair methods will be needed. Transition the product through sole source justification and utilizing Logistics outfitting and provisioning of approved products, technical manuals, and maintenance documentation through the program offices and fleet type commanders. Major industrial systems incorporating engines, generators, and turbines will benefit from capabilities developed under this SBIR topic.

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2. MIL-STD-777F(SH) Schedule of Piping, Valves, Fittings, and Associated Piping Components for NAVAL Surface Ships. https://navysbir.com/n25_1/N251-045-Reference-2-MIL_STD-777F_Change-2.pdf

KEYWORDS: Pipe Repair; Water Mist; High Pressure; Temporary Repair; Damage Control; Fire Fighting

N251-046 TITLE: Joint Track Manager Data Synchronization

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

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 innovative software algorithm that seamlessly interacts with the Joint Track Manager (JTM) to provide a consistent and reliable transmission and reception of tactical data link (TDL) messages for real time comparison of track databases.

DESCRIPTION: The Command and Decision (CND) element of the AEGIS Weapon System (AWS) consists of multiple track management applications working in conjunction to create and maintain source and system level track data for use by the overall AEGIS Combat System (ACS). These applications include, but are not limited to, Product Line Architecture (PLA) System Track Manager/Track Server (STM/TS), System Track Processor (STP), Link Interface Function (LIF), AN/SPY-1(6) Processing Functions (SPF/SPF6), and Cooperative Engagement Function (CEF). Combat system baseline configuration dictates which source managers are contained within a specific version of the AWS. While the STM implements a TS to store all Source and System level track data, each of the other source managers utilize local, internal track stores, maintained in parallel to the TS, while receiving and processing Source and System level track data. At times, these internal track stores can become out of synch with the TS, leading to the potential for a degraded state of track management functionality, and overall situational awareness. The Navy seeks an innovative software application that performs real-time monitoring of all link message types for interoperability to interface with CND and make corrections as necessary to keep them all in synch with the TS. This capability would ensure that the most accurate and up to date track data is available to the weapon system. This leads to increased situational awareness and decision-making abilities for the warfighter. This provides the Navy with a reduction in manning and maintenance costs. Currently there are no commercial solutions available to provide the synchronization needed.

This solution shall run in the background and not constrain the flow of track data between source and system level track management applications. The application will compare, at a minimum, track numbers, track identification/classification, and Identification Friend or Foe (IFF) modes and codes, with an objective to compare and synchronize all track attributes from incoming and outgoing link messages. The solution will benefit the Navy in improving product quality to ensure all track management subsystems are in synch and provide for the highest level of situational awareness in the Command and Control (C2) Track Management domain. The speed and accuracy of the solution must exceed existing ACS performance by 10% or better.

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 JTM data synchronization that meets the objectives stated in the Description. Demonstrate the feasibility of the concept in meeting the Navy's need by any combination of analysis, modelling, and simulation. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Develop and deliver a prototype JTM data synchronization software application based on the results of Phase I. Demonstrate performance of the prototype in an existing Government-approved modeling and simulation environment. The demonstration will be conducted in a Government-provided facility. Analyze the accuracy of the software through assessment of the logic in mathematical algorithms developed to accurately represent a passive reporting capability approach to integrate into the Aegis Test Bed (ATB) environment. Deliver prototype software to the Navy along with complete test data, installation and operation instructions, and any auxiliary software and special hardware necessary to operate the prototype.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for government use. The prototype will be incorporated into the AEGIS baseline testing modernization process. This will consist of integration into a baseline definition, incorporation of the baselines existing and new threat capabilities, validation testing, and combat system certification.

STM/TS algorithms could provide assistance to air traffic controllers in monitoring potential collisions by increasing the accuracy and throughput of data.

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KEYWORDS: Product Line Architecture (PLA); System Track Manager/Track Server (STM/TS); System Track Processor (STP); Link Interface Function (LIF); SPY Processing Function (SPF); Cooperative Engagement Function (CEF).

N251-047 TITLE: Multi-sensor and Acoustic Contact Localization through Artificial Intelligence/Machine Learning

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

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 technology that can localize maritime entities from passive sensor contact information using artificial intelligence or machine learning (AI/ML) algorithms.

DESCRIPTION: Modern submarines are fitted with numerous arrays with the intent of minimizing blind spots. However, the parameters associated with these disparate arrays makes it difficult to create a unified picture, particularly where entities are detected by multiple sensor arrays. Submarines and other undersea warfare systems use passive sensor information to develop track information (bearing, range, course and speed vs. time) of maritime entities. It does so by leveraging multiple separate algorithms and observations of changes in the dynamics of acoustic sensor data such as signal arrival angle at the sensor array, Doppler shift, and data from spatially separated arrays. Often the submarine will maneuver to drive changes in how the entity appears to the sensor to enable Target Motion Analysis (TMA). The sensor data feeds various algorithms that suggest the proper 4-state solution (bearing, range, course, and speed) for entity location and velocity. The quality of the solution depends on the completeness and accuracy of the data fed into the algorithms and how the submarine maneuvers.

Several of the acoustic arrays that submarines rely on are towed, with estimated shape and position used when computing entity positions.

The operator typically cycles between multiple separate solution development and evaluation tools to arrive at candidate contact track solutions. This process becomes increasingly inaccurate as the incoming information becomes more complex, as might occur with noisy, sparse, or weak contact signals or when a large number of contacts must be managed. Advances in solution accuracy have been achieved through refining the operator machine interface to support efficient operator workflow based on the current paradigm of cycling through multiple algorithm-generated displays to assess validity of multiple hypothetical track solutions.

The Navy seeks to shift to an integrated technology for simultaneously evaluating all available information for localizing maritime entities. A solution for obtaining this shift is not commercially available.

AI/ML algorithms for U.S. Navy Undersea Warfare sensors have been used to assist in detection and classification of signals within the current cyclic process. This SBIR topic seeks to migrate to AI/ML technology where detection information such as operator-promoted contact followers are used to achieve rapid and accurate localization of individual maritime entities in support of a holistic tactical contact picture. The tool developed will need to demonstrate an ability to develop contact track solutions using all promoted sensor data and associated environmental propagation information as measured by estimated 4-state solution (bearing, range, course, and speed) when compared to the true track.

In addition to producing rapid estimates of contact position and speed, the desired AI/ML technology should also be able to provide refined array shape and position estimates in real time, rather than relying on predicted shape and position using high-level parameters such as platform speed and tow cable scope. The technology architecture must be extensible to multiple arrays and array types as well as contact follower data from multiple vehicles. It must use data that is diverse and representative of real world acoustic data. The data should be representative of both hull mounted and line array configurations. It is desirable for the technology to provide a confidence value in addition to track solution estimates. The solution will provide novel visualization tools or processes that suggest track solutions, the quality of constituent data sources, and instances where operator-specified information (e.g., propagation paths) do not make sense in light of the larger sets of data considered by the AI/ML technology.

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 an AI/ML TMA tool that meets the parameters of the Description and demonstrates the feasibility of the concept using unclassified data obtained or created by the awardee and that is clearly extensible to the acoustic data use case. Show feasibility through analysis, modelling, simulation, and testing. 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 AI/ML TMA tool with architecture and methodology for incorporating the capability into submarine sonar contact management. Demonstrate that the prototype meets the required range of desired performance attributes given in the Description. System performance will be demonstrated through installation and prototype testing on a testbed with the lead system integrator provided by the government.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use in Anti-Submarine Warfare (ASW). Demonstrate and report on performance during laboratory testing. The prototype will be integrated into ASW combat systems for which IWS 5.0 develops updates, which include the AN/SQQ-89, AN/BQQ-10, and AN/BYG-1 systems.

The technology can be extended to any passive sensor, including non-acoustic sensors. This technology can be used in a wide range of complex systems of systems where AI/ML is used to characterize operator proficiency and just-in-time performance assistance is crucial to mission performance. The technology would be of greatest use in complex safety-critical systems where mistakes carry disproportionate risk of mission failure.

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KEYWORDS: Artificial intelligence or machine learning (AI/ML); acoustic sensor data; undersea warfare systems; data that is diverse and representative; Target Motion Analysis (TMA); Holistic Tactical Contact Picture

N251-048 TITLE: Analog to Digital Converter for Low Noise Electromagnetic Measurements

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics

OBJECTIVE: Design a specialized Analog to Digital Converter (ADC) to support the data acquisition needs of extremely low-noise underwater electromagnetic (UEM) sensors, enabling measurements of lower UEM signals.

DESCRIPTION: The Navy seeks a specialized ADC technology that interfaces with low-noise Underwater Electromagnetic (UEM) sensors to achieve extremely low system noise levels. The ADC shall support specific magnetometers and electropotential sensors that are currently used by U.S. Navy measurement facilities.

UEM sensor technologies (i.e., magnetometers and underwater electropotential sensors) continue to improve at a rate that is faster than the available commercial off-the-shelf (COTS) ADC solutions. This disparity in technology growth has resulted in UEM sensors no longer driving the noise floor of the acquisition system. The COTS ADC solutions were generated from a demand in significantly different sensors and mediums. With some of the modern sensors on the market, ADCs are the limiting factor for improving total system noise levels. There is evidence from the research communities and industry, that shows ADC performance can be optimized for specific applications.
Research into the specific composition of ADC circuits is needed to acquire either magnetic field or electropotential data. This needs to be done to ensure the most optimal performance. Additionally, the form factor of existing COTS ADCs can drive the minimum size requirements of UEM measurement systems. A smaller form factor would allow for more flexibility in arrangements, locations, and quantity considerations of field-able systems.

The ADC will be evaluated against other commercially available ADCs supporting identical sensors, including the ADCs that have historically been leveraged by U.S. Navy UEM measurement systems. These criteria may include the following, but may not be limited to:

- Dynamic Range
- Resolution
- Sampling Rate (Specifically 6-10 kHz desired)
- Power Consumption
- Effective Signal to Noise Ratio (SNR)

A successful candidate will show the ability to design an ADC that is tailored to a specific measurement device while optimizing ADC performance for common ADC parameters like the ones mentioned above.

PHASE I: Design and develop a concept ADC to meet the requirements in the Description section. The Phase I Option, if exercised, will include the initial ADC design that would be leveraged to build out a prototype for testing in Phase II. Additionally, performance simulations demonstrating the expected noise levels will also be required to move forward with a Phase II award. The circuit design will need to demonstrate simulated noise levels meeting or exceeding advertised noise levels for existing COTS ADC solutions.

PHASE II: Fabricate and deliver a prototype ADC to be lab tested to demonstrate component noise performance to be compared with the simulated results from Phase I. Additionally, the prototype ADC will also be integrated with a UEM sensor in a lab setting to demonstrate system noise performance. After lab testing is completed and noise levels are demonstrated, if satisfactory with U.S. Navy expectations, the next portion of Phase II will be integrating the ADC prototype into a U.S. Navy measurement system that will be deployed at the South Florida Ocean Measurement Facility (SFOMF) in

Dania Beach, FL to demonstrate the total system noise levels in an operational environment to achieve TRL 7.

PHASE III DUAL USE APPLICATIONS: Integrate the Phase II developed ADC prototype into a standard form factor capable of back-fit to existing hardware or forward-fit current and future data acquisition system designs and architectures. Designs would likely support SFOMF systems and other facilities with deployed UEM sensors.

The ADC developed under this project could be utilized for the same type of sensors that are frequently employed for the oil and gas industry. UEM sensors are commonly utilized for oil and gas exploration and lower noise sensors would be more capable for this purpose.

The product will be initially validated in a similar method the prototype was evaluated in Phase II with lab and SFOMF testing with a deployed system. Component certification would be completed by NSWC Carderock, NAVSEA’s engineering agent for underwater electromagnetic measurement systems.

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KEYWORDS: Analog to Digital Converters (ADC); Acquisition Systems; Underwater Electromagnetic Signatures; Magnetometers; Electropotential; electric field; magnetic field.

N251-049 TITLE: Emergency & Short-term Structural Repair System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials

OBJECTIVE: Develop a patching and repair system able to replace or strongly reinforce the original form and function of a damaged structure or component.

DESCRIPTION: Several past incidents (e.g., collisions, fires, drone/missile hits, and general material failure) have created hull penetrations and structural failures or scenarios where internal structural repairs are required on an immediate basis. The Navy seeks the development of a cost-effective durable patching and repair system that is convenient to store, can be easily applied to a variety of surfaces, and can be set or stiffened to the extent the patch material is able to substitute or strongly reinforce the original form and function of a damaged structure or component. The Navy seeks to develop a product that functions as a temporary repair in the event of a hull penetration or structural failure. The solution must be able to be applied while underway in a wide range of environmental conditions. The primary purpose of the repair will be to allow the ship to safely return to a destination where a more permanent repair is possible. Current commercial repair methodologies are not suitable for remediation of emergent damage while underway.

The solution should be able to be applied to a range of irregularly shaped openings and provide support for structural loads and restore the environmental integrity of the space. The repair system must stiffen to form a temporary but strong, durable, and water-tight seal. Examples of repairs include but are not limited to bracing, bonding, joining, encapsulating, plugging or patching. The repair technology will be required to be applied either indoor or outdoor and should cure regardless of temperature, humidity, and dampness. The desired product should fully cure within 1 hour. The solution must not emit toxic fumes during application and curing. Innovative joining and bonding methods are expected outcomes of this SBIR topic. The developed product should be applicable to all traditional ship steel and aluminum construction materials as well as support structures. Repair work should require minimal surface preparation such as degreasing, removal of foreign matter, or smoothing to allow for maximum contact with the patch material.

The repair material once cured should be resilient against normal pressures and in-plane ship motion/system stresses/loads. Repairs should survive wave slap green sea pressures of 4.65 Pounds Per Square Inch (psi) (normal to the deck) to 14.33 psi (normal to vertical surfaces/bulkheads), weapon blast pressures up to 20 psi, and survive a lap shear strength of the joint > 3 kilopound per square inch (ksi). In-plane structural stress levels expected are 7-9 ksi for aluminum structures and 20-30 ksi for steel. The largest damage to be addressed in this topic would be a 4’ diameter hole from a missile or drone penetration. The patch may or may not employ a system of ribbing for reinforcement to achieve the necessary strength; however, the ribbing must use the same patch material (either in flat sheets or geometric configurations) and must be able to be stiffened upon application within the same hour of set-time allotted for the primary patch. In repair applications, the repair must be resilient against tensile and torque forces.

Repair materials should meet Navy Fire, Smoke, and Toxicity (FST) standards. NAVSEA has published Design Data Sheet (DDS-78-1) to facilitate the transition of the new composite materials in U.S. Navy shipbuilding [Ref 3]. The material fire performance requirements described in this design data sheet are intended to provide consistent safety criteria for the application of composites aboard ships. These requirements have been developed based on Navy fire safety policy and international maritime standards for fire safety. Fire performance requirements for surface flammability, fire growth, smoke generation, fire gas toxicity, fire resistance, and structural integrity under fire have been established. Initial FST performance testing should include flame spread testing ASTM E162, E662, E800.

PHASE I: Develop a concept for a rapid damage repair system that meets the requirements in the Description. Demonstrate the feasibility of the operational concept with development and initial testing of the repair system. Demonstrate by Modeling and Simulation (M&S) or Finite Element Analysis (FEA) of the predicted performance of the proposed repair system to meet the requirements defined in the Description. The Phase I Option, if exercised, should include the initial layout and capabilities to demonstrate the application in Phase II.

PHASE II: Develop and deliver a prototype able to demonstrate the hardened patch material to the requisite specs, and ultimately be tested to failure. Evaluate the durability and how long the patch/repair holds. Perform a test plan as defined in Phase I to include applicable FST standards. Incrementally increase the stress loads to induce a failure point while observing and recording the failure. Prepare a Phase III development plan and cost analysis to transition the technology to Navy use.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the Emergency & Short-term Structural Repair System for use on the Large Surface Combatant Modernization and Sustainment program. Strong temporary repairs that rapidly set have a wide range of applicability in the U.S. Navy as well as the commercial marine industry. The specifications cited are generally more rigorous and designed to allow for a strong temporary repair while a ship is underway and in a range of weather conditions. Such a repair will allow the ship to safely arrive at a destination where a more permanent repair is possible. The repair system also has universal applicability for non-maritime repairs.

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KEYWORDS: Temporary Patch; Patching and Repair System; Ductile strength; Tensile strength; Emergent repair capability; Structural Patch.

N251-050 TITLE: Compact Underwater Electromagnetic Sensor with Internal Data Logging

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics

OBJECTIVE: Develop an Underwater Electromagnetic (UEM) sensor package that includes magnetic and electric field sensing, and internal data logging. The sensors need to be sensitive to small field variations, stable in underwater environments, and packaged in a compact design with self-contained data logging.

DESCRIPTION: Current UEM measurement systems on the market are typically bulky and are not designed to support simple transportation methods and ad-hoc stand-alone deployments. A majority of these systems are limited to specific sensors and the electronics supporting the measurement components have not been optimized for smaller form factors. Over the last decade, sensors and electronic improvements to power consumption and form factor could enable smaller sensor packages and increased endurance.

The end product of this SBIR topic will be a stand-alone compact UEM sensor that can be easily deployed and recovered in an ocean environment that can measure magnetic and electric fields. When deployed, the UEM sensor will land and operate from the seafloor. The UEM sensor is expected to be able to be deployed and collect data for up to 7 days.

The magnetic field sensing should be capable of collecting magnetic field in all three orthogonal vector components. The electric field sensing capability should also be capable of collecting electric field in all three orthogonal vectors components. The compact UEM sensor should also consist of a pressure sensor to enable post-processing of system depth during the data collection windows.

The UEM sensor should be programmable to enable delayed operations and allow for targeted data collection windows.

The UEM sensor should be packable into a 6.75” diameter cylinder and shall not exceed 80 inches in length. Upon deployment, the system can expand as required to support data collection operations and recovery.

The awardee will be expected to fabricate 3-5 prototype compact UEM sensors to test in the lab and on land to ensure all the capabilities are integrated, power consumption is verified, and data storage is adequate for the length of deployment. Additionally, the electric field and magnetic field measurement capabilities will be tested to ensure noise levels are satisfactory.

After lab testing is completed and noise levels are demonstrated, if satisfactory with U.S. Navy expectations, the next effort will be to deploy and test the compact UEM sensor at the South Florida Ocean Measurement Facility (SFOMF) in Dania Beach, FL to demonstrate the total system performance in an operational environment to achieve TRL 7. The sensor recoverability will also be demonstrated.

PHASE I: Define and develop a concept for a compact underwater UEM sensor with internal data logging that can meet the performance and the SWaP constraints listed in the Description. Perform modeling and simulation to provide initial assessment of concept performance. The Phase I Option, if exercised, includes the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Develop and deliver 3-5 prototypes based on Phase I work for demonstration and validation. Three to five prototypes should be delivered during the Phase II for lab and field testing as identified in the Description. Additional testing as identified in the Description will be performed to demonstrate the total system performance in an operational environment. Sensor recoverability will also be demonstrated.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to Navy use. The Navy would use these sensors as an alternative to collect UEM signature measurements of ships and submarines that don't have operational measurement arrays available. The compact design and portability allow for low-cost, feasible shipping methods that could be rapidly deployed in various locations.
The sensors could also benefit civilian uses including geologic surveys of the ocean floor, ocean wave dynamics research, and other related areas of interest. Reducing sensor and acquisition noise, optimizing sensor battery life and data storage, and other issues would decrease maintenance costs of existing systems, providing additional feasibility for a variety of applications.

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KEYWORDS: Compact Acquisition Systems; Underwater Electromagnetic Signatures; Magnetometers; Electropotential; Electric Field; Magnetic Field

N251-051 TITLE: Aegis System Track Manager/Track Server

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

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 automated software capability that ensures mismatches between internal track management components of the AEGIS Weapon System are identified and corrected in a real-time environment.

DESCRIPTION: The Command and Decision (CND) element of the AEGIS Weapon System (AWS) consists of multiple track management applications working in conjunction to create and maintain source and system level track data for use by the overall AEGIS Combat System (ACS). Track management is the process of utilizing all available sources of track data and supporting information, including on and off-board sensors and external communications systems, to create and maintain an accurate and consistent track picture, providing reliable Command and Control (C2) capabilities to the war fighter. Track management includes the processes of managing track numbers across disjointed track databases, maintaining track attributes such as, but not limited to, kinematic state, identification, classification, and Identification Friend or Foe (IFF) modes and codes, as well as providing for track data availability throughout the combat system. These applications include, but are not limited to, Product Line Architecture (PLA) System Track Manager/Track Server (STM/TS), System Track Processor (STP), Link Interface Function (LIF), SPY Processing Function (SPF), and Cooperative Engagement Function (CEF). Combat system baseline configuration dictates which source managers are contained within a specific version of the AWS. While System Track Manager (STM) implements a Track Server (TS) to store all Source and System level track data, each of the other source managers utilize local, internal track stores, maintained in parallel to a TS, while receiving and processing Source and System level track data. At times, these internal track stores can become out of synchronization with a TS, leading to the potential for a degraded state of track management functionality, and overall situational awareness.

The Navy seeks an innovative software application that will perform real-time monitoring of all track databases within CND elements and automatically make corrections as necessary to keep them all in synchronization with the TS. This capability is not currently found anywhere else commercially and will provide for reduced hands-on maintenance of the systems, improved decision making with less researching of items, and provide smoother operation of the system.

This solution shall run in the background and not constrain the flow of track data between source and system level track management applications. The application will compare, at a minimum, track numbers, track identification/classification, and IFF modes and codes, with an objective to compare and synchronize all track attributes. The solution will benefit the Navy in improving product quality to ensure all track management subsystems are in synch and provide for the highest level of situational awareness in the Command and Control (C2) Track Management domain. The speed and accuracy of the solution must exceed existing ACS performance by 10% or better.

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 an Aegis STM/TS software application that meets the objectives stated in the Description. Demonstrate the feasibility of the concept in meeting the Navy's need by any combination of analysis, modelling, and simulation. Analyze the accuracy of the software results through assessment of the logic in mathematical algorithms developed to accurately represent a passive reporting capability approach to integrate into the Aegis Test Bed (ATB) environment. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Develop a prototype Aegis STM/TS software application based on the results of Phase I. Demonstrate performance of the application in an existing Government-approved modeling and simulation environment in a Government-provided facility. Deliver the prototype software to the Navy along with complete test data, installation and operation instructions, and any auxiliary software and special hardware necessary to operate the prototype.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for government use. The prototype STM/TS software application will be incorporated into the AEGIS baseline testing modernization process. This will consist of integration into a baseline definition, incorporation of the baselines existing and new threat capabilities, validation testing, and combat system certification.

STM/TS algorithms could provide assistance to air traffic controllers in monitoring potential collisions by increasing the accuracy and throughput of data.

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KEYWORDS: Track identification/classification; Track Management domain; System Track Manager (STM); Track Server (TS); Product Line Architecture (PLA); synchronize all track attributes

N251-052 TITLE: Multi-Observer Multi-Spectral Passive Object Detection

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with 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 remote sensor capability that can identify and provide a wide range of targets and objects into the existing active sensors within the battlespace using multi-spectral passive sensing capabilities.

DESCRIPTION: Currently real-time detection and targeting capabilities are limited to shipborne and controlled aircraft organic sensing equipment. The surface force can and does leverage additional capabilities from off-board and non-organic sources but often these commercial sources do not meet time critical needs.

The Navy is seeking to add passive sensor capability that can identify and provide a wide range of targets and objects into the existing decision-making process. Developing and incorporating a multi-spectrum passive detection enhancement capability, integrated and fused with current surface navy sensors, will expand the current battlespace, contribute to a robust Common Operational Picture (COP), enhance decision maker situational awareness, and allow end users to operate in contested environments. In addition to addressing time critical needs, the addition of robust multi-spectral passive sensing will operate in all environmental conditions and account for atmospheric phenomena that can clutter traditional active sensors. The passive sensors shall account for environmental factors, weather interference and debris associated with military applications.

The Navy seeks an innovative tracking software algorithm(s) that accurately and reliably provides data to be integrated into the battlespace from passive sensors. The solution shall not degrade current capability. A solution will not increase combat system processing time to achieve its primary objective. It will integrate with all elements of the Aegis Combat System (ACS). This includes track managers, weapons, and missile systems. The software will permit realistic testing of all threat types and configurations in a dynamic test environment designed for use in operational and testing environments. Track visualization will be delivered through existing ACS console Graphical User Interfaces (GUIs). It will support operator track management and decision-making. The solution will integrate with the AEGIS Test Bed (ATB) to facilitate system evaluation against more advanced and prolific threats. Integrated “in-stride” testing utilizing the ATB will facilitate a shortened certification timeline and ferret out deficiencies and software errors in the testbed, thus increasing product quality at delivery.

The solution will provide an enhanced capability to address targets in all configurations and provide optimal engagement options to the sailor. This will increase mission capability and effectiveness against the latest threats. The modeling and simulation will optimize weapon system testing; thereby reducing test costs associated with fielding new ACS baselines.

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 Multi-Observer Multi-Spectral Passive Object Detection software algorithm(s) for instant and accurate reporting of objects of interest and threats. Demonstrate feasibility in meeting the requirements in the Description to support the test and operational environments. Feasibility will be established through analysis and modelling. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Develop and deliver a prototype Multi-Observer Multi-Spectral Passive Object Detection software algorithm based on the results of Phase I. The application will be implemented in an existing Government-approved and provided modeling and simulation environment to validate performance. It will be evaluated by Government subject matter experts for validation.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the prototype passive sensors software applications to allow for further experimentation and refinement. The prototype passive sensors software application will be incorporated into the AEGIS baseline testing modernization process. This will consist of integration into a baseline definition, incorporation of the baselines existing and new threat capabilities, validation testing, and combat system certification.

Passive sensors algorithms could aid air traffic controllers in monitoring potential collisions.

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KEYWORDS: Passive Sensors; Multi-Observer; Multi-Spectral; Software Algorithm; Track Managers; Off-Board

N251-053 TITLE: Autonomous Charging and Energy Management for Large Drone Fleets

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Renewable Energy Generation and Storage;Sustainment;Trusted AI and Autonomy

OBJECTIVE: Develop a common system of energy monitoring, electrical generation, charging configurations, and autonomous behaviors for a fleet of 100+ unmanned entities (Class 1 drones and other small unmanned vehicles) to maintain their own charge cycles without human intervention for up to 1 week.

DESCRIPTION: Small drones and unmanned air/surface/ground vehicles are present in increasingly large numbers at smaller units of force (company-level and below), and the appetite for more unmanned assets continues to grow. However, their utility is presently hampered by the energy management demands that are incurred by charging cycles, a problem that is only expected to worsen as more and more unmanned systems make their way into small units. With some flight durations as short as 20 minutes, but charge cycles on the order of hours, the users are often relegated to carrying and swapping large numbers of charged batteries or waiting long periods of time without any capability during charge cycles. An innovative solution for improving the operational availability of drone fleets is to utilize the self-tending nature of intelligent autonomy to manage energy requirements on their own, with all energy management tasks relegated to the entities themselves. This will free up human teammates to focus on their own priorities and reduce or eliminate the requirement to carry and swap batteries for extended coverage.
The outcome of this SBIR topic is a set of universal standards, configurations, and equipment for autonomous power management. The required elements include:

- Deployable electrical power generator complexes that fuse traditional fuel-powered sources with non-traditional and renewable sources (solar, wind, small hydro and found fuels via Stirling engine generators) to fully exploit all charging energy sources and reduce/eliminate dependence on fuel chain logistics
- Energy management software that resides in on-board processing and monitors usage, predicts time remaining, and assumes control of the entity to direct its movement to a charging source prior to battery exhaustion
- Connector configurations that allow single charge stations to support multiple customers simultaneously
- Command and Control (C2) interfaces that alert humans to charging “break-offs” and provide an opportunity for override and an option to assign standby assets

Performance Goals include using self-charging protocols to:

- Continuously maintain fleets of up to 100 entities for periods of up to 1 week
- Utilize the full range of available energy sources to provide uninterrupted charging power without sole reliance on fossil fuel generation
- Maximize deployability by minimizing size and weight of generating station components to 2-person lift and setup

Related state-of-the-art available technologies include recent advances in small Stirling cycle electrical generators that utilize “found fuels” such as sticks, trash or any burnable material to produce useful amounts of power, along with direct-conversion (heat to electricity) technology that can be scaled up for charging purposes. Also, tactical networks and advances in Command and Control (C2) systems for coordinated operation of large numbers of unmanned assets by few or one human, and vehicle-agnostic autonomous control systems. The key attribute of the generation component is a diversity of methods that reduce or eliminate the need to transport volatile fuels from a distance for the 1-week notional period of the engagement.

The focus of technology development is on:

- The selection of and integration of diverse power generating approaches into a single component that can be transported and set up by a typical United States Marine Corps (USMC) squad-sized element. Approaches can utilize either small modules with human carry or self-transport via wheels, tracks or unmanned airlift. The technical challenges are in developing a package that produces stable charging power on demand from diverse sources while maintaining low Size, Weight, and Power (SWaP).
- The capability of a single charge source to meet the diverse needs of autonomous platforms that do not share a common battery configuration. The technical challenges are in standardizing battery configurations across an array of in-use autonomous systems, or in developing controllable charging stations that can sense the charging requirements and vary their output to match.
- The development of docking stations and charge connections that allow a variety of in-use vehicles to autonomously connect, charge, and disconnect when needed
- The development of on-board or remote autonomous charge/monitoring behaviors that continuously sense state of charge, locate charge sources, predict transit requirements, and break off mission to execute charging protocols without battery exhaustion

Performance Parameters:

- Transportable by a 13-member squad-sized element for distances of 5Km, or self-transporting
- Integrated into existing autonomous vehicles and control systems (no new vehicles)
- Two or more independent generation methods in a single package
- One week of unattended operation (exception for fueling at 6-hour intervals by 1-2 people)

PHASE I: Conduct a feasibility study utilizing existing vehicles in ONR Code 34's current fleet of unmanned assets and ONR Code 34's sequence of virtual and real-world experimentation to explore configuration options, interfaces, communication protocols, and autonomy software to assess options specified in the Description section. Investigate all known options that meet or exceed the minimum performance parameters suggested in the Description. Address the tradeoffs and risks in accordance with the level of innovation. Prepare a report to ONR on designs, simulations, prototype production, and a Phase II testing plan.

PHASE II: Design, develop, and produce prototype generators, hands-off automatic charger connections, and software that can support the charging requirements of up to 10 users for a period of 72 hours with no human interaction other than fueling Stirling generators at 6-hour intervals. This requirement is different from the 1-week, 100 user requirement to allow phased upscaling within the Phase II and the Phase III transition, and because servicing more users for longer periods can be accomplished by using more generators and extending fueling cycles. Develop, demonstrate, and validate the Concept of Operations (CONOPs) using ONR Code 34's Kobol sequence of virtual and real of force-on-force unscripted simulated combat operations (4x yearly at multiple Department of Defense locations in the continental U.S.).

PHASE III DUAL USE APPLICATIONS: The final (Phase III) state of the technology is a set of rugged multi-source generators with unmanned connection capability that can operate for extended periods with limited human contact to supply the electrical needs of a large drone fleet.

The dual-use capability is for any user who operates unmanned fleets of similar size, and desires to transition to unattended charging in austere environments. Examples include law enforcement, forestry services, firefighting, humanitarian assistance, and disaster relief.

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KEYWORDS: Stirling engine; Energy conversion; Automated management, Battery Management, Unmanned Power, Direct Conversion

N251-054 TITLE: Rifleman-Assisted Instructional Device (RAID)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop a fieldable, small arms/weapon mounted device (e.g., M27, M4, M18) and associated software application that detects and provides individual and group level feedback regarding marksmanship performance during dry- and live-fire training.

DESCRIPTION: Dry-fire weapon simulators provide safe mechanisms in which service members can practice weapon handling and marksmanship fundamentals [Refs 1-2]. However, these systems are large, obtrusive, require maintenance, and support personnel to operate. A simplified, more scalable platform is needed to provide the capability to conduct weapons training in resource constrained environments or at larger scale. The development and employment of a modular and scalable weapon mounted sensor/device that can track and provide feedback about weapon handling and marksmanship fundamentals would greatly enhance training time dedicated to small arms proficiency. Anecdotal reports from Marine Corps commands indicate that using a commercial product designed for individual shooters may reduce training resources (e.g., time and ammunition) required to make Marine recruits into proficient shooters [Ref 3]. Dry-fire training is a fundamental component of the Marine Corps revamped marksmanship training programs, such as Infantry Marksmanship Training Program (IMTP), and supporting these programs will lead to a more lethal force. However, the current devices used are missing key components to support training doctrine, such as: military focused design, group level training, and after-action review at aggregate level.

The objective of this SBIR topic is to develop a device for use with Marine Corps issued small-arms (i.e., M4, M27, M18) that can capture data during dry-fire marksmanship training (and live-fire) at the individual and aggregate level. The software product should provide group reporting and accountability, create powerful data dashboards for training cadre to review, and provide immediate, comprehensive, and specific answers regarding marksmanship capability – based on the data captured by the device. The device should allow for group monitoring by an individual instructor or cadre for up to 20 shooters at the same time, where the instructor can also create specific drills, and user-defined performance parameters associated with those drills. The device and associated software should maintain historical records, provide comparisons, and add group-level features that drive competition, competency, and capability improvement.

The weapon mounted device sensor (WMDS) prototypes should be developed to be employed via picatinny attachment, modified magazine/bolt, or other novel means so as to not encumber upon normal and safe weapon handling. The prototypes should not significantly add or reduce the felt weight of the weapon, nor should they interfere with normal weapon functions, such as holstering. The WMDS should be rated to IPX7 water resistance and store at least 150 minutes of training data. The WMDS should connect wirelessly in real-time, or post-hoc in event of transmission loss, to a smartphone or tablet device, that houses the associated software, which provides the analysis, data aggregation, data display, and controls the training sessions. The software application should have a readily understandable user-interface (UI) which allows users to navigate to the training or analyses dashboards with ease and maintains a search function to find historical data.

PHASE I: Define and develop a plan for the design, development, and fabrication of a small arms weapon (i.e., M27, M4, M18) mounted device with integrated sensors, and a corresponding software application, that can capture weapon handling fundamentals and small arms dry-fire training performance. The device should be capable of transmitting data wirelessly to a tablet that contains software application that interprets real-time dry-fire and weapons handling performance at both the individual and group level. The WMDS should be ruggedized to handle regular training use in military settings and should be rated to

IPX7 water resistance. The proof-of-concept hardware device should be able to transmit data wirelessly, in real-time and store up to 150 minutes of training data when out of range of transmission. Multiple devices (n=20) should be able to connect wirelessly to a single tablet with the program's software application so that an instructor can view multiple users simultaneously. Phase I will result in a proof-of-concept for testing and refinement in Phase II. The deliverables for the Phase I are to include, but are not limited to, conceptual development of the WMDS and detailed plans for the software application to perform the data capture, aggregation, analyses, display, and storage. In addition, the Phase I will deliver a defined plan to improve any existing capabilities to support disconnected military relevant environments.

PHASE II: Focus on prototype development and refinement of at least 150 devices of the proof-of-concept small arms WMDS conceptualized in Phase I; along with a software prototype. The prototypes will be demonstrated in a military relevant environment in Phase II. Additionally, the WMDS should be capable of storing at least 150 minutes of training data onboard the device should wireless signals be interrupted or unable to be established during a training session. During normal use, the WMDS should transmit data wirelessly to a smartphone or tablet with a preloaded software application that will store the data locally on the smartphone or tablet and can also analyze and interpret the data for user and instructor feedback. The WMDS should use accelerometry or other means to determine actions taken by the user such as, but not limited to: reloading, accuracy, and trigger press. A detailed definition of the device requirements will be provided to the firm(s) selected for Phase II award. The Phase II awardee should also provide a detailed plan that will occur for testing and evaluation (to include data type, frequency, and structure).

PHASE III DUAL USE APPLICATIONS: Further refine the products developed in Phase II to include adding more automated processes for data analyses for Marine Corps end-users. Phase III will focus on integrating the finalized products into current and future training programs, such as IMTP, under USMC TECOM, as well as expand out to active-duty operational units to maintain small arms weapon handling and performance during time in the fleet. The Phase III effort should lay out a plan for longitudinal evaluation of their Phase II product in a real-world training environment. This evaluation will consist of a comparison of the performance and skill retention in Marines provided the training tool and those not. In Phase III performers shall outline the ability to mass produce, support, and service the developed wearable devices. The small business should also aim to leverage the products developed under this SBIR effort for commercialization to federal and local law-enforcement agencies, as well as the civilian market.

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KEYWORDS: Lethality, Dry-Fire, Live-Fire, Marksmanship, Human Performance, Shooting, Small-arms

N251-055 TITLE: Reduced Cost Thermoplastic Composite Fabrication by Thermoforming Drapable Pre-pregs

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop and demonstrate technologies to produce high quality thermoplastic composite parts with complex geometries at a high rate using emerging materials and fabrication techniques.

DESCRIPTION: Thermoplastic parts offer unique advantages, such as room temperature storage, recyclability and lighter weight compared to both metals and thermoset composite parts. A common and relatively cost-effective way to make thermoplastic parts is thermoforming. In this process thermoplastic pre-pregs are heated until pliable and then formed over a mold under pressure and/or vacuum.
The challenge in this process is avoiding wrinkles and maintaining tight tolerances of the formed part. This limits the formability especially when large deformation over a mold with complex geometry is required. However, a new generation of drapable “dry” pre-pregs and processing techniques is available now to address these challenges. The drapable materials can closely conform to the shape of the mold. These materials conform to the mold and thus have the potential of forming complex parts. Even for parts that can be formed by traditional methods, these materials reduce the number of steps, while maintaining tighter tolerances and reducing overall time and cost for forming a part.

The available drapable pre-pregs are still limited, but new forms are actively being developed and coming to market. Examples include, KyronTEX® by Mitsubishi Materials and ET40 by Toray. These materials are cited as examples only, and this SBIR topic does not exclude any other suitable material system.
This is not a material development effort. The primary focus of this SBIR topic is to use an available material that can be used as is or with incremental changes to develop and demonstrate it by fabricating a representative aerospace part that demonstrates the capabilities of these drapable prepregs. This is not a material development effort, however, incremental changes with the support of the pre-peg manufacturer to make it more suitable for aerospace applications is acceptable.

PHASE I: Choose one or more aircraft component that has sufficient complexity and yet can be successfully formed with drapable pre-pregs. Examples include deep drawn manifolds, and aircraft rib structures. The Phase I study should include assessment of drapability and formability of the pre-preg. This should include a modeling component to predict drapability, and an experimental campaign to validate. Additionally, coupon level studies should be done to assess changes in porosity and mechanical properties during the process. Wrinkling during forming also should be evaluated. The results should be used to establish the feasibility of the prototype(s). The feasibility assessment should be complete at the end of Phase I base period.

PHASE II: Develop a forming plan for the prototype component. Develop tooling needed for the project. Develop a test plan to assess the prototype qualitatively and quantitatively. Fabricate the part. Assess part quality. Develop and perform a mechanical test campaign to assess strength and stiffness.

PHASE III DUAL USE APPLICATIONS: Support the transition to Navy use. Use of thermoplastic composites is on the increase in navy fixed wing and rotary wing airframes. This is especially true for unmanned air systems. On the civilian side the technology is very relevant to the urban air mobility market.

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KEYWORDS: Composite manufacturing; lightweight; deep drawn component; affordable airframe; aerospace composite

N251-056 TITLE: Compact Prime Power Source for Unmanned Aerial Systems

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

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 compact, highly efficient prime power source that provides a power density exceeding currently available technologies for future Department of Defense (DoD) unmanned aerial systems (UASs) while maintaining an acceptable form factor, exhibiting reliability for extended endurance operation, providing compatibility with multiple payloads, and demonstrating suitability for potential re-use.

DESCRIPTION: Many industries and DoD systems utilize turbine-generator (turbo-generator) powertrains due to their unmatched energy density and power to weight ratios. In airborne applications, these powertrains can distribute electric power to both propulsion systems and tactical payloads. In theory, this permits ideal dynamic allocation of power to both aircraft performance (e.g., dash / climb speed) and payload functions. Platforms that support Modular Open Systems Approach (MOSA) payloads naturally benefit from increased available payload prime power. Increased platform prime power permits larger or more capable MOSA payloads and increases the platform operational flight envelope.

Turbo-generators are the identified (incumbent) solution of choice due to their high specific power, ability to use approved high energy density liquid fuel sources such as Jet Propulsion-10 (JP-10), low vibration, reduced maintenance, and overall safety when compared to other potential solutions such as lithium batteries. However, turbo-generators (or other prime power sources) meeting the stringent size, weight, performance, reliability, operational lifecycle, and environmental requirements for existing DoD UASs are already at the limits of available technology. Small turbines and generators suffer from scale effects that drive their ideal operating point to higher turbine inlet temperatures and shaft speeds greater than conventional materials and designs allow. Operating at off-ideal conditions reduces the overall thermal efficiency, mass-specific performance, and operational life of miniature turbine generator systems. Solutions that mitigate these challenges and meet overall performance objectives may require innovation in multiple technical areas including:

- Cycle design – such as recuperation or supercritical carbon dioxide
- Advanced high-performance materials (ceramics or superalloys)
- Novel manufacturing or machining techniques
- Advanced miniature high-speed bearing, lubrication, and seal systems
- 3D optimized magnetics (rotor / stator)
- Highly integrated power conversion and engine / generator control electronics
- Thermal management

While turbo-generators using JP-10 are currently the solution of choice, alternate solutions will be considered. However, the potential safety impact of alternative designs (relative to a baseline of JP-10 fueled system) will be weighed during selection. Proposers should therefore identify any required mitigation elements (e.g., storage, handling, disposal, etc.) necessary to provide a credible path to qualification and approval for shipboard use.

The main objective of this SBIR effort is to maximize power density and efficiency where power density is defined as the ratio of generated electrical power to weight. However, the source must also be operationally useful so the solution must also be capable of meeting a number of performance objectives. Principally, the proposed solution should:

1. deliver a full rated net DC power (averaged over 1.0 sec into an ideal load), at 270VDC nominal (in accordance with MIL-STD-704F), of 20 kW (threshold) to 25 kW (objective),
2. be capable of rapid start without operator intervention and be capable of ramping up output power from idle to 75% of the full rated output power within approximately 200 msec of receiving the command to do so (idle is defined as the minimum state of operation required for the power source to maintain its own function),
2b. time from cold-start to idle will also be factored in during the selection process
3. be capable of storage, start, and operation in horizontal and vertical orientation, and
4. be capable of rapidly increasing (surging) power output when commanded. For this requirement, a nominal surge rate of 2.5 kW per 50 msec, starting at 50% rated power, is desired. Note that, in meeting this requirement, the source controller may assume feedforward information regarding load surge demand. However, absent this information, the source shall maintain safe operation.

Note that acceptable solutions must also anticipate the intended application of UAS deployment. Therefore, solutions that can be realized in an axially symmetric form factor with the center of gravity located on the center axis are desired. For demonstration purposes, a cylindrical form factor of 90 mm radius should be assumed. Mating interfaces (e.g., fasteners, connectors, fittings, etc.) should not break the 90 mm radius cylindrical boundary. Within these constraints, the most power-dense solution is desired to have a mass less than 11.5 kG for fuel based systems (this weight does not include the fuel). As weight is a critical design factor, all solutions (fuel and non-fuel) will be compared by Wh/kg (fuel will be considered in this calculation). Any ballast required to meet the center of gravity requirement is included in the mass. Within the cylindrical form factor, a target volume of 0.0125 m3 is desired. However, for highly efficient solutions, this may be relaxed provided the increase in efficiency results in a comparable decrease in the volume required for energy storage/fuel. For fueled systems, the exhaust should not interfere with the intake and preferably be directed along the axis. Solutions should accommodate communications with the UAS using a standardized digital, differential (balanced), and galvanically isolated interface, preferably CAN, Ethernet, or RS-422, to provide command and control signals and receive status, diagnostic, and built-in-test information from the power source.

To simplify the design trade-space, the baseline for comparing the Specific Fuel Consumption (SFC) of each proposer will be conducted at sea level and at 50°C. As such, each proposer shall present SFC (kg/kWh) and fuel flow (ml/min) data with respect to the power setting at a voltage of 270 VDC at sea level and at 50°C. The proposer shall describe how their SFC changes with respect to temperature and altitude. The proposer shall also define their “specific power” (kW/kg), defined as their threshold power level of 20kW, at sea level at 50°C divided by the weight of their engine system, to include the weight of everything except fuel. If a proposer presents a solution which does not include fuel, their specific power solution will be compared to the fueled solutions by adding the weight of the fuel required to match the endurance of the non-fueled solution. Acceptable solutions should anticipate and address the operational environment through design, as supported with analysis, modelling and simulation, limited testing, and proven practice. The application is intended for a maritime environment with operation anticipated over a temperature range of -32° to +55° C and non-operation (storage) over a range of -40° to + 70° C. A launch acceleration of 50 G, aligned with the center axis, is expected. In addition, the solution should be designed to withstand normal shipboard shock and vibration requirements (defined in the applicable Military Standards).

The solution should be designed for reliable service over at least three mission cycles (10 objective) with a mission cycle defined as start and operation, followed by six hours of non-operation during which time, refueling, recharging, and minimal maintenance (e.g., lubrication) are acceptable. For fueled solutions, mission operational time is fuel dependent and should not be fundamentally constrained to less than four hours other than by the fuel supply. However, for demonstration purposes, the operational time is 60 minutes. In comparing fueled versus non-fueled solutions, the baseline (weight, volume, form factor) is a JP-10 fueled turbo-generator with fuel sufficient for 60 minutes of continuous operation at full rated power. Within the constraints detailed herein, power density and efficiency are the primary measures of success for this SBIR effort. Therefore, in assessing both fueled and non-fueled solutions for power density and efficiency, the total weight (power converter plus energy storage) shall be considered. Therefore, fueled solutions shall use the total weight of the turbo-generator plus fuel storage required to provide full rated power for 60 minutes as the metric for comparison. Non-fueled solutions shall use the total weight of the converter plus the energy storage system required to provide full rated power for 60 minutes as the metric for comparison.

Finally, logistical and operational realities have shown that the system might sit idle for extended periods of time in a fueled (charged) and ready state. The solution should therefore anticipate long periods of system standby and provide for a service life of at least 10 years. During periods of system standby, low-level electrical power will be provided to the prime power source to maintain system diagnostics and provide fault monitoring. However, during the service life (unless deployed for a mission), maintenance will not be performed nor will the energy storage be changed. Therefore, lubricants, seals, filters, etc., and the energy source must be chosen for long-term stability meeting the service life. For fueled solutions, the fuel must remain stable and not degrade other system components.

PHASE I: Propose a concept for a compact prime power source suitable for UAS deployment that meets the objectives stated in the Description above. Define an architecture, develop initial designs for key components, and identify critical areas requiring innovation. Demonstrate the feasibility of the concept in meeting the Navy need through analysis, modeling and simulation, and limited testing of key components or subsystems, where possible. Produce a development plan with specific tasking and milestones to support the Phase II effort. Manufacturing is anticipated to be a critical issue in realizing the power source. Identify areas of the proposed design that are likely to present manufacturing challenges. In the Phase I Option if exercised, identify and propose manufacturing processes to address key manufacturing challenges, develop test procedures, specifications, interface requirements, and a capabilities description necessary to build and demonstrate a prototype in Phase II.

PHASE II: Develop, demonstrate, and deliver a prototype prime power source based on the concept, architecture, specifications, plans, and processes resulting from Phase I. Demonstrate performance through stationary (fixtured) testing at the proposer’s facility or at a facility of their choosing (flight testing is not required). Collect, organize, and summarize test results and deliver to the Naval Research Laboratory. For demonstration purposes, the prime power source shall be oriented so that the longest axis is vertical. For fueled solutions, the fuel tank may be located separately from the power source, provided performance is not affected. Develop an initial technical data package including key drawings, schematics, assembly drawings, and process documents for key components and especially those components identified as requiring innovative manufacturing techniques. Develop a cost estimate for the power source in production quantities (use 100 and 400 units as a baseline). Upon completion of the effort deliver the prototype to the Naval Research Laboratory.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use. Assist in integrating the power source into specific Navy systems and support environmental testing and qualification. Modify electrical, control, and mechanical interfaces to meet individual system configurations and produce application-specific source control drawings. Create production-ready technical data packages. Assist the Navy in development of operation and maintenance documentation, safety procedures, performance predictions, and training materials. Identify and propose manufacturing cost reduction initiatives and long-term product improvement programs.

The prime power source developed under this effort is expected to have multiple future applications in the area of military UASs. It potentially has land-based applications including serving as the power source for remotely deployed repeater stations and weather monitoring stations. As commercial use of medium size drones expands, innovative elements of the power source (especially components benefiting from affordable manufacturing technologies) will find their way into the commercial market.

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KEYWORDS: Turbine-Generator; Turbo-Generator; Power Source; Power Conversion; Unmanned Aerial Systems; Novel Manufacturing

N251-057 TITLE: Dispersive Optics for Vacuum Ultraviolet Applications

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Space Technology

OBJECTIVE: Develop innovative methods to fabricate and replicate high quality dispersive optical components specifically geared for applications at ultraviolet (UV) and vacuum ultraviolet (VUV) wavelengths, for use within sensors in space on microsats and smallsats.

DESCRIPTION: The Navy is interested in the development of methods to fabricate and replicate cost-effective concave gratings and other dispersive optical elements needed to meet the demands of compact, proliferated optical systems designed for operation in space. Such elements are expected to be critical components of the next generation of small satellites to study the upper atmosphere, ionosphere, aurora, Sun, and solar-terrestrial space environment. Availability of customizable, high-quality optics of different optical figures, shapes, and dispersive properties will allow for future mission growth. The Navy is seeking to foster the development of affordable optical components and systems that could have broad application to space sensors and systems. Current UV and VUV grating technology involves substrates with machined or holographically ruled grooves, usually customized for single-use applications, with trade-offs on efficiency, scattered light, and often at high cost. For VUV applications, the product is typically coated to provide improved efficiencies, but with materials that are reactive to atomic and molecular oxygen, hydrocarbons, and other contaminants in the spaceflight environment. Advances in standard technology and innovative concepts and methods are sought to provide small-scale optics (target dimensions on the order of 5-10 cm) that have the potential to improve the cost, speed-of-manufacture and replication, customization, and applicability across the UV and VUV spectrum, while meeting or exceeding the optical performance, ruggedness, mass, and material properties necessary to meet the evolving demands of these new classes of space-based remote sensing instruments.

Dispersive elements applicable to both the UV and VUV (30-300 nm) are reflective due to the lack of refractive and transmissive materials at the shorter wavelengths. Total grating on-blaze efficiencies are typically on the order of 30% (near-normal incidence angle), but solutions including improvements in the combined blaze efficiency and coating reflectivity to achieve a higher overall efficiency will be taken into account. Low scattered light is a primary concern for space-environment applications where bright out-of-field and out-of-spectrum scattered light can obscure dimmer atmospheric emissions being observed. Spectral resolutions ranging from 0.1 to 2.0 nanometers, and/or groove spacing capabilities from 500-4000 l/mm, are desirable targets, with tolerances on the order of 20 l/mm. Precisely formed shapes ranging from flat to concave with radii of curvature as small as 10 cm are desired, including both spherical and toroidal surfaces. Additional consideration will be given to concepts that address grating-standard qualities including groove homogeneity, surface roughness, figure precision, or other corresponding performance factors.

Additional factors related to spaceflight compatibility are hardiness to contaminants, a coefficient of thermal expansion (CTE) compatible with typical spacecraft materials, low outgassing, survival at temperatures of -50° – +60°C, and the ability to survive a NASA GEVS3 vibration specification and thermal test environment, all typical of the requirements imposed for flight on small spacecraft. Technologies proposed should not contain hazardous or high outgassing materials and should be capable of being integrated into typical optical systems. It is desired that they be moderately electrically and thermally conductive to avoid developing static charge and thermal gradients in space. They should be durable and able to withstand normal optical component handling procedures. They should be delivered in an optically clean state and be robust enough to withstand precision cleaning and vacuum baking as part of normal spacecraft processing.

PHASE I: Demonstrate and document the feasibility of a dispersive optics concept and/or methodology for meeting Navy needs for compact satellite optical systems in the UV/VUV. Demonstrate the new methodologies for proof-of-concept and technical feasibility. Provide a demonstration by test or analysis that clearly identifies the possible gains of the concept made by advancing innovative methodologies, improving performance, and/or reducing cost and timeline for customized fabrication and replication from concept to delivery. Address performance capabilities, advantages, and limitations at all wavelengths in the spectrum from 30-300 nm as related to the optical performance metrics as presented in the Description in the Phase I report. Optical test reports and samples may also be provided for evaluation.

PHASE II: Develop a minimum of two prototype units of 10 mm size class, with different design parameters, for evaluation. The prototype designs should provide areas no less than 4 cm by 4 cm (objective) but not to exceed 10 mm in any dimension. Work with the Navy to define the complete set of details of the prototype based on the technology and methodology being developed. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II Statement of Work (SoW) and the Navy need. Perform detailed environmental, shock, and vibration analysis to ensure materials are rugged and appropriate for Navy application. An optical performance report will be included to document the relevant physical and performance aspects of the samples provided. Deliver the prototypes to the Navy for evaluation.

PHASE III DUAL USE APPLICATIONS: Apply the knowledge gained in Phase II to build two lines of flight-demonstration units, suitably configured for a smallsat application, including flight spares, and characterize its performance in the UV/VUV as defined by Navy requirements. Working with the Navy and applicable Industry partners, demonstrate application to a Navy Space Test program (STP) flight test. Support the Navy for test and validation to certify and qualify the system for Navy use. Explore the potential to market and transition this capability to other military and commercial systems (NASA, University, Optics Industry). Commercial industries that may be able to use the developed technology include telecommunications and laser optics industries, and developers of systems designed for inspecting materials and medicines. Advances in EUV lithography for manufacturing integrated circuits may also provide a burgeoning opportunity for applying the developed technology. Market research and analysis shall identify the most promising technology areas and the awardee shall develop manufacturing plans to facilitate a smooth transition to the Navy.

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KEYWORDS: Spectroscopy; gratings; ultraviolet; vacuum ultraviolet; optics fabrication; remote sensing; optical imaging; spaceflight

N251-058 TITLE: Kinetic Projectile Ammunition Design & Demonstration for 50-foot Standoff with Service Weapons or EOD Disrupters

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

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, build, and demonstrate a ballistically stable projectile/cartridge that can be used with the current service issue ammunition and rifles and/or the Explosive Ordnance Disposal (EOD) 12-gauge disrupter [Ref 1]. The desired target effect is to cause an explosive reaction of the munition. The explosive fill must be fully consumed with a high order reaction preferred. The proposed solution shall be effective for targets at a minimum of 50 feet of standoff. The accuracy shall be one minute of angle (MOA) with a circular error of probability of 50% at one inch. The proposed projectile/cartridge must meet the performance specifications of the service weapon or disrupter. Service issue ammunition for consideration includes: 1) 5.56x45; 2) 7.62x51; 3) .300 NM; 4).338NM and 5) 6.8x51 common cartridge. Targets shall include Blu-97, M118, Blu26, M38, Area Denial Munitions such as Volcano, PTAB family, artillery projectiles such as 155/105mm and Mk 80 series bombs.

DESCRIPTION: EOD operators currently use disrupters of all types (including service weapons) to address explosive hazards and mitigate threats. These threats can include Unexploded Ordnance (UXO) and/or Improvised Explosive Devices (IEDs). According to JP-3-42, Joint Explosive Ordnance Disposal, render safe procedures are the part of the EOD procedures involving the application of special EOD methods and tools to provide for the interruption of functions or separation of essential components of UXO to prevent an unacceptable detonation or intentionally cause a detonation [Ref 2]. As a defensive force, EOD must understand the reliability to detonate and NOT detonate explosive hazards with a high confidence level.

The objective of this effort is to design, develop, build, and demonstrate a ballistically stable projectile that can be used to meet the stated objective. Any service weapon cartridge must meet Sporting Arms and Ammunition Manufacturers Institute (SAAMI) specifications for the relevant caliber [Ref 2].

PHASE I: Develop kinetic projectile/cartridge designs with ballistic models/calculations. This will be in the forms of a PowerPoint presentation and design report. The report shall include the Computer Aided Design (CAD) file for analysis and data to verify that it can perform within the service weapon/disrupter specifications.

Build a statistically relevant number of projectile(s)/cartridges for testing to SAAMI specifications (service weapon solutions only). Test and demonstrate the projectiles/cartridges to assess ballistic performance, accuracy, and precision. Produce a test report with the round configuration, results from the firings, conclusions, and recommendations for Phase II maturation. Deliver 40 projectiles/cartridges to the government for testing.

PHASE II: Characterize the projectile/cartridge interior and exterior ballistics, specifically muzzle velocity, velocity at distance, and flight characteristics.

Characterize the barrier limit thickness with mild steel (1018/A36 steel).
Build an additional 100 projectiles/cartridges for testing against live targets at a government test facility.
Refine the design of the proposed capability based on performance and lessons learned.
Repeat the characterize, build and test steps above with an additional 100 projectiles/cartridges.
Test and validate the projectile capability performance with a statistically supported demonstration.
Document the proposed final design via a CAD file and technical data package.
Provide a final test report with all test results, analysis and recommendations.
Provide 100 projectile/cartridges for the final design to the government.

PHASE III DUAL USE APPLICATIONS: Support transition of the technology for Navy use.
The projectile developed from this effort could be commercialized for industry to provide to the EOD acquisition community in response to EOD requirements. The dual-use aspect of this capability is that it could be supplied to state and local bomb squads.

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3. Sporting Arms and Ammunition Manufacturers Institute https://saami.org/

KEYWORDS: Explosive Ordnance Disposal; EOD; kinetic; projectile; disrupter; ammunition

N251-059 TITLE: Low Cost, Rugged Laser Eye Protection for Sailors, Marines, Soldiers, and Ground Support

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Directed Energy (DE)

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 deliver innovative, low cost, rugged, scratch resistant, lightweight, dismounted soldier-wearable Personal Protective Equipment (PPE) in the form of interchangeable flexible lenses that can be inserted into currently existing and used U.S. Marine Corps (USMC) ballistic protection eyewear or eyeglass frames that will greatly reduce the hazards from adversarial threats or unintentional friendly high energy laser (HEL) on the battlefield.

DESCRIPTION: High energy lasers (HELs) have been and are being deployed on the current battlefield, and these threats are only forecast to increase in power and spectral diversity in the future. HELs use in both conventional and non-conventional warfare means that the risks to the human eye are increasing and include their potential use on the battlefield by allied and friendly forces. The threat of optical damage within the eye, from intentional or inadvertent illuminations, can result from lower powers and spectral frequencies that are significantly different than those that can be physically seen with the eye (e.g., infrared (IR) or ultraviolet (UV)) or felt (e.g., thermally sensed on skin). Current laser eye protection (LASPRO) systems are expensive, prone to damage (scratched easily), and not compatible with currently issued ballistic protection eyewear. These issues drive this SBIR topic for innovation in new LASPRO PPE for USMC ground troops and front-line soldiers. The sought solution to the problem of lack of easy to obtain LASPRO does not have to provide complete protection against all HEL types with one single lens, but instead the development of an easy to swap out series of multiple, inexpensive lenses that can be used to provide spectrally-specific protection over a known portion of the entire electromagnetic or light spectrum. For example, if a soldier can have a group of four or five lenses that provide sufficient protection from a majority of potential threats and hazards, this would enable mission completion with lower potentials for injury or fratricide. More specifically, if a lens could be clipped into an existing ballistic eye protection frame offering near infrared (NIR) wavelength protections such as that used with neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers based on other warnings or tactical protocols, permanent eye damage may be completely avoided. However, such PPE developed for industrial users of HELs are far too fragile, costly, and difficult to wear when using military hardware. The PPE LASPRO proposals should focus on researching and evolving a rugged, soldier wearable "clip in" product that is low cost (objective of under $50/lens in production quantities of 10,000 or more) while offering protective optical densities (OD) of 6 or more. Further, since HEL sources can have irradiances greater than 10 W/cm2 or powers greater than 500 W, innovative techniques may be necessary to shield from damage while allowing standard military operations to continue. Where possible, Photopic Luminous Transmittance (PLT) should be maintained for the visible light spectrum (400-750nm), even though some lasers encountered may use visible light sources (e.g., blue, green, or red color spectrums) and have eye damaging level of illumination. In these cases, transmittance in a specific pre-determined band (e.g., green, 500-560nm) should be reduced to below nominal ocular hazard damage levels when the appropriate lens is used. While some degradation may be acceptable for some operations, others may find it unacceptable to limit the spectrum completely through complete reflection, absorption, or scatter. In those cases, the amount of optical density for wavelengths may require special tailoring to meet mission based on those needs and may have higher cost acceptance. And while some technologies like photochromatic change may be useful, the cost and reaction time required to achieve the desired levels of protection (or speed of change in optical density) may be seen as unacceptable. Ultimately, the LASPRO PPE must demonstrably reduce the potential for burn injury/retinal/eye damage. Proposers should also note that HEL LASPRO PPE that spectrally reflects laser light versus scattered reflections or defused reflections could also result in eye injuries of unprotected bystanders. The HEL LASPRO PPE must be unpowered, durable, wearable, flexible, temperature insensitive (-40°F to +140°F) and able to be carried by an individual soldier in a small case or protective cloth drawstring bag which is easily put on or attached to a jacket, vest, or pants pocket.

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: Research and develop innovative approaches to personal HEL LASPRO. Deliver technical reports detailing scientific and programmatic progress and potential options for configurations and lens development. At minimum, provide a technical report detailing the proposed materiel solution with expected (from accepted modeling and simulation methods) or laboratory testing to collect protection data and levels in terms of spectral OD capability from laser direct illumination, expected cost, and ability to be ruggedized. Address manufacture readiness levels (MRL), wearability, flexibility, weight, and size. Ensure that the approaches' ability to preserve visual performance, visual acuity, contrast sensitivity, and color perception while increasing readiness of soldier or ground troops when in the use of a laser (friendly or threat) is supportable by verifiable, documented technical data collected, sound reasoning, and substantial evidence. Any modeling and simulation shall use commonly available software tools and also shall be shared with military services and government agencies for peer review. If possible, an initial functional prototype should have completed within the laboratory. (Note: No direct or indirect human or animal testing shall be permitted or conducted in Phase I. All preparation for initial Institutional Review Board (IRB) shall be prepared in Phase I for entrance into Phase II.)

PHASE II: Develop a prototype lens for laboratory testing. The R&D is a baseline for a system or series of easily available, functional, future HEL LASPRO PPE clip in lenses for Marines, Sailors, and ground crews offering effective battlefield eye shielding shall be established and advanced for laboratory testing. The end-state is the ability to provide soldiers individual LASPRO at a cost and availability that supports mission activities in otherwise restrictive or adversarial conditions. An Institutional Review Board (IRB) shall be required in Phase II at the end of laboratory testing. Human factor and human subject testing are critical in follow-on Phases of this topic and ultimately support the warfighter, Navy and Marine Corps training and operational capability, and ensure the competency of the Navy medical department- includes the development of personal protective equipment such as body armor, hearing protection, helmets and of course, eyewear. Please carefully review the requirements of approval for proposals that include testing of human subject and compliance with Institutional Review Board (IRB): https://www.nre.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections

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

PHASE III DUAL USE APPLICATIONS: Support transition of the product to a Program of Record through a USMC MCSC, Navy, Army, USAF, or OSD level Product Manager. The baseline is for HEL LASPRO PPE for Soldiers on the battlefield or where tactics are being practiced with emerging high energy laser sources. The end-state is the ability for Soldiers to have extra time if and when irradiated, to complete a mission, or to evade or engage any threats. Additional tasks in follow on testing, evaluations, refinement and modification to improve user acceptance, provide wider spectrum protections, enhance usability or performance are possible.

Additionally, a commercial need for such low cost, rugged LASPRO exists and would help in driving down fabrication costs as the market grows. Potential markets include industrial users of lasers or other intense sources of heat and radiant energy in the field.

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6. ANSI Z136.1-2022, American National Standard for Safe Use of Lasers.
7. ANSI Z136.7-2020, American National Standard for Testing and Labeling of Laser Protective Equipment.
8. OPNAV INSTRUCTION 5100.27C 2 /MARINE CORPS ORDER 5104.1D, Navy and Marine Corps Laser Hazards Control Program

KEYWORDS: Directed Energy Weapons, Lasers, High Energy Lasers, HEL, Eye Protection, LASPRO, Eyewear, Optical Materials, Personal Protection Equipment, PPE

N251-060 TITLE: Automated, Fast Computational Fluid Dynamics (CFD) Solver Technologies for Hypersonics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Hypersonics;Trusted AI and Autonomy

OBJECTIVE: Develop automated and fast computational fluid dynamics (CFD) solver technologies for accurately predicting laminar hypersonic base flows in thermo-chemical non-equilibrium, significantly reducing the dependency on user expertise and computational costs during the early design phases of hypersonic vehicles.

DESCRIPTION: Boundary layer transition (BLT) is critically important for the design and performance of hypersonic weapons. The transition from laminar to turbulent flow significantly impacts the heating rates experienced by the vehicle. Laminar flow heating rates are 4 to 7 times lower than those in fully turbulent flow, which reduces the requirements for Thermal Protection Systems (TPS) and insulation [Ref 1]. Additionally, BLT affects the aerodynamic performance of slender high lift-to-drag (L/D) ratio vehicles, where a significant increase in drag due to turbulent flow can lead to a reduced range. Therefore, assessing BLT early in the design phase is essential to optimize vehicle performance and ensure the effectiveness of hypersonic weapons.

Significant progress has been made in the computation of hypersonic boundary layer instabilities, which are crucial for predicting BLT. Advanced methods such as quiet and forced Direct Numerical Simulation (DNS) [Ref 2] and Planar Parabolized Stability Equations (PSE) [Ref 3] have enhanced our understanding and compute flow instabilities. Input-Output analysis [Ref 4], One-Way Navier-Stokes [Ref 5], and Adaptive Mesh Refinement Wavepacket Tracking (AMR-WPT) [Ref 6] techniques further contribute to accurate predictions. Examples like instability computations on the fin-cone [Ref 7], BOLT [Ref 8] and HyTRV [Ref 9] illustrate these advancements.

Accurate prediction of the BLT process requires a high-quality laminar base flow, which depends on user-generated computational grids and chosen numerical schemes. A key challenge for obtaining a high-quality laminar base flow at high Mach numbers is maintaining low noise levels to avoid premature transition and using steady-state marching techniques to avoid disturbance amplification. Obtaining base flows at Mach numbers high enough to produce thermal and chemical non-equilibrium also provides significant challenges.

Incorporating realistic features into hypersonic boundary layer stability analysis remains challenging. Simulations are complicated by factors such as thermo-chemical nonequilibrium, ablation, steps and gaps, surface roughness, realistic wall temperature distribution with spatiotemporal variations, and surface deformations or Outer Mold Line (OML) morphing. These elements are critical for accurate modeling but increase the complexity and computational cost.

Performing reliable and fast stability analysis on complex geometries presents several challenges: Generating high-quality grids for these simulations requires significant time. Achieving convergence can be problematic. Robustness of the methods is often an issue. The overall cost of obtaining accurate solutions is high. These challenges hinder the timely and efficient design of hypersonic systems. Emerging approaches show promise in improving solution time and robustness for hypersonic simulations. High-order, low-dissipation numerical methods can enhance accuracy while reducing computational costs. Adaptive Mesh Refinement (AMR) focuses computational resources on critical areas, improving efficiency. Implicit shock tracking techniques can handle complex shock interactions more effectively. Additionally, leveraging efficient computing architectures such as graphics processing units (GPUs) can significantly reduce computation time, making high-fidelity simulations more practical for hypersonic vehicle design.

Integrating data-driven methods like Artificial Intelligence (AI), Machine Learning (ML), and neural networks can significantly enhance stability analysis and system optimization. However, the training costs for these models are prohibitive. Developing automated fast CFD solvers can enable the rapid training of ML models for reduced-order modeling. This integration can facilitate BLT analyses earlier in the design cycle within a Multi-Disciplinary Analysis and Optimization (MDAO) framework, enhancing the overall efficiency and effectiveness of hypersonic weapon development. Automating grid-generation and solver parameter selection is crucial to reducing the sensitivity of predictions to user expertise and shortening design cycles, while ensuring the tools can run efficiently on both existing and emerging high-performance computing architectures (Central Processing Unit [CPU]/GPU).

This SBIR topic aims to implement fully automated fast CFD solvers. The target requirements are:

- Order of Magnitude Improvement: Achieve at least 10X improvement in solver efficiency and time to solution on heterogeneous computing platforms, ensuring platform-independent performance gains.
- Complex Configuration Simulation: Ability to simulate realistic, complex hypersonic vehicle configurations along a flight trajectory, including the effects of surface roughness, thermo-chemical nonequilibrium, steps, gaps, wall temperature distribution, and other relevant physical phenomena.
- Automated Integration: Provide automated solver interface BLT prediction tools and MDAO frameworks.
- Pre- and Post-Processing Automation: Automate pre-processing (solver parameters setup and grid generation) and post-processing tasks to minimize user intervention and expertise requirements.

The objective is to achieve operational readiness and integration into existing design and analysis workflows.

Preference will be given to approaches that do not require large HPC systems and can run on affordable GPU hardware.

PHASE I: Develop a prototype CFD solver for automated grid-generation and grid-adaptation for hypersonic laminar flows. Demonstrate this approach on canonical problems, including both sharp and blunt leading edges, using existing experimental data. Showcase the accuracy and computational cost of the proposed automated method for a 3D problem. Highlight a path forward for platform-independent computation on existing and emerging high-performance computing architectures (CPU/GPU).

PHASE II: Implement a fully integrated automated simulation approach for computing hypersonic base flows for transition prediction. Key requirements include the ability to automatically track shocks, employ low-dissipation numerics, adaptively mesh to track relevant flow features, and include reacting flow and ablation capabilities. Ensure efficient utilization of computational resources on both existing and emerging high-performance computing architectures. The solver should compute hypersonic flow fields with minimal user interaction and be operable by non-expert users through an effective user interface. Demonstrate the solver technology on realistic, non-canonical hypersonic flow scenarios, including non-equilibrium effects, steps and gaps and efficient ablation simulation. Preference will be given to approaches that do not require large HPC systems and can run on affordable GPU hardware.

PHASE III DUAL USE APPLICATIONS: Transition the developed solver technology to practical applications within the Department of Defense (DoD) and commercial sectors. Perform extensive validation and optimization of the solver for a broad range of hypersonic vehicle configurations and flight conditions. Achieve operational readiness and integration into existing design and analysis workflows. Collaborate with industry partners and DoD agencies to ensure the solver meets the required standards for deployment. Additionally, develop comprehensive training programs and documentation to facilitate widespread adoption and use by non-expert users.

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KEYWORDS: Hypersonic Flows, Boundary Layer Transition (BLT), Computational Fluid Dynamics, CFD Solver, Thermo-Chemical Nonequilibrium, Automated Grid Generation, Adaptive Mesh Refinement (AMR), High-Performance Computing (HPC), Laminar Base Flows, Ablation, Multi-Disciplinary Analysis and Optimization (MDAO)

N251-061 TITLE: Carbon Dioxide Modular Refrigeration System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

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 non-hydrofluorocarbon (HFC), shipboard modular refrigeration system (MRS) using carbon dioxide (CO2/R-744) as the refrigerant.

DESCRIPTION: Shipboard refrigeration systems are used to store perishable foods and operate at temperatures between 41°F (5°C) and 33°F (-0.6°C) for chilled food storerooms and 0°F (-17.8°C) and -4°F (-20°C) for freeze food storerooms. The Navy currently relies on R-404A and R-407A for its MRSs sized for 0.75 and 1.5 tons-refrigeration (rTons) at freeze conditions. Each MRS consists of a modular refrigeration unit (MRU) located in the refrigerated storeroom (hung from the ceiling), a control panel with programmable logic controller (PLC), and a condenser located external to the refrigerated storeroom cooled with 44°F (6.7°C) chilled water. Each MRU contains a compact scroll compressor, refrigerant suction accumulator (receiver), motorized impeller to circulate air from the space through dual evaporators configured in a horizontal vee, controlled by two thermal expansion valves, a pressure regulating valve, and a solenoid valve to allow either chill or freeze operation. Each refrigerated storeroom contains at least two MRSs with integrated electrical defrost cycles (one installed as a spare) . Production and import of hydrofluorocarbons (HFC) are now being phased down in a step wise fashion due to their high global warming potentials (GWP), as mandated by the Kigali Amendment to the Montreal Protocol and the American Innovation and Manufacturing (AIM) Act of 2020 culminating in an 85% phase-down by 2036.

R-744/CO2 has reemerged as a credible very low GWP (GWP = 1) natural refrigerant, particularly for refrigeration systems that have condensers cooled by chilled water. But the use of CO2 is a far greater technical challenge than fluorinated refrigerants requiring additional engineering expertise to incorporate additional components of greater complexity with more complex controls. The toxicity and pressure safety aspects of CO2 are far more complex than fluorinated refrigerants. A R-744 MRS would need to be designed for transcritical operation to account for shutdown conditions, as well as transients that are inherent to a Naval combatant. Transcritical compressors are commercially available, but they are typically reciprocating designs, about three-times larger/heavier than scroll compressors. Developmental prototypes are necessary to fully understand the benefits and issues required for a CO2-MRS to be successful shipboard. The objective of this SBIR topic is to explore potential opportunities surrounding a non-HFC, shipboard transcritical carbon dioxide (CO2/R-744) MRS.

PHASE I: Design a compact 0.75 rTons MRS. Verify feasibility using modeling and/or component demonstration. Perform rough size, weight, electrical power, reliability, operating charge, and manufacturing cost analysis. Develop a Phase II plan.

PHASE II: Demonstrate a working prototype of the system and test in a laboratory environment. Validate analytic models developed in Phase I and scale design to a 1.5 rTon application. Complete a cost analysis of concepts established to ensure the selected technology is competitive with current approaches.

PHASE III DUAL USE APPLICATIONS: Optimize the concept design for manufacturability, performance and military requirements using the knowledge gained during Phases I and II. Develop the next generation of MRS that meets unique military requirements, such as shock and vibration. Explore similar commercial applications such as retail and supermarket refrigeration systems.

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KEYWORDS: refrigeration; carbon dioxide; low global warming potential; vapor compression

N251-062 TITLE: Asymmetric Large Language Model Aided Cyber Effects (ALL ACES)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber;Trusted AI and Autonomy

OBJECTIVE: Develop a comprehensive Cyber/Electromagnetic Spectrum Operations (EMSO) platform to support timely effects-based targeting, mission planning, as well as access and employment by utilizing Artificial Intelligence/Machine Learning (AI/ML) for "Human-AI Partnered" automated technical workflows to improve efficiency, capability, breadth and deployment of effects, and decision support.

DESCRIPTION: The latest evolution in Generative AI/Large-Language Model (LLM) technology presents a strategic opportunity to address challenges in cost, processing-latency, and talent shortages in Offensive Cyber Operations (OCO) and/or Defensive Cyber Operations (DCO). Solutions should demonstrate secure, efficient processing of real-time Cyber Threat Intelligence to inform agile (e.g., same-day) response to new threats, vulnerabilities, and exploits, thereby speeding and simplifying cyber risk mitigation through aligned security operations and threat-specific response.

Technology areas of interest are below. Proposals should focus on or incorporate one or more of the following areas technology areas of interest. Please indicate the technology areas of interest within the Abstract section of the Cover Sheet, Volume 1.

1. Artificial Intelligence: This area encompasses the integration of computing solutions to use learning and intelligence to take actions that maximize their chances of achieving defined goals. This includes the use of LLMs to understand and provide reactive capabilities for mission-defined tasking and workflow automation. The AI component would perform the heavy lifting that operators can fine-tune to quickly yield the best and most desired results.
2. Cyberinfrastructure and Advanced Computing: This area focuses on ensuring solutions push the boundaries of current hardware and software technologies to ensure efficient and scalable solutions while still focusing on security. Focusing on a wholistic approach to solutions ensures effectiveness and increases the reach for operational use.
3. Cybersecurity: This area explores the use of both offensive and defensive cyber strategies for exploitation utilization and vulnerability mitigation. The offensive side would seek to collect existing and novel mission-specific exploitation solutions and facilitate delivery when necessary. The defensive side would gather information from various up-to-date sources and guard against the latest cyber vulnerabilities. Both pieces would use the same collage of vulnerability knowledge for performing their respective tasks.

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: Provide architecture definition, AI Model selection, and concept refinement to support OCO and DCO operations. In addition, prototyping should be used as for validation for technology selection. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Create a demonstrable system prototype for evaluation by USN/USMC personnel to support OCO and DCO operations. Ensure the prototype's capability for showing ingestion of specified data and ability to interface with it with a chat-style interface in natural language, as well as demonstration of automated analysis of the ingested threat intelligence, overlaid on the real or simulated environment for relevance and actionability. The technology should reach TRL 6 at the conclusion of this phase. Successful completion of Phase II is expected to result in Phase III funding.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support transition for Navy use. Further develop and productize the prototype(s) for the intended mission in an operational environment and then test to ensure requirements are satisfied. The prototypes shall be TRL 7 at the conclusion of testing. The concept also will allow potential product opportunities in the Information Security vendor market. The Information Security vertical has a systemic and historical need for skilled practitioners. The technology developed by this SBIR opens an opportunity for product development in this vertical that helps create more productive Information Security practitioners faster. This productivity increase has the potential to reduce the skills gap that currently exists.

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KEYWORDS: Artificial Intelligence, AI, Machine Learning, ML, Offensive Cyber Operations, OCO, Defensive Cyber Operations, DCO, Large Language Models, LLM, Electromagnetic Spectrum Operations, EMSO

N251-063 TITLE: Aerial Refueling Latch Indicator

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Integrated Sensing and Cyber

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 prototype sensing system that can positively identify when a refueling drogue is securely latched onto the refueling probe.

DESCRIPTION: The U.S. Navy (USN) uses the probe and drogue style of aerial refueling. This involves a receiver aircraft maneuvering its probe tip into the coupling portion of a refueling drogue that flies on the end of a refueling hose. Once in the coupling, the probe is pushed into the coupling until a latch occurs. This latching provides a retaining force holding the drogue onto the probe, keeping the fuel valve open, and allowing fuel to flow to the receiver. Maintaining a positive latch is critical to ensuring fuel flow and preventing fuel spillage. Currently, with manned aviation, the receiver pilot visually confirms the drogue stays latched onto the probe by looking for excess movement, positive fuel flow, and no leakage. As unmanned receivers come into the fleet, a visual indication will not be enough to confirm latch. Sometimes, a soft contact occurs where the drogue is in the right position (visually looks OK), but is not fully seated, that results in fuel leakage, or a drogue coming unseated. This would present a safety risk to the unmanned receiver.

A device must be developed that can be used as a sensor to provide input to an unmanned receiver to confirm positive latch, or to alert when the nozzle becomes unseated. This device by design will have to be very low power, and have a very small form factor, to fit inside either the probe nozzle, or the refueling coupling/drogue. It will need to be powered by either existing aircraft power on the receiver, or by on board power generation on the refueling drogue/coupling. No power can be run down the hose. It must be extremely damage tolerant as the refueling mission involves the collision of the refueling probe with the drogue at up to 15 ft/s. It must have some means of providing the indication to the receiver aircraft.

The probe nozzle used by the Navy conforms to MIL-N-25161 [Ref 1]. MIL-PRF-81975 is the specification for the MA-3 coupling that the refueling nozzle mates with [Ref 2]. MS-24356 gives the basic nozzle dimensions [Ref 4].

PHASE I: Develop and refine initial design concepts that converge on a final prototype design. Assemble system requirements and complete a preliminary prototype design to the extent that the USN can determine technical feasibility. Implement the design in a CAD software of choice. It is expected that some level of bench/breadboard testing will be completed to evaluate technology solutions and justify the preliminary design. A final report shall address requirements generation, lab testing completed and document the prototype design. The system design shall allow for easy adaptation to the current aerial refueling hardware.

The Phase I Option, if exercised, will continue the prototype design refinement and prepare for system level demonstration and validation in Phase II.

PHASE II: Produce a full up prototype design and prototype full up system hardware/software. Throughout Phase II, requirements will be reassessed against original design assumptions and a requirements document will be produced outlining path to full system qualification. Component level testing shall be conducted on actual hardware and software, and ultimately, a system level test will be conducted to demonstrate and validate the system meets the requirements. It is expected that GFE hardware in the form of a refueling coupling and refueling nozzle will be provided to awardees.
The robustness of the system must be considered so that the vendor can capitalize on any developmental flight opportunities that might exist.

PHASE III DUAL USE APPLICATIONS: Update and finalize system design based on system level testing and conduct full qualification testing. This product is intended to transfer to the USN via the MQ-25 and/or PMA-201 Aerial refueling store. With multiple commercial aerial refueling companies in the market, this system would have commercial viability as well.

REFERENCES:
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KEYWORDS: Refueling; Aerial Refueling; Unmanned Refueling; In Flight Refueling; Drogue; Probe

N251-064 TITLE: Sparse Data Initialization for Machine Learning Weather Prediction Models

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Sustainment;Trusted AI and Autonomy

OBJECTIVE: Develop a machine learning weather prediction (MLWP) system to generate a complete model analysis, initialization, and produce skillful forecasts from an incomplete, non-gridded set of observations that may include sparse and irregular spatial and temporal sampling of in-situ, remote sensing, satellite, and qualitative forecaster-based information.

DESCRIPTION: In the last few years, there has been a substantial increase in the number of skillful MLWP models that have demonstrated competitive results with state-of-the-art traditional physics-based numerical weather prediction (NWP) systems. However, these efforts not only require multiple decades of high-quality full physics reanalysis information to train the model, but similar quality high-resolution gridded fields from which to initialize the model. This latter point limits the utility of running MLWP systems operationally since full scale traditional data assimilation and reanalysis methods are needed to inform the MLWP model initial conditions.

While MWLP model development requires sufficiently large and balanced datasets to train appropriate physical relationships, it is not clear that a full data assimilation system is needed as with traditional NWP. MWLP time integration is not achieved via discretized partial differential equations, and thus does not share some NWP limitations such as requirements for Courant-Friedrichs-Lewy stability conditions or dynamically balanced states. The need to map real-world data onto a numerically regular grid necessitates smoothing, observation thinning, and methods to spread observational influence in space and time, all of which may lead to a loss of information. This topic solicits innovative machine learning development to build off of recent references (see selection below) that inform methodologies capable of initializing a MWLP model without the need of a full end-to-end NWP-type of data assimilation capability.
Given operational constraints of real-time data quality and quantity, this SBIR topic seeks to scope, prototype, and demonstrate a technique to create a MLWP analysis/initialization capability that: 1) is informed by and transcends state-of-the-science data assimilation methods and practices; 2) accepts a variety of observations and data sources, types, qualities, and characteristics; and 3) can be processed with varying and irregular amounts of data over consecutive model cycles.

PHASE I: Focus on understanding and documenting the technical limitations of initializing MLWP forecast models with sparse observations and formulating innovative concepts to overcome those challenges. Perform a background study of both data assimilation and state-of-the-art forecast analysis methods that will be required to motivate and inform how the proposed effort will address gaps in current processes. Develop a theory and/or simple method to demonstrate the feasibility of the initialization methods to produce robust analyses and stable, skillful forecast fields based on AI/ML techniques. It will be important to properly scope the breadth of analyzed and model environmental variables as well as the appropriate downstream applications for their use.

PHASE II: Using results from the Phase I, develop, demonstrate, and validate an end-to-end prototype MLWP software suite focused on the novel data ingest, initialization, and analysis scheme. Ensure that the toolset must be able to accept widely varying modalities, qualities, and types of observational data, including in-situ state variables, remotely sensed raw and retrieved quantities, gridded background fields of varying age and accuracy, and qualitative assessments of the environment including forecaster notations of important features and locations of environmental phenomena. Ensure that the prototype software must also allow for discontinuities in data streams (temporally or spatially) and have the ability to run or restart with old/degraded information. Intermediate processing outputs of data impacts and sensitivity to the analysis and/or forecast fields is highly desired. The developed workflow should also include robust methods of validation and verification as well as identify strengths and weaknesses of the product compared to traditional NWP modeling. Perform multiple demonstrations in coordination with field testing (may be required). Submit required Phase II deliverables to include regular reporting, participation in program reviews, technical documentation, and the end-to-end prototype software at the conclusion of the effort.

PHASE III DUAL USE APPLICATIONS: Operational hardening and establishing utility and trust for real-time application forms the main effort for transition and commercialization. Dynamic analysis software tools that quickly and accurately convey software system health, error logging and debugging, and processing metadata will need to be created and demonstrated. Develop additional metrics and diagnostics to facilitate expert forecaster guidance on using the product (and comparing to current state-of-the-art weather forecast information). Ensure that the system has a formalized methodology and data/compute needs for model training and a separate, leaner set of requirements for operational runs. Techniques should be generalizable to apply to a variety of environmental modeling use cases such that follow-on work and commercial applications can be addressed.

Dual-use applications will include partnering with other intergovernmental meteorological agencies such as USAF, NOAA, and NASA as well as commercialization for multiple potential markets with decision making requirements based on forecast skill.

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KEYWORDS: Data assimilation; initialization; machine learning; artificial intelligence; ai/ml; meteorology; oceanography; METOC; weather; forecast; machine learning weather prediction; mlwp

N251-065 TITLE: Active Scenarios Learning of Evolving Situations, Multimodal Counterfactual Reasoning, and Explanations Toward Artificial Intelligence-assisted Wargaming

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces;Integrated Sensing and Cyber;Trusted AI and Autonomy

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 multimodal Artificial Intelligence (AI)-based scenario learning technology that continually adapts to the formation of emerging situations. Develop counterfactual augmentation machine reasoning and explanation techniques to correct human feedback behaviors that may cause bias in scenario learning. Scenarios forewarn risks, elicit decisions, and induce human-AI collaboration to exploit vulnerabilities. Apply large language models to explain scenarios, risks, recommend decisions, and course of action. These explanations serve as a crucial tool for evaluating the efficacy of human-AI wargaming collaboration.

DESCRIPTION: Creating unbiased adaptive scenarios as situations unfold is crucial for effective wargaming and conflict simulations. The aim is to predict events and trends that could have a significant impact on U.S. National Security Interests. It requires decision-makers to 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. Currently, a diverse team consisting of decision-makers, analysts, and warfighters invests significant time and resources into anticipating adversarial strategies and tactics through wargaming and brainstorming. However, this human-centric approach is vulnerable to costly errors, biases, and omissions, which can seriously undermine the assessment of evidence, statistical analysis, and the understanding of cause and effect.
To achieve the objectives, this SBIR topic will develop the following technologies:

- Multimodal active AI-scenario generator that continually monitors, assesses, and exploits all-source-INT (ASI) datasets and streaming ISR data to detect, understand, and reason about hostile activities, interactions, and operational changes over time. It tracks and identifies assets including deceptive decoys based on their distinct deployment patterns. It provides warning signals as events develop and evaluates the potential consequences. The system remains impartial and helps to reduce human cognitive biases through counterfactual reasoning. It calculates various engagement options and outcomes for human consideration that may not have been recognized or properly understood. Additionally, it assesses the risk of escalation, identifies potential triggers of escalation, and helps with preparations. This capability is critical when it's too uncertain to rely solely on human judgments about potential engagements and their implications.
- Collaborative human-AI course of action learning, reasoning, and explanations of engagement plans. It is a collaborative interplay of machine-to-machine (M2M) prediction of alternative futures integrated with the human-to-machine (H2M) supervisory system that examines and validates the end-state scenario risks. H2M interactive path allows for joint sensemaking, contextual reasoning, logical consistency checks, and Q&A query to probe AI generated scenarios and observed warning signs. The key technology development components are as follows:

1. Machine learning (ML) to uncover opponent's multimodal assets (people, places, things), movements, and activities.
2. AI Red Team Reason-and-Act (ReAct) agents that discern and simulate opponent's Tactics, Techniques and Procedures (TTP) and reactions.
3. AI Blue team ReAct agents, as a collaborative human-AI team executing strategic and tactical plans and maneuvers.
4. Counterfactual augmentation multimodal ML to prevent human perception biases influencing the course of action.
5. Apply large language models to explain multimodal events (text, voice, video, electro-optical/infrared (EO/IR) imagery, acoustics, synthetic aperture radar (SAR), etc.), decision points, course of action, interactions between Red vs. Blue teams, Player's behaviors, and engagement outcomes are coherently expressed in natural language.

- Wargaming applications may include scenarios that capture a joint military and commercial mobilization activities or exercise activities to control contested waters such as amphibious landing and sea-lane blockade.
- Analytic tools that support the development include wargaming databases, engagement rules for all players, whether human or machine, and a multimodal exploitation gaming environment.

PHASE I: Determine the technical feasibility of designing and developing collaborative human-AI wargaming and AI-generated scenarios technologies as described in the Description section. Testing and demonstrations may use datasets from the Department of the Navy (DoN), Marine Corps Warfighting Laboratory (MCWL), Automatic Identification System (AIS) maritime traffic, commercial satellite imagery, and open-source intelligence (OSINT). The wargaming datasets and engagement rules need to take into consideration the littoral maritime environment and seaside terrain, including weather, view/geo-effects, routes; the maritime order-of-battle and movement; engagement rules/doctrine; engagement attrition; victory, standoff, and defeat conditions and status; logistics and supply demands, etc. Utilize associative data mining techniques for entity extraction (people, places, and objects) and related transactional activities. 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.

Software validation and verification must assess AI scenario structuring and logic-tree performance, consistency, and credibility as it relates the initial scenario states to the final scenario states through intervening events and processes. 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. Conduct performance assessment on the following human sensemaking and decision-making:

- TTP Confidence on engagement plans, options, and risk reduction associated with the ups and downs of encounters.
- Cause and effect sensitivity analysis on contextual understanding of AI-generated scenarios.
- Efficiency gains in human responsiveness through timely decision-making, chain-of-actions, and resources spent.

Deliverables include end-to-end initial prototype technology, T&E, demonstration, a plan for Phase II, and a final report.
Note 1: Phase I will be UNCLASSIFIED and classified data is not required.

Note 2: Awardees must provide appropriate dataset release authorization for use in their case studies, tests, and demonstrations, and certify that there are no legal or privacy issues, limitations, or restrictions with using the proposed data for this SBIR project.

PHASE II: Develop a prototype of the candidate technologies. Test and demonstrate the prototype with representative operational data sources. Assess the prototype's performance against the metrics detailed in Phase I. Conduct an end-user satisfaction assessment, on a scale of 0 to 5, on the following matters: a) Situational understanding for events that go dark, disguised activities and maneuvers, and dormant targets; b) Alignment with formal warning signals; c) Alignment with prioritized deterrence and engagement options; and d) Timeliness for responsive decision-making across different domains and collaborating effectively. Deliver prototype software, systems interface requirements for mobile and stationary devices, design documentation, source code, user manual, and a final report. Additionally, develop a plan for the Phase III transition into a program of record.

Note 3: Work produced in Phase II may become classified. However, the proposal for Phase II will be UNCLASSIFIED. 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.

Note 4: If the selected Phase II contractor does not have the required certification for classified work, the Office of Naval Research (ONR) or the related DoN Program Office will work with the contractor to facilitate certification of related personnel and facility.

PHASE III DUAL USE APPLICATIONS: Advance these capabilities to TRL-7 and integrate the technology into the Maritime Tactical Command and Control Program of Record (POR) or Intelligence, Surveillance and Reconnaissance (ISR) processing platforms at the Marine Corps Information Operations Center. Once conceptually and technically validated, demonstrate the dual-use applications of this technology in the video gaming industry.

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KEYWORDS: Artificial Intelligence; Machine Learning; Machine Reasoning; Scenario; Multimodal; Counterfactual; Wargame; Bias; Explanations

N251-066 TITLE: Carbon-Carbon Modular Structures

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Hypersonics;Sustainment

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 the manufacturing capability to create precise, rugged, and consistent high tolerance carbon-carbon (C/C) structures that allow for modularity of a hypersonic vehicle.

DESCRIPTION: Current C/C technology is very expensive, time consuming, and difficult to produce. These factors limit the ability to perform research and development for modification to current designs. New designs will allow for more advanced vehicles. The Conventional Prompt Strike (CPS) Program desires a manufacturing capability to create very strict tolerances that allows for different architectures/designs for hypersonic vehicles. The ability to modularly construct, mold, carve, form, or alter the C/C material in the manufacturing process is of interest. In the case of additive manufacturing capabilities, there is high risk of failure to withstand the shock, vibration, heat, and other environmental conditions of hypersonics. This new manufacturing capability shall provide significant proof of concept to meet these requirements. The C/C manufacturing capability should have mitigations for these considerations along with all other capability considerations. This capability shall follow standard manufacturing readiness level (MRL) progression.

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 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: Demonstrate the feasibility of the C/C manufacturing capability to demonstrate modular integration of aeroshell components while maintaining robust structural integrity of the entire system. Show the design considerations such as size of piece that can be constructed, thermal limits, shear limits, compression limits, tensile strength limits, etc. Compare these metrics to current state of the art C/C manufacturing capabilities and other C/C processes. Show the trade space between the process presented and these other processes. For consideration of Phase II, there is significant emphasis on the ability to have a technical and rigorous process flow for manufacturing that demonstrates the repeatability and reliability of the process. 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: The modular C/C structure shall be tested with multiple environmental conditions. A successful demonstration shall be presented by the end of the Phase II. Unlike technology readiness levels (TRLs), MRL requires testing similar environments throughout Phase II. The Technical Point Of Contact (TPOC) shall approve the validity of the test environment meets the requirements given in Phase II.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the government in transitioning the technology for government use.

The transitioned product is expected to be able to support current and future weapon and space systems, as well as a wide range of other air, land, and sea-based systems. Commercial applications should be considered for transition (i.e., ocean exploration, space exploration, commercial autonomous vehicles, and mapping systems). The primary objective of this project is for transition to defense contractors for high-speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

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KEYWORDS: Novel; Creative; Innovative; Advanced; Rugged; Hypersonic; Manufacturing; Additive Manufacturing; Modular; Carbon-Carbon; Carbon Structures: Embedded; Aerospace

N251-067 TITLE: Radiation Hardened Gallium Nitride Electronics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;Nuclear;Space Technology

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: Characterize Gallium Nitride (GaN) materials and develop the techniques to design radiation hardened GaN electronics for power and/or radio frequency (RF) applications. Additional objectives include development of radiation hardened discrete GaN High-Electron Mobility Transistor (HEMT) devices and radiation hardened GaN integrated circuits for power conversion and/or RF applications.

DESCRIPTION: The desire for smaller and more efficient power and RF devices has led the electronics community in the direction of wide band gap power devices. GaN HEMTs offer improvements in size, weight, and power (SWaP) over silicon transistors. The enhanced capabilities and SWaP reductions are desirable for DoD and Space system deployments. Commercially available GaN HEMTs have been demonstrated to show sensitivity and permanent damage due to exposure to radiation, specifically heavy-ion radiation while the part is biased [Refs 1-3]. This radiation-induced damage is a significant concern for mission-critical applications. Additionally, many GaN HEMT and integrated circuit products face supply chain uncertainty through an evolving GaN manufacturing landscape and fabrication facilities that are not domestic to the continental United States (CONUS). It is highly desirable to develop radiation hardened by design (RHBD) GaN HEMT and integrated circuit solutions, to mitigate radiation effects damage and performance degradation, within a fabrication flow with a path to Defense Microelectronics Activity (DMEA) certified transited status. The final designs should be suitable for packaging in standard commercial footprint packages. Development of a screening flow, similar to a MIL-PRF-19500 screening, should be established and included in part productization and qualification.

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, Part2004.20 of the Code of Federal Regulations.

PHASE I: Identify candidate GaN foundry processes and characterize the baseline technology for radiation-response and RHBD potential. Comparison to currently available GaN products for commercial applications should be made for target electrical performance capabilities. Develop design concepts for radiation hardened GaN HEMT devices and integrated circuits for power conversion and/or RF applications. Simulation results to establish the feasibility of design concepts. Target specifications for radiation resiliency may include

- Total Ionizing Dose: 1×106 rad (Si) equivalent dose
- Neutron Fluence: 5×1013 n/cm2
- Single-Event Burn Out: 60 MeV-cm2/mg
- Single-Event Upset: 15 MeV-cm2/mg
- Dose Rate Survivability: 1×1012 rad(Si)/sec equivalent
- Dose Rate Upset: 1×109 rad(Si)/sec equivalent

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: The concept design and specifications from Phase I will be developed as fabrication-ready designs. Final designs will be demonstrated through simulation across process corners, the standard military temperature range, and modeled strategic radiation environments. The designs will be fabricated, in a trusted foundry and a CONUS fabrication facility, and tested to confirm device and circuit functionality and radiation resiliency. A lot of twenty (20) threshold to twenty-five (25) objective prototype devices should be delivered by the completion of Phase II.

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

PHASE III DUAL USE APPLICATIONS: The final version of the HEMT devices and/or integrated circuit designs will be productized at the selected foundry from Phase II. The final designs should be suitable for packaging in standard commercial footprint packages. Development of a screening flow, similar to a MIL-PRF-19500 screening, should be established and included in part productization and qualification.

Many military, commercial, and scientific systems that operate in hard environments require radiation hardened electronics. Space radiation effects impact systems such as communication and navigation satellites. Systems operating in adverse environments in and around nuclear reactors and particle accelerators also require a degree of radiation hardness electronics.

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KEYWORDS: Gallium Nitride; GaN, High-Electron Mobility Transistor; HEMT; power conversion; radio frequency; radiation hardened electronics; radiation-hardened by design; RHBD; prompt dose; foundry

N251-068 TITLE: Smart Contracts for Supply Chain Risk Management (SCRM)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Sustainment

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 acquisition and sustainment contracting framework to implement Smart Contracts for Supply Chain Risk Management (SCRM) (blockchain technology) for Strategic Systems Programs (SSP) . This technology can be applied to acquisition or sustainment programs across the DoD. This collaboration between government and industry will provide the government greater visibility of sub-tier vendors in the supply chain.

DESCRIPTION: As noted in the February 2022 memorandum, “Securing Defense-Critical Supply Chains An action plan developed in response to President Biden's Executive Order 14017”; The Department of Defense (DoD) is aligning its priorities and capabilities to enhance our readiness. By modernizing our approach to supply chain resilience, DoD can deliver decisive advantages to our Warfighters in a dynamic threat landscape. In an effort to improve supply chain resilience and protect against material shortages, President Joseph R. Biden Jr. signed Executive Order (E.O.) 14017, America's Supply Chains. In response to the EO, this report provides DoD's assessment of defense critical supply chains in order to improve our capacity to defend the Nation [Ref 1].

As stated in the SSP Director’s Mission Priorities section of Sea Based Strategic Deterrence (SBSD) Director’s Intent: “Through programmatic excellence in shipboard sustainment and modernization programs across the Strategic Weapons System (SWS) subsystems and in Nuclear Weapons (NW) surety, and through diligent oversight of the logistical supply chains, SSP not only will maintain a credible and reliable weapons system, but will also continue unlocking new capabilities the warfighter can leverage to enhance strategic deterrence and act decisively should deterrence fail.” A significant aspect in delivering and maintaining a credible and reliable weapon system is having a thorough understanding of our global supply chain.

New concepts to improve visibility and responsiveness to address issues for sub-tier vendors within the global supply chain are necessary to ensure weapon system delivery. The implementation of smart contracts backed by blockchain technology can provide government with visibility into all sub-tier vendor activities. This can provide program managers with an understanding of where critical parts and technologies are coming from (around the world). Implementation of this technology provides a revolutionary increase in the government’s ability to conduct Supply Chain Risk Management, Systems Security Engineering, and Program Protection Plans.

The April 2024 Investopedia article “What Are Smart Contracts on the Blockchain and How Do They Work?” provides a high level description of smart contracts and blockchain technology [Ref 4]. It states, “A smart contract is a self-executing program that automates the actions required in an agreement or contract. Once completed, the transactions are trackable and irreversible. The best way to envision a smart contract is to think of a vending machine—when you insert the correct amount of money and push an item's button, the program (the smart contract) activates the machine to dispense your chosen item. Smart contracts permit trusted transactions and agreements to be carried out among disparate, anonymous parties…".

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 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: Provide a concept to incorporate smart contract (blockchain based) technology into Navy contracting and supply operations. This concept will be captured in a Word document that describes "to-be" business processes, potential technology solutions, and potential pilot industry partners for Phase II. This should also discuss integration of supply chain data into SCRM and related efforts and insights that may be gleaned to help the Government better understand industrial base capability, capacity constraints, risks, and opportunities. The concept should describe how this solution can provide:

- Manufacturing Visibility
- Inventory Visibility
- Logistics Visibility
- Visibility into "Nth Tier" subcontract vendor information and associate parts/material delivery

Perform data discovery, examination of supply chain challenges from both the Government and Vendor perspectives, operational use cases, and a governance mode.

PHASE II: Develop and deliver a prototype SCRM system for Smart Contracts that utilizes blockchain technology (immutable ledger) in order to achieve the visibility described in Phase I. Collaborate with Government, industry stakeholders, and active partners. The prototype will be evaluated on its ability to operate from a manager and end-user perspective, data security, and data analytics capabilities. This should include chosen technology solutions and agreed upon business practices. An additional deliverable will be a "scalability assessment."

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Phase III should result in a small number of SSP contracts executed as Smart Contracts. These contracts will serve as use cases that will be managed and executed at multiple layers of the supply chain. Data analysis should provide information regarding all supply chain sources (company level information) and identify products/parts they are under contract to deliver. This information must be easily transferrable to other SCRM and Supply Chain Illumination tools in use by SSP and the Navy. Due to the sensitive nature of some contracts, it is expected that pricing data may not be maintained on the blockchain or will have very limited access. The Defense Information Systems Agency (DISA) will likely need to validate and accredit the new system.

This technology can be applied to any industry (commercial or government) that is concerned with understanding and managing risks of sourcing/procurement of parts that end up in their products/platforms. All industries can benefit from having more clarity on sub-tier vendors.

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KEYWORDS: Blockchain; Smart Contract; Supply Chain; Contracting; Industrial Base; Acquisition; Sustainment; Supply Chain Risk Management; Program Protection; Critical Programs & Technologies

N251-069 TITLE: Highly Applicable Mechanical Metamaterial (HAMM) for High G-Load Flight Structures.

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Hypersonics;Sustainment

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 mechanical metamaterial with adaptive hierarchical periodic microarchitecture that can survive increased mechanical loading at high temperatures. The design will provide an increase in overall specific strength using novel high entropy alloys per volumetric performance.

DESCRIPTION: Flight vehicle structures operating in hypersonic environments are traveling at speeds above MACH 5 and may experience structural G-force loads above 50Gs. These variables make the material property requirements very stringent for survivability. To account for these conditions, structural alloys designed must have high strength, creep resistance, and high operating temperature. Historically, new material systems have always played a transformative role in advancing these capabilities. In the operation of flight structures, reducing weight while increasing strength improves flight performance with each new design iteration. For structural materials, aluminum and titanium alloy manufacturing have made advances by providing structures with high specific strength in operation. These alloys are used in a limited number of flight applications for hypersonics, due to operational temperatures of ~300°C (Al alloys) and ~540°C (Ti alloys). Nickel based alloys, like Inconel, provide a solution when extreme temperatures, mechanical loads, and high corrosive environments are persistently present. Inconel has been able to withstand temperatures up to 1200°C, which makes it very unique for these environments. The caveat is that traditional manufacturing makes Inconel production expensive due to machining and overall material cost. For sustainability, Inconels have a material design limitation due to the requirements for a high nickel concentration, > 50%. Advanced manufacturing methods that use less material, reduce machining time, or provide a whole new materials solution without significant loss of mechanical properties are of need.

Mechanical metamaterial provide a unique approach by specifically using advanced manufacturing to create hierarchal lattice structures. These structures have macroscopically high mechanical strength in the designed principle direction due to their multiple instances of material orthotropy. Topological optimization has been utilized to research hierarchal structures that are specifically designed for higher loads. These designs seek to use less material without sacrificing mechanical capability. This SBIR topic looks for a Mechanical Metamaterial structural design that is able to maintain or improve upon the properties of a forged structural component. This topic intends for the use of new high entropy alloys that reduce or provide alternatives to nickel based alloys. The design should be informed by using modern topological optimization tools driven by machine learning. The final design will be a representative component structure to be tested under loading conditions experienced by hypersonic flight 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 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: Develop a high entropy alloy and architecture with an optimized design for incorporating high mechanical loads via advanced manufacturing. Produce sample test articles using advanced processing and characterize them under tension, compression, and hardness. Assess the alloy through crystallography, microscopy, calorimetry, and gravimetric analysis to access ablative mass loss at high temperature. The resulting article must have a low oxygen concentration and be able to operate in extreme temperatures above 1000°C. Use an understanding of characteristics to demonstrate a viable proof of concept.

PHASE II: Create a larger mechanical test architectures to conduct a side-by-side comparison of properties to other comparable structural alloys. Perform a manufacturing repeatability analysis on the manufacturing process for this optimized mechanical metamaterial. Establish a manufacturing process workflow to incorporate an optimization design of experiments to allow for future concept variability.
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: Integrate manufactured metamaterial into a component scale flight experiment and begin developing a pilot line for transition to full production.
Support the government in transitioning the technology for government use. The transitioned product is expected to be able to support current and future weapon and space systems, as well as a wide range of other air, land, and sea-based systems.

Commercial applications should be considered for transition (i.e., 5G, navigation systems, and tracking systems). The primary objective of this project is for transition to defense contractors for high-speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

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KEYWORDS: Mechanical Metamaterial, Light Weight High Entropy Alloys, Hypersonic, Lattice Structures, HEAs, Advanced Manufacturing, Machine Learning

N251-070 TITLE: Carbon-Carbon Structures with Embedded Electronics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Hypersonics;Microelectronics

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 the capability to create precise modifications, rugged, and consistent high tolerance carbon-carbon (C/C) structures that allow for antennas or other electronics to be embedded into the C/C structure (no window or cover required) while able to operate in a hypersonic regime.

DESCRIPTION: Current C/C technology is very expensive, time consuming, and difficult to produce. These factors limit the ability to perform research and development for modification to current designs. New designs will allow for more advanced vehicles. The Conventional Prompt Strike (CPS) Program desires the ability to create C/C structures with very strict tolerances that allow for different architectures, designs, or configurations of the thermal protection system in a hypersonic regime. This would require advanced manufacturing capabilities, facilities, and expertise. The CPS Program desires these capabilities for antennas and other electronic integration with large C/C structures. This capability will increase the effective volume in which electronics may reside. The ability to modularly part, mold, carve, form, or alter the C/C material in the manufacturing process is of interest. In the case of additive manufacturing capabilities, there is high risk of failure to withstand the shock, vibration, heat, and other environmental conditions of hypersonics. This new manufacturing capability shall provide significant proof of concept to meet these requirements. Note that when the C/C material is in close contact with other metals and semiconductors there is room for additional manufacturing demands such as thermal expansion effects, bonding/reactive effects, and warping of the metals at high temperature. The C/C manufacturing capability should have mitigations for these considerations along with all other capability considerations. This capability shall follow standard manufacturing readiness level (MRL) progression.

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 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: Demonstrate the feasibility of the C/C manufacturing capability to embed antennas or electronics within the structure while maintaining robust structural integrity of the entire system. Show the design considerations such as size of piece that can be constructed, thermal limits, shear limits, compression limits, tensile strength limits, etc. Compare these metrics to current state of the art C/C manufacturing capabilities and other C/C processes. Show the tradeoffs for this comparison. Demonstrate the feasible functionality of embedded antennas or electronics. Show the trade space between the process presented and current state of the art processes. For consideration of Phase II, there is significant emphasis on the ability to have a rigorous process flow for manufacturing that demonstrates the repeatability and reliability of the process. 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: The C/C antenna or electronic structure shall be tested with multiple environmental conditions. A successful demonstration shall be presented by the end of the Phase II. Unlike technology readiness levels (TRLs), MRL requires testing similar environments throughout Phase II.) The Technical Point Of Contact (TPOC) shall approve the validity of the test environments and that the test meets the requirements given in Phase II.

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

PHASE III DUAL USE APPLICATIONS: Support the government in transitioning the technology for government use.

The transitioned product is expected to be able to support current and future weapon and space systems, as well as a wide range of other air, land, and sea-based systems. Commercial applications should be considered for transition (i.e., ocean exploration, space exploration, commercial autonomous vehicles, and mapping systems). The primary objective of this project is for transition to defense contractors for high speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

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KEYWORDS: Novel; Creative; Innovative; Advanced; Rugged; Hypersonic; Manufacturing; Additive Manufacturing; Carbon-Carbon; Carbon Structures: Embedded; Aerospace

N251-071 TITLE: Novel Autonomous Dead Reckoning Navigation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Hypersonics;Microelectronics

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 novel, State Of The Art (SOTA) autonomous navigation capability, utilizing dead reckoning, to improve navigation accuracy, over longer distances, while traveling in a hypersonic regime.

DESCRIPTION: Development of a novel, dead reckoning navigation technique may provide an increase in robust updates, at discrete intervals, to aid in the navigation of a hypersonic vehicle. These discrete interval updates provide time, vector (direction), and velocity information of the system's current position. Dead reckoning uses these updates, with the previous update as a reference, to identify the vehicle's current position. Dead reckoning is known to be accurate only over short distances. Corrections from navigation aids (such as GPS) are needed to fix the drift error over longer distances. With the use of increased accuracy, the hypersonic vehicle can perform autonomous travel for longer distances. While an increase in Inertial Measurement Unit (IMU) performance helps the dead reckoning accuracy, IMU accuracy alone may lack the unique innovation desired. Additional sensor information for drift error correction in the IMU allows for increased accuracy, redundance in sensor options, and resilience from external effects. Individual sensors shall utilize a modular design that is integratable with multiple different types of IMUs to show interoperability. Software used to communicate with the IMU and other hardware shall be open source and/or with no proprietary limitations that would require significant changes to any system it may be integrated. A successful autonomous dead reckoning travel advancement may utilize sensory updates in the local area of the hypersonic vehicle such as temperature, altitude, vibrations, light produced by/near the hypersonic vehicle, etc. Updates that do not apply are external feedback from a known reference outside the local area of the hypersonic vehicle such as GPS, antennas on the ground or in space, light from stars, etc.

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 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: Develop a concept for a technology with superior accuracy over long distances to SOTA dead reckoning navigation systems. The technology shall show improvement in technical parameters while maintaining similar Size, Weight, and Power (SWaP) compared to current, commercially available, SOTA technology. The technical parameters will vary significantly based on the type of dead reckoning technology, and will be compared to similar current SOTA technology in an “apples to apples” comparison. The following SWaP constraints should be considered:
Size of the design should fit within 64 inches cubed (4 inches in all axis).
Weight of the design should weigh less than three pounds.
Power of the design should draw less than 100 Watts.

These considerations should be treated as bare minimum requirements, and may change based on the type of technology selected. If awarded a Phase I, reduction in SWaP is important for Phase II.

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 any hardware and/or software required to demonstrate a refined prototype solution for the advanced dead reckoning navigation system. The refined prototype shall not use any known external references other than initial starting position and IMU data, unless previously approved by the Government Technical Point of Contact (TPOC). Identify a work plan that provides proof of concept to meet the performance goals and reduce SWaP. Focus on reduced SWaP and increased accuracy of dead reckoning algorithms while operating in a hypersonic regime. The prototype hardware, software, and all modeling and simulation, shall be delivered to show technically measurable improvements to dead reckoning navigation. By the end of Phase II, the final prototype is intended to be integrated into test asset(s) for verification and validation of the technology.

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

PHASE III DUAL USE APPLICATIONS: Support the government in transitioning the technology for government use.

The transitioned product is expected to be able to support current and future weapon and space systems, as well as a wide range of other air, land, and sea-based systems. Commercial applications should be considered for transition (i.e., ocean exploration, space exploration, commercial autonomous vehicles, and mapping systems).

This technology has use in the Department of Defense (DoD) and also has significant interest in industry from many autonomous navigations such as deep sea and deep space.

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KEYWORDS: Navigation; Dead Reckoning; Autonomous; Guidance; Sensors; Sensor Fusion; Rugged; Resilient; Hypersonic; Network; Neural Network; Internet of Things

N251-072 TITLE: Lithium Niobate Fabrication and Processing

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;Quantum Science;Space Technology

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 innovative solutions for the fabrication, production, and processing of optical quality lithium niobate substrates.

DESCRIPTION: Lithium niobate ($LiNbO_3$ or LN) is a versatile optical material used in a range of active optical components such as acousto-optic and electro-optic modulators, Pockels cells, and non-linear optics [Ref 1]. It supports optical wavelengths spanning the visible through infrared bands favored for telecom applications. It is an excellent substrate for optical waveguides either in bulk form or in the form of thin film lithium niobate (TFLN) on insulators. TFLN provides a versatile platform for the development of photonic integrated circuits (PICs), providing a path to the miniaturization and integration of complex optical systems into packages of lower size, weight, and power (SWaP). LN is a critical material used in many high precision inertial sensors for DoD applications, which includes an integrated optical component (IOC) that is typically a y-branch LN crystal waveguide. It also plays a key role in various active components that support cold atom based quantum inertial sensors, such as electro-optic phase and frequency shifters.

LN substrates exist in a variety of grades. Though somewhat loosely defined, optical grade represents the highest quality grade, best suited for use in optical waveguides and modulators. This is characterized by its highly uniform composition, typically achieved by tightly controlled crystal growth conditions, and lack of impurities and defects. For the purposes of this SBIR topic, the following goal specifications for optical quality are defined:
• Composition uniformity: +/- 0.01 mol% Li_2O
• Curie temperature uniformity: +/- 1 °C
• Refractive index / birefringence uniformity: +/- 1e-4
• Impurities: < 1 ppm (each transition metal)

Over time, the U.S. supplier base for optical quality LN substrates has declined to the extent that nearly all single crystal LN must now be obtained from foreign sources [Ref 2]. The Navy has an interest in developing a robust supply chain for LN source material that can support the U.S. photonics industry. This SBIR topic seeks innovative approaches for LN fabrication processes for the growth of LN single crystals through wafer processing.

PHASE I: Perform an initial study to assess the feasibility of the proposed production methods and the expected material specifications. Optimize for any crystal composition (such as congruent, stoichiometric, doped) and provide an assessment of the targeted uniformity and purity of the material (neglecting any proposed dopants) and the expected optical quality. Propose methods of testing substrates to be developed in Phase II for defect concentration and other relevant measures of optical quality.

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

PHASE II: Grow and process LN wafers with the following target specifications:
• Orientation: x-cut or z-cut (+/- 0.5 degrees)
• Minimum wafer diameter: 150 mm
• Wafer thickness: 1 mm (nominal)
• Wafer flatness: 15 microns (total thickness variation)

Characterize both the surface quality of substrates and the concentration of material defects according to methods defined in Phase I. Deliver five (5) wafer substrates to the Navy at the conclusion of Phase II.

PHASE III DUAL USE APPLICATIONS: Continue development in collaboration with the Navy and potential industry transition partners. Refine the wafer substrates to the requirements for LN substrates relevant for Navy applications. Define specific crystal specifications.

This work will result in a more robust supply chain for components and quantum inertial sensors. This work will have relevance for commercial dual use applications for telecommunications components, Light Detection and Ranging (LIDAR), and quantum information processing.

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KEYWORDS: Lithium niobate; thin-film lithium niobate; wafer processing; optical modulation; non-linear optics; photonic integrated circuits

N251-073 TITLE: Robust Fiber-to-Photonic Integrated Circuits (PIC) Coupling for the Near-Infrared (NIR)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;Quantum Science;Space Technology

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 robust method of achieving efficient optical coupling between PICs and single mode optical fiber operating at NIR wavelengths relevant for quantum sensing (700 nm to 900 nm).

DESCRIPTION: Atomic accelerometers and clocks are important elements of advanced inertial navigation and timing systems. In recent years, there has been significant effort to reduce the size, weight, and power (SWaP) of various subsystems. For the laser subsystem in particular, this is typically anticipated to be accomplished by a transition from bulk optics to PICs [Ref 1].

One challenge of this transition is the efficient on- and off-coupling of light between PICs and off chip components such as laser sources and sensor elements such as vapor cells. Single-mode polarization-maintaining fiber provides a convenient mode of transferring light between subcomponents because it maintains optical mode quality and decouples the mechanical interface between subcomponents. It is also crucial in the testing and development of subcomponents, as it enables light to be coupled to external instruments for analysis and component testing.

Mature processes exist for robust fiber attachment at telecommunications wavelengths [Refs 2, 3]. These include grating coupling, prism coupling, and edge coupling into tapered waveguides. Active alignment techniques involving the attachment of one fiber at a time ensure coupling efficiency but at the expense of being labor intensive. Passive and multi-fiber alignment techniques may reduce labor at the expense of reduced coupling efficiency. While coupling losses on the order of 1 dB are achievable at telecom wavelengths, losses at wavelengths relevant for quantum sensing (700 nm to 900 nm) are typically less efficient. Quantum sensors often utilize high optical powers (up to 1 W), which impacts the robustness of fiber interconnects and demands greater efficiencies. The goal of this SBIR topic is to develop robust PIC to fiber connections that are labor efficient, optical power efficient, and robust to high power operation.

Target specifications for the desired process include:
• Optical power handling: Up to 1 W continuous wave
• Optical wavelength: 700 nm to 900 nm (any photonic architecture compatible with this range is acceptable for demonstration purposes)
• Fiber type: Single mode polarization maintaining
• Coupling loss: 1 dB

PHASE I: Perform a design and materials study to assess the feasibility of the proposed technology or process to meet the target specifications listed in the description. Prepare a final report that must include an assessment of:

• The SWaP implications of the proposed technique (particularly the size and density of fiber connections)
• A discussion of the technology's compatibility with PIC architectures
• The scalability of the approach and the labor involved in making fiber connections both for an envisioned production environment 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 a PIC-fiber attachments in Phase II.

PHASE II: Demonstrate the proposed fiber attachment technique and characterize its performance against the target goals listed in the Description. At the conclusion of Phase II, deliver five (5) representative photonic chips demonstrating fiber attachments on both the input and output of a waveguide.

PHASE III DUAL USE APPLICATIONS: Continue development to assist the Government in integrating the technology with other PIC components.

In addition to advancing a quantum sensing capability for military/strategic applications, this technology will improve the SWaP and lower the development cost of commercial photonic components that utilize wavelengths down to the visible spectrum, including, Light Detection and Ranging (LIDAR) systems, spectrometers, data communications, and quantum technologies.

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KEYWORDS: Photonic integrated circuit; PIC; optical fiber interconnect; silicon nitride photonics; optical fiber attachment; grating coupler; edge coupler