DEPARTMENT OF THE NAVY (DON)
23.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to topics:**
  - **N232-079 through N232-116**
- **The information provided in the DON Proposal Submission Instructions document takes precedence over the DoD Instructions posted for this Broad Agency Announcement (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.

Digital Engineering. DON desires the ability to design, integrate, and test naval products by using authoritative sources of system data, which enables the creation of virtual or digital models for learning and experimentation, to fully integrate and test actual systems or components of systems across disciplines to support lifecycle activities from concept through disposal. To achieve this, digital engineering innovations will be sought in topics with titles leading with DIGITAL ENGINEERING.

The Director of the DON SBIR/STTR Programs is Mr. Robert Smith. 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	Program Managers list in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic. Refer to the Proposal Fundamentals 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 Fundamentals 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	Navy 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
N232-079 to N232-082	Mr. Jeffrey Kent	Marine Corps Systems Command (MCSC)	sbir.admin@usmc.mil
N232-083 to N232-099	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil
N232-100 to N232-101	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N232-102 to N232-111	Ms. Lore-Anne Ponirakis	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil
N232-112 to N232-116	Mr. Michael Pyryt	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); 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. Please refer to the DoD SBIR/STTR Program BAA for further information.

Proposal Volumes. The following six 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 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 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. 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:
    - It is highly recommended that proposing small business concerns use the Phase I proposal template, specific to DON topics, at https://navysbir.com/links_forms.htm to meet Phase I Technical Volume (Volume 2) requirements.
    - 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)

- 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 Phase I Proposal 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.
  All proposing small business concerns must review and submit the following items, as applicable:
  - **Telecommunications Equipment Certification.** Required for all proposing small business concerns. The DoD must comply with Section 889(a)(1)(B) of the FY2019 National Defense Authorization Act (NDAA) and is working to reduce or eliminate contracts, or extending or renewing a contract with an entity that uses any equipment,

system, or service that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As such, all proposing small business concerns must include as a part of their submission a written certification in response to the clauses (DFAR clauses 252.204-7016, 252.204-7018, and subpart 204.21). The written certification can be found in Attachment 1 of the DoD SBIR/STTR Program BAA. This certification must be signed by the authorized company representative and is to be uploaded as a separate PDF file in Volume 5. Failure to submit the required certification as a part of the proposal submission process will be cause for rejection of the proposal submission without evaluation. Please refer to the instructions provided in the Phase I Proposal section of the DoD SBIR/STTR Program BAA.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries.** Each proposing small business concern is required to complete Attachment 2 of this BAA, "Disclosures of Foreign Affiliations or Relationships to Foreign Countries" and upload the form to Volume 5, Supporting Documents. Please refer to the following sections of the DoD SBIR/STTR Program BAA for details:
    - Program Description
    - Proposal Fundamentals
    - Phase I Proposal
    - Attachment 2
- **Certification Regarding Disclosure of Funding Sources.** Each proposing small business concern must comply with Section 223(a) of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021. The disclosure and certification must be made by completing Attachment 4, Disclosure of Funding Sources, and uploading to Volume 5, Supporting Documents. Please refer to the following sections of the DoD SBIR/STTR Program BAA for details:
    - Phase I Proposal
    - Attachment 4
- **Majority Ownership in Part.** Proposing small business concerns which 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 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
    - Do not include documents or information to substantiate the Technical Volume (Volume 2) (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 Phase I Proposal 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 Phase I Proposal 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 criteria 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 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.

- **Company Commercialization Report (CCR) (Volume 4).** The CCR (Volume 4) will not be evaluated by the Navy nor will it be considered in the Navy's 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.

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 Program Description section of the DoD SBIR/STTR Program BAA for details on how DoD will assess security risks presented by small business concerns.

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. The TABA amount, of up to $25,000, 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 $1,800,000 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 Office.

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

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

TABA must NOT:

- Be subject to any 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 NOT exceed:

- Phase I: A total of $6,500
- Phase II: A total of $25,000 per award, not to exceed $50,000 per Phase II project

If a proposing 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 DON SBIR/STTR 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 DON 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.

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 Proposal Fundamentals, 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. 2371/10 U.S.C. 2371b 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. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) 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 $1,800,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $1,800,000 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. The Phase I Final Report, Initial Phase II Proposal, and Transition Outbrief (as applicable) will be used to evaluate the small business concern's potential to progress to a workable prototype in Phase II and transition 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.

NOTE: All SBIR/STTR Phase II awards made on topics from BAAs prior to FY13 will be conducted in accordance with the procedures specified in those BAAs (for all DON topics, this means by invitation only).

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 DON 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 23.2 Topic Index

N232-100	Predictive Asset Rerouting and Inventory Availability for Tactical Intelligence, Surveillance, and Reconnaissance Platforms
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N232-115	Radiation Tolerant Fiber Optic Communication
N232-116	Direct Etched Silicon Wafer Bonding for Micro-Electromechanical Systems (MEMS).

N232-079 TITLE: Rapidly Deployable Assault Gap Crossing Systems

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

OBJECTIVE: Develop gap crossing solutions that are modular, scalable, ground and air transportable, compatible with aerial delivery techniques, deployable in a short timeframe without additional construction support equipment, and capable of supporting and being transported by light- and medium-weight combat and tactical vehicles, and unmanned ground vehicles.

DESCRIPTION: The intent of this SBIR topic is to develop hasty gap crossing solutions that are transportable and deployed by tactical vehicles.
The technology must meet Threshold requirements = (T)
It is highly desirable that the technology meets Objective requirements = (O)

1. Transported by Joint Light Tactical Vehicle (JLTV) and Medium Tactical Vehicle Replacement (MTVR) (T); unmanned ground vehicle (UGV) (O).
2. Deployed by JLTV and MTVR (T); UGV (O).
3. Span a 12 meter gap (T); 15 meter gap (O)
4. Military Load Class 40 ton (T); 60 ton (O)
5. Bridge width 12 feet/3.66 meters (T=O)
6. Wheel way widths 4 feet/1.2 meters (T=O)
7. Ability to deploy the bridge, vehicles cross the gap, and then retrieve from the far bank to continue the assault (T=O)
8. Time to deploy 15 minutes (T); 5 minutes (O)
9. Time to recover 15 minutes (T); 5 minutes (O)
10. Capable of being placed in an unprepared gap (T=O)
11. Capable of being assembled with common hand tools (T); No tools (O)
12. Capable of being assembled without heavy equipment (T=O)
13. Unit cost $350,000 (T); $125,000 (O)

PHASE I: Develop concepts for rapidly deployable assault gap crossing systems that meet the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps requirements. Establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Develop 1-2 prototype rapidly deployable assault gap crossing systems for evaluation to determine their capability in meeting the performance goals defined in the Description above. Demonstrate technology performance through prototype evaluation and modeling 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; and for evaluation to determine its effectiveness in an operationally relevant environment approved by the Government. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

Commercial applications may include, but not be limited to: disaster relief, homeland security, emergency services, and commercial construction.

REFERENCES:
1. "VIPER.". General Dynamics European Land Systems. https://www.gdels.com/mtb.php
2. Higgins, Rae. "Joint Assault Bridge aces Operational Test; fielding plans include all COMPOs." U.S. Army PEO Combat Support & Combat Service Support, December 11, 2020. https://www.army.mil/article/241689/joint_assault_bridge_aces_operational_test_fielding_plans_include_all_compos
3. "ATP 3-21.21 SBCT Infantry Battalion. Headquarters, Department of the Army, March 2016. https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp3_21x21.pdf

KEYWORDS: Bridge; bridging; gap; crossing; maneuver; mobility; transportable

N232-080 TITLE: Self-driving Convoy Operation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment;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 and demonstrate reliable autonomous convoy operations within narrow and confined spaces including negative obstacles such as roadside ditches.

DESCRIPTION: The Navy/Marine Corps Expeditionary Ship Interdiction System (NMESIS) provides a ground based anti-ship capability. The NMESIS utilizes an unmanned launcher based upon the Joint Light Tactical Vehicle (JLTV) chassis called the Remotely Operated Ground Unit Expeditionary Fires (ROGUE-Fires) carrier. ROGUE-Fires has several operational modes including a Leader-Follower mode which autonomously follows the path of the Leader Vehicle, which is a JLTV Heavy Gun Carrier equipped with the NMESIS Leader Kit. Leader-Follower convoy operations function well on wide roads but encounter difficulties on narrow roads, requiring switching to remote control operations. Remote control operation is designed for use at very slow speeds for parking and maintenance and are not suitable for convoy operations.

The current autonomy system relies on a combination of forward looking and backup cameras, RADAR, and LIDAR. The March Unit Leader (MUL) vehicle provides a video patch for the following ROGUE-Fires vehicles to follow. The MUL path is 18 feet wide, and the autonomy software keeps each ROGUE-Fires vehicle within the path. However, many secondary roads, dirt roads, and paths are much narrower than primary roads. This puts ROGUE-Fires vehicles in danger of leaving the road surface, possibly getting stuck in ditches, and hitting obstacles.

ROGUE-Fires utilizes sofrware derived from U.S. Army DEVCOM Ground Vehicle Systems Center (GVSC) Expeditionary Leader-Follower (ExLF). The Program Office does not have the authority to release this software.

This SBIR topic seeks to develop and demonstrate safe and reliable leader/follower convoy operations on secondary roads, trails, and paths narrower than 18 feet, ideally down to 8 feet. The command to utilize a narrower MUL path shall be user selectable by an operator in the Lead Vehicle. It is expected that operation under these conditions will be done at reduced speeds but still faster than having an operator tele-operate the ROGUE-Fires vehicles at walking speed. Demonstration utilizing RTK software is not required, but is acceptable. We anticipate having the software converted to the ROGUE-Fire Kernel in Phase II or Phase III. Adding additional sensors, such as additional cameras, LIDAR/RADAR, or SONAR is acceptable but cost and logistical burden will also be considered.

CLARIFICATIONS:

1. In the Description, there is discussion on how the ROGUE-Fires autonomy system functions. Currently for Leader/Follower, the Leader vehicle creates a MUL path map utilizing LIDAR

which is sent to the Follower vehicles. Use of the other sensors in addition to or in lieu of LIDAR is acceptable.

2. Methods for navigating in narrow and confined spaces in convoy operations do not need to rely on the current MUL Leader/Follower construct – meaning the Leader vehicle providing a map to the follower vehicle. Other methods which utilize the MUL method or operate without the Leader vehicle providing a map are acceptable.

PHASE I: Develop concepts for Autonomous Narrow and Confined Space Convoy Operations, detailing required sensors, transition between operating modes (path widths), fault tolerance, and failure modes. Concepts and Models will detail performance on various drive surfaces, weather conditions, on-road and roadside obstances including vegetation, and negative obstacles such as potholes and roadside ditches. System trade options, including sensor types, autonomous methods, and performance impacts will be completed.

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 and the Phase II development plan, develop a prototype system. 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 Autonomous Narrow and Confined Space Convoy Operations. Performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop the Autonomous Narrow and Confined Convoy Operations system for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.
The potential for commercial and dual-use is significant. Leader/follower convoy technology in tight quarters is directly applicable to airport cargo operations, warehousing, and future road transport, which would result in fuel and labor savings.

REFERENCES:

1. U.S. Army Combat Capabilities Development Command "Ground Vehicle Systems Center ROS-Military – ROS 2 Overview", 30 September 2020 https://rosmilitary.org/wp-content/uploads/2020/11/CoVeR-EET-2-ROS-2-Overview-Distr-A-OPSEC-4622-1.pdf
2. U.S. Army Tank Automotive Research, Development And Engineering Center "Introduction to Robotic Technology Kernel (RTK)", May 2018 https://www.gl-systems-technology.net/uploads/3/4/5/7/34572805/introduction_to_rtk_-_may2018_-_dista.pdf
3. ROS - Robotic Operating System (Open Source). documentation for ROS 1 and ROS 2 distributions https://ros.org/, https://docs.ros.org/

KEYWORDS: Autonomy; Self-driving; Convoy; Leader/Follower; Image Processing; Sensing

N232-081 TITLE: High Expandable Sticky and Incapacitating Foam

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

OBJECTIVE: Develop a non-toxic sticky foam material capable of expanding and sticking to targets to non-lethally entangle, restrain, and disable them.

DESCRIPTION: The Marine Corps through the Joint Intermediate Force Capabilities Office (JIFCO) is seeking to develop a sticky foam material that is capable of expanding and sticking to targets in order to non-lethally entangle, restrain, and disable them.

Relevant efforts were previously developed by the U.S. Government for security purposes to support the Department of Justice, the Department of Energy, and the Department of Defense. In the 1990s, the Marine Corp developed a sticky foam gun which was used in Operation United Shield to assist in the withdrawal of UN peacekeeping forces from Somalia.

The sticky foam material developed was safe to use, but also came with few drawbacks. It introduced ancillary risks to targets such as blocking breathing airways leading to suffocation and making it impossible to transport targeted individuals due to the intense stickiness of the foam. The JIFCO is seeking to eliminate those risks as well as increase effectiveness and usability of the sticky foam material. The JIFCO supports the Joint Forces across the Competition Continuum and presents Intermediate Force Capability (IFC) relevance for contemporary operations - including irregular warfare (IW). The sticky foam disabling technology will give users the ability to non-lethally entangle, restrain, disable, and detain targets.

This SBIR effort will provide aid to the military and law enforcement to block threats for physical security applications; and tools to compete below the level of armed conflict in gray-zone missions.
In comparison with the 1990s sticky foam efforts, this SBIR topic seeks to explore innovative and new approaches to developing a highly expandable sticky foam with the following characteristics:

- Able to be contained and stored in small packages (handheld)
- Expandable: Able to expand 100s of times of its stored contents when released into the atmosphere
- Harden when fully extended in 5-10 seconds
- Immediately stick to skin and clothing upon contact
- Sticky foam disperser/launcher device (ex. Grenade, Weapon)
- Dissolvable after use with immediate removal safety kit
- Open-cell and breathable foam end state to avoid suffocation risks
- Safe non-toxic material
- Adhere to Military Standards such as MIL-STD-810, a military test standard for environmental testing

PHASE I: Explore advanced materials and concepts for the expandable sticky foam. Demonstrate the feasibility of expandable foam material and the effectiveness of its disabling properties upon activating with the atmosphere. Determine the technical feasibility of the concept design and model key elements that can be developed into a useful product for the Marine Corps and the Joint Non-lethal Weapon Program (JNWP) through analytical modeling and simulation to provide initial assessments of the concept performance.

Phase I will not require human subject or animal subject testing.
Provide a Phase II development plan with performance goals and key technical milestones that addresses technical risk reduction and defines the development of a state-of-art Expansive sticky foam.

PHASE II: Develop sticky foam material and process for prototype testing based on the result of the Phase I performance goals as defined in Phase II development plan. Demonstrate system performance through prototype evaluation and modeling to include usability and environmental performance. Use evaluation results to refine the prototype into an initial design that will meet the Marine Corps requirements. Prepare a Phase III development plan to transition the technology for the Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the JIFCO/Marine Corps with test and validation to certify and qualify the technology to transition to the Marine Corps and the Joint Services. The advanced non-lethal technology developed under this SBIR topic would have direct application to the DoD IFC community in the joint services, civilian law enforcement, the Department of Justice, the Department of State, the Department of Energy, the Secret Service, and Customs and Border Protection.

REFERENCES:

1. Leimbach, Wendell. “The Commandant’s Guidance for the DoD Non-Lethal Weapons Program.” Marine Corps Gazette, May 2020. https://mca-marines.org/wp-content/uploads/The-Commandant%E2%80%99s-Guidance-for-the-DOD-Non-Lethal-Weapons-Program.pdf
2. Berger, David H. “Executive Agent’s Planning Guidance 2020 – Intermediate Force Capabilities – Bridging the Gap Between Presence and Lethality.” U.S. Department of Defense Non-Lethal Weapons Program, March 2020. https://mca-marines.org/wp-content/uploads/DoD-NLW-EA-Planning-Guidance-March-2020.pdf
3. “Sticky Foam.” Wikipedia. https://en.wikipedia.org/wiki/Sticky_foam

KEYWORDS: Sticky foam; non-lethal weapon, Intermediate Force Capability

N232-082 TITLE: Non-Destructive Delamination and Crack Detection Solution for USMC Hard Armor Plates

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 low cost, portable solution to detect cracks and delamination in Enhanced Small Arms Protective Insert (ESAPI) and Lightweight Plate (LWP) hard armor plate systems.

DESCRIPTION: Currently the USMC fields two different body armor protective plate solutions. Both body armor plate systems are comprised of a polyethylene backer (made of several consolidated layers of polyethylene material) and a ceramic strikeface. The specific material makeup and the number of polyethylene layers provide the ballistic and fragmentation protective properties of the body armor plates. There are generally two primary defect modes that can take a plate out of service by significantly reducing its protection capabilities; cracking of the ceramic layer and or delamination within the polyethylene layers or between the polyethylene backer and ceramic interface. It is imperative to Marine safety to ensure the plates do not contain either defect before issuing the plate for use. Currently the USMC checks the hard armor plates on a regular basis before and after Marines use the plate in a combat or training environment. Cracking of the ceramic layer is detected using an x-ray machine while delamination is detected through a manual tap test. The tap test is performed by tapping the back face of the armor plate with a metal rod. If a plate is in good condition, the noise reflected off of the plate sounds like a chime, however a delaminated plate produces a thud sound. While the sound difference in the legacy USMC plate is audibly distinctly different between a delaminated and non-delaminated plate, the newest plate fielded by the USMC does not produce an easily identifiable sound difference between good and bad plate conditions. Another alternative to detecting both cracks and delamination is to CT scan the hard armor plates. This method is extremely expensive and requires highly trained personnel. For these reasons, the USMC seeks to fund an SBIR effort that produces a solution to regularly survey both legacy and new USMC hard armor for cracks and delamination defects. The desired prototype should represent a solution that is low cost and easy to operate such that any person without any special skills could be quickly trained. The solution should allow operators to perform plate surveillance at a throughput rate of 2-5 plates/minute. If possible, the solution should also be portable.

In summary, the crack and delamination detection system should be easy to use and understand, and accurately identify whether a hard armor plate contains a crack or delamination defect. The solution will identify the type of defect and notify operators of the plate’s status (cracked vs. delaminated). The solution will also inform the operator if the plate is without defects. The solution shall not be a technology that becomes affixed to a plate.

PHASE I: Develop concepts for a non-destructive crack and delamination detection solution for USMC hard armor plates. Demonstrate and evaluate their technical feasibility. Generate a prototype to demonstrate accurate defect detection; 70-80% accurate with a plan to improve/optimize.

PHASE II: Optimize the prototype for accuracy (90% accurate with a 90% confidence level) and to include an easy-to-use user interface based on USMC feedback and data collected on hard armor plates. Demonstrate the ability to replicate the solution for a total of at least 12 detection systems.

PHASE III DUAL USE APPLICATIONS: Two systems would go to each of the six USMC gear issuing facilities across the world. Personnel at the issuing facilities who are responsible for monitoring hard armor before re-issuing the gear to Marines would use the products to test each hard armor plate for defects.

Presently, law enforcement does not monitor hard armor plates in the same way the military does. Instead, law enforcement bases the serviceability of a plate based on its recommended shelf life. If a relatively low-cost solution was created to detect cracks and delamination, law enforcement including SWAT teams (or others that employ hard armor solutions) may be interested in re-evaluating their plate surveillance methods.

REFERENCES:

1. Product Management Infantry Combat Equipment (PdM ICE). “Marine Corps Tap and Torque Tests for ESAPI plates.” Youtube, https://youtu.be/31dO_Xyj5ik
2. Testing of Body Armor Materials Phase III (2012) https://nap.nationalacademies.org/catalog/13390/testing-of-body-armor-materials-phase-iii
3. Defect Classification Tables https://navysbir.com/n23_2/N232-082-Reference_Defect.pdf
4. Table with legacy ESAPI LWP dimensions and weights - https://navysbir.com/n23_2/N232-082-Reference_Legacy_ESAPI_LWP.pdf

KEYWORDS: Armor; body amor; delamination; ceramic; cracks; non-destructive; Enhanced Small Arms Protective Insert, ESAPI; materials; Lightweight Plate; LWP

N232-083 TITLE: Helicopter Seat-Integrated Power Assist Device

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

OBJECTIVE: Develop a seat-integrated power assist device that reduces low back pain and improves aircrew endurance by effectively reducing the weight of torso-mounted Personal Safety Equipment (PSE).

DESCRIPTION: The musculoskeletal burden of prolonged and repeated exposure to torso-mounted PSE has been tied to an increase in the number of complaints of fatigue and chronic low back pain among helicopter pilots. One survey of 648 Navy H-60 helicopter pilots indicated that 88.1% had experienced back and/or neck pain during or immediately after flight [Ref 1]. Fatigue and chronic back pain lead to a reduction in pilot availability, reduced operational readiness and effectiveness, shortened careers, and increased medical costs over the career and life of the aviator.

Although helicopter pilots' fatigue and low back pain are most likely attributable to several factors that include PSE weight, poor posture, seating ergonomics, vibration of the aircraft during flight, and total number of flight hours, the weight of torso-mounted PSE is considered a leading contributor to naval and military aviators' fatigue and low back pain.

This SBIR effort will be focused on the development and integration of technologies that will substantially reduce (> 70%) the effective weight of PSE. Technologies and design concepts will focus on reducing the frequency and severity of fatigue and back pain among naval aviators that must wear up to 45 lb (20.41 kg) of PSE during their flights. The main goal of the resulting technology is to protect the musculoskeletal health of naval aviators, increase their mission endurance, and to reduce the incidence of low back injuries.

Given that the H-60 type, model, series (TMS) platform is widely used across multiple services (Navy, Army, Air Force, and Special Operations Command), the program plan for this effort calls for the use of the H-60 TMS as the testbed for flight demonstration of the system. The burden of torso-mounted PPE is not unique to the H-60 platform; technology borne out of this effort is expected to be portable to other rotary-wing platforms and fixed-wing non-ejection aircraft seating systems.

It is intended that the system will:

(a) be compatible with aviator/operator body-borne mission equipment and vests,
(b) not cause a substantial increase in weight of the seating system,
(c) be retro-fittable into the H-60 pilot seat and airframe without aircraft modifications,
(d) avoid diminishment of crash performance and occupant protection of the baseline seat,

and avoid:

(a) increasing muscle activity in the torso,
(b) increasing energy expenditure (metabolic cost),
(c) reducing range of motion,
(d) impeding motion,
(e) increasing discomfort due to localized contact pressure,
(f) reducing task performance,
(g) inhibiting emergency egress, and
(h) creating abnormal spinal loading.

The goal of this effort is to develop and qualify an assistive device that reduces the load of PSE borne by military pilots. Successful completion of the work tasks outlined for each phase is designed to incrementally and iteratively build toward a qualified system.

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 and develop concepts that allow for integration of the Power Assist Device (PAD) into the SH-60S seating system and component level testing to assess the feasibility and utility of the PAD system. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype PAD system based on the results of Phase I and integrate into the SH-60S seat with minimal modifications to the pilot seat. Perform laboratory testing to demonstrate prototype is capable of off-loading the weight of PSE onto the pilot seat by at least 70% without increasing muscle activity in the torso, without creating or increasing any other adverse physiological condition, and without reducing the occupant's range of motion. Develop plans and obtain approval for human-in-the-loop testing that will be conducted during the Phase II option period.

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

PHASE III DUAL USE APPLICATIONS: Further refine the PAD system design based on human testing, install on host helicopter and conduct flight testing to demonstrate PAD integrated seat can meet Navy requirements. The U.S. Government intends to conduct a wide range of testing to certify that the performance of this system warrants use onboard Navy aircraft. Broadly, the Government intends to conduct the following system levels tests in order to qualify the PAD: (a) system performance testing, (b) user acceptance testing, (c) service life characterization testing, (d) environmental exposure testing, and (e) flight demonstration testing.

As the system is designed to reduce effective torso-borne weight, services with heavy PSE will realize the greatest benefit; commercial operators with minimal body-borne equipment will have a reduced benefit from the system.

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4. Healing, R. F., & Hamon, K. (2014, May 20–22). Eliminating avoidable helicopter seating-related injuries to improve combat readiness and mission effectiveness [Paper presentation]. American Helicopter Society International 70th Annual Forum, Quebec, Canada. https://vtol.org/store/product/eliminating-avoidable-helicopter-seatingrelated-injuries-to-improve-combat-readiness-and-mission-effectiveness-9482.cfm-injuries-to-improve-combat-readiness-and-mission-effectiveness-9482.cfm

KEYWORDS: Pilot Back Pain; helicopter seats, endurance; aircrew; Personal Survival Equipment; PSE; torso-mounted equipment

N232-084 TITLE: Modeling and Simulation of Supersonic Turbulent Combustors for Application in Hypersonic Weapon Systems

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

OBJECTIVE: Develop and improve modeling and simulation tools for predicting the performance of air-breathing propulsion systems within Navy-relevant hypersonic weapons systems.

DESCRIPTION: Future naval weapon systems operating in hypersonic flight regimes (freestream Mach numbers between Mach 5 and Mach 10) likely will employ propulsion systems that utilize mixing and combustion in supersonic flows (e.g., scramjet engines).

Current design methods rely on low-order models, either empirical or from first principles, that don't account for the complex physics that occur within a hypersonic air-breathing propulsion system (i.e., inlet, isolator, combustor, and nozzle). These methods typically lack the ability to predict scramjet engine unstart, a complex physical phenomenon where the shock train is expelled from the inlet/isolator and flow through the engine becomes fully subsonic, resulting in a significant loss of thrust, vehicle performance, and maneuverability.

High-fidelity multi-physics computational fluid dynamics tools (CFD) can, in principle, better predict the complex physical mechanisms involved in scramjet unstart. However, further advancement of transient, physics-based CFD tools (e.g., reactive Large Eddy Simulation) is required to accurately predict combustion in supersonic flow within complex geometries. Improvements to multi-physics sub-grid scale models for supersonic turbulent mixing, combustion, and chemical kinetics are required. Furthermore, for realistic Navy-relevant geometries (e.g., 3D-streamline traced inlets, cavity flameholders), near-wall resolution typically suffers, and the use of wall-modeling is required. Wall-modeling improvements need to incorporate additional physics, including large thermal gradients, improved models for turbulent heat flux, near-wall boundary layer flames and near-wall combustion. Incorporation of relevant physics for advanced hydrocarbon fuels (JP-5, JP-10, and RP-2) at supercritical/transcritical regimes is also important.

Improved modeling and simulation tools are desired for predicting with confidence transient, three-dimensional, multi-phase, supersonic mixing, and combustion-within-hypersonic propulsion systems. High-performance computing and high-fidelity modeling should be leveraged to assess the mechanisms that affect scramjet engine operability and lead to unstart.

Furthermore, increased understanding of the mechanisms that lead to unstart should drive the development of reduced-order models (either from first principles or high-fidelity multi-physics models). These models are desired to quickly and accurately predict engine operability and unstart in different flight regimes to be able to impact a typical design cycle.

PHASE I: Design and develop initial improvements to high-fidelity models and surrogate/reduced order models to predict scramjet engine unstart and demonstrate feasibility. Describe the highest anticipated risks with developing the tools and potential risk mitigations. Efforts should focus on robust, parallel, highly efficient software improvements that can be utilized for complex, realistic geometries. Identify canonical scramjet design and vehicle geometry to be used in Phase II for analysis and validation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Using the results from Phase I, develop high-fidelity, multi-physics computational fluid dynamics tool for predicting engine performance and unstart within scramjet propulsion systems. Apply the developed tool sets to a canonical, Navy-relevant hypersonic vehicle geometry in order to validate physical models and build confidence in predictive capability. Combustion methodologies should focus on Navy-specific fuels (e.g., JP-5, JP-10, and RP-2). Deliver prototype software tools on high-performance computing hardware, and document the theory, assumptions, and instructions. Demonstrate the capability to use high-fidelity models to develop surrogate/reduced-order models to quickly and accurately predict engine unstart and operability envelopes within a typical design cycle (e.g., 1–2 weeks) using modest hardware.

PHASE III DUAL USE APPLICATIONS: Transition the developed tool and capability to the Government for implementation on fleet aircraft. Modify the methodology and tools based on feedback from use within a DoD acquisition program. Support the application of advanced, mature, multi-physics design tools on inlet and engine performance in a hypersonic propulsion system.

Commercial aviation engines presently operate subsonic with standard combustors within the gas turbine engine. While vastly different aerodynamically, advanced higher fidelity methods and tools developed under this topic could be applied to other flow regimes. Chemical kinetics, combustion models, and reduced order methods could be applied to typical aircraft engine and combustor design processes.

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KEYWORDS: Hypersonics; Computational-Fluid Dynamics; Multi-physics; Scramjet; Reduced-Order Model; Engine Unstart

N232-085 TITLE: Autonomous Precision Landing onto Non-Cooperative Targets

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems;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 modular system that enables a vertical takeoff and landing (VTOL) aircraft to precisely and repeatedly land on a small non-cooperative target, then take off again.

DESCRIPTION: Autonomous landing systems have become common in both manned and unmanned aviation. Uses span from commercial airliners to small drones. Most of these systems are GPS-based, which enables autonomous landing to an approximate location, but lacks the accuracy to enable autonomous landing in a very small or confined space, such as the deck of a boat. To enable high-precision autonomous landing, systems have been developed using additional sensors, including RTK-GPS, radar, acoustic, ultra-wideband (UWB), and vision. However, these precision landing systems require sensors and/or optical targets to be placed on the landing target prior to landing. This prevents their use with “non-cooperative targets (NCTs)”, such as the roof of a building or an enemy vessel, that are not accessible prior to the initial landing. This approach would also have applicability to EMCON conditions on current assets.

This SBIR topic seeks to develop a non-cooperative target landing system (NCTLS) to enable VTOL aircraft (manned or unmanned) to autonomously land on and take off from a small area or NCT, without a pilot providing control inputs. The NCTLS should enable the following pilot workflow:

1. The pilot designates an NCT landing site using satellite imagery or data from an aircraft-mounted sensor.
2. The NCTLS tracks the landing site in real time and generates aircraft control inputs to guide the aircraft safely onto the NCT, without any operator input.
3. The pilot may later decide to launch from the NCT; during launch, the NCTLS should track the landing site during takeoff and generate aircraft control inputs to guide the aircraft straight up relative to the NCT.

It may be assumed that the general location of the NCT is known, and that the NCT is large enough to accommodate the small unmanned aircraft system (sUAS). Landing accuracy should be less than 50% of the largest aircraft dimension (e.g., landing error for a 1000 mm diameter quadcopter drone should be less than 500 mm).

The NCTLS should be modular and adaptable to a range of VTOL aircraft. It is desirable for the NCTLS system to operate with sensor data from pre-existing sensors already on board most aircraft (e.g., GPS, IMU, imagers), however, additional sensors and computers may be added to the aircraft to enable the system. Overall size, weight, and power (SWaP) requirements of the system should be minimized. Control output signals from the NCTLS should be provided in a generalized format such as velocity or acceleration commands. The NCTLS should not interfere with other aircraft subsystems.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop technology that enables autonomous landing of a VTOL aircraft on an NCT, as described above. Provide a detailed description of the system architecture and necessary input and output interfaces to integrate into a small drone. Identify key components necessary for operation. Build a prototype NCTLS and demonstrate the prototype operating in a relevant environment, landing on a stationary NCT. Identify limits of operating conditions, such as NCT environmental conditions, weather, aircraft dynamics, and sensor requirements. Develop a Phase II implementation plan. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Build, test, and validate a complete NCTLS prototype that successfully lands a VTOL aircraft on a moving NCT such as a vehicle or vessel at sea. Demonstrate the prototype system in relevant operational environments. Demonstrate portability of the system to different VTOL aircraft. Produce and deliver a final technical data package that includes system and subcomponent specifications, interface descriptions and definitions, and operating instructions for the prototype. Prepare for transition to deployment.

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

PHASE III DUAL USE APPLICATIONS: Complete final testing, and perform necessary integration and transition for use in landing/take-off operations with appropriate existing platforms and agencies, and future combat systems under development.

Commercially this product could be used to enable remote delivery/pickup of various payloads to unattended locations, surveillance/interdiction operations, and in search and rescue (SAR) operations.

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KEYWORDS: Artificial intelligence/machine learning; AI/ML; surveillance; autonomous landing; non-cooperative; sensors; unmanned systems

N232-086 TITLE: Novel Multifunctional Materials and Lightweight Structures for Improved Small Unmanned Aerial Vehicle (UAV) Mission Capability

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

OBJECTIVE: Develop novel integrated multifunctional materials and lightweight structures to increase performance of small, unmanned aerial vehicles (UAVs).

DESCRIPTION: UAVs play an increasingly important role on the modern battlefield. Computing hardware and mass manufacturing have made camera-equipped, man-portable UAVs readily available. In order to maintain a technical advantage and increase mission capabilities, the state of the art in small UAV design and operation must be advanced by the use of novel materials and structural concepts. UAV performance could be improved by consolidating functions through the use of multifunctional materials, or novel lightweight materials. Multifunctional materials are any material or structure that integrates two or more previously separate functions. Some examples include sensors, circuitry, antennas, batteries, fluid conduits, or actuators that are embedded within, comprised of, or make up structural members [Refs 1–4]. Lightweight materials are those that advance the state of the art by making use of novel lightweight/high-strength materials and manufacturing technologies, to ensure the final part meets or improves design performance requirements and service life. Some examples include novel applications of additive manufacturing, aerogels, graphene, carbon nanotubes, or other technologies to reduce aircraft weight while maintaining structural integrity.

Proposed concepts should seek to advance the state of the art of the design and construction of Group 1–3 UAVs. New materials, technologies, or methods shall utilize novel multifunctional or lightweight/high strength materials and structural components to enable UAV designs with improvements in weight, range, and/or time on station as compared to those constructed from conventional materials.

Proposed concepts should:
Introduce new technologies, materials, or methods, which advance the state-of-the-art of UAV design through the use of multifunctional or novel lightweight materials.
Avoid areas that have already been well-explored (e.g., using topology optimization to design single-function structure) without adding significant novel value.
Be readily applicable to aircraft structural components.
For multifunctional materials, present the expected net weight savings vs using commercially-available, single-function alternatives.

For novel lightweight/high-strength materials, present comparison of the expected specific strength as compared to conventional metals/composites for aircraft structural components.
Present analysis of the ease/feasibility of manufacturing of the concept.

PHASE I: Demonstrate the proposed concept through laboratory bench testing and/or coupon testing, as appropriate. Develop material properties, based on proposed concept, for use in commercial finite element analysis tools such as ANSYS, ABAQUS, and so forth. Demonstrate the feasibility of the proposed concept by developing models to predict material behavior and model all intended functions of the concept (i.e., for multifunctional materials all intended material functions should be modelled). The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Expand on Phase I work to refine and further develop the original concept by creating and evaluating prototype parts or structures. Produce, in a production-relevant environment, a representative full-scale prototype part or structure and demonstrate its performance in a simulated or realistic environment. Identify and evaluate risks, roadblocks, and challenges of full-rate production. Specific target parts for weight reduction are to be provided as appropriate during this phase.

PHASE III DUAL USE APPLICATIONS: Validate and demonstrate an aircraft-ready part as provided in Phase II. Develop solutions to the risks, roadblocks, and challenges of full-rate production as discovered in Phase II. Commercial demand for small UAVs is increasing as the technology becomes more mature. Industries such as farming, land management, and last-mile delivery are exploring or already using systems comparable to Group 1–3 UAVs. Materials or methods developed as part of this SBIR will have direct private sector commercial potential, as they would serve to increase the overall efficiency and capability of such systems.

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KEYWORDS: Unmanned Aerial Vehicle; UAV; Multifunctional; Material; Structure; Lightweight; Optimization

N232-087 TITLE: Novel Oil Quantity Sensor for Aerospace Applications

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

OBJECTIVE: Design and develop an oil quantity sensor capable of measuring and assessing oil quantity, volume, and/or level of aircraft propulsion and power lubrication systems independent of oil reservoir size/form/shape of reservoir during all flight conditions. The sensor should consider aerospace requirements of low power, weight, and size and be compatible with military (MIL) and Department of Defense (DoD) Lubricant Specifications.

DESCRIPTION: The Navy requires an oil quantity sensor that greatly improves the method for identifying the oil volume within an oil tank or gearbox. Currently, oil level sensors can only accurately measure during straight and level flight and have limited sensing range, which can contribute to incorrect oil servicing and subsequent maintenance or safety events. The current sensor design is incapable of resolving oil quantities oil levels near maximum (~88%) or minimum (~23%) reservoir capacity, resulting in maintainer confusion and improper oil servicing that can lead to damaged hardware or in-flight emergencies. Current sensors are cylindrical in shape and the technology is capacitance based. The sensor developed under this SBIR topic should consider aerospace requirements of low power (less than 10 W at 5 V Alternating Current), weight of less than 2 lb (.907 kg), and size that must fit in the 23 in. x 3 in. x 3 in. (58.42 cm x 7.62 cm x 7.62 cm) envelope including power supply provisions. The sensor must operate in temperatures between -40 °F (-40 °C) and 450 °F (232.22 °C) and be compatible with MIL and DoD Lubricant Specifications. It should be capable of measuring the quantity of oil during any flight maneuver and be able to measure to the minimum and maximum capacities of the tank, regardless of tank geometry to an accuracy at least +/- 3.5 % full scale at a sample rate of at least 5 samples/sec. The sensor can mount internal or external to the tank or gearbox housing, depending on the technology. The application can vary from fixed-wing gearbox oil tanks or rotorcraft splash-lubricated gearboxes. Oil quantity will be the main function of the sensor, but added capabilities such as debris monitoring, cavitation detection, oil TAN, foreign fluids, and so forth are desirable but proposed design total weight should not exceed 2 lbs. Oil temperature monitoring may also be required to account for thermal expansion and/or oil viscosity effects. Oil temperature monitoring capabilities should roll up to the complete sensor accuracy and sample rate requirements specified herein.

CLARIFICATIONS:

- Power requirements:
  - Current: “less than 100 W at 5 V Alternating Current”
  - Recommended: “less than 10 W at 10 V Direct Current”
- Temperature requirements:
  - Current: “The sensor must operate in temperatures between -40 degF…and 450 degF…”
  - Recommended: “All sensor components exposed to oil must operate in temperatures between -40°F (-40°C) and 450°F (232.22°C) and be compatible with MIL and DoD Lubricant. If there are limitations to sensor equipment that cannot operate in this environment, an upper/lower temperature limit for this hardware should be specified.”

The original/current verbiage for power requirements was considered the best guess at the time, but we have since found updated specification requirements for this hardware and we would like to make the update to the solicitation. I don’t believe this change will fundamentally change the technical approaches of the proposals.

The temperature requirements change reflects a better understanding of the operating environment for this hardware based on data received today (5/5/23) that was not available at the time of the original topic draft.

PHASE I: Design an initial concept for an oil quantity sensor architecture and develop a breadboard prototype. Demonstrate feasibility to accurately measure oil quantity and volume and describe how the technology can be applied to aerospace applications. Technology risks identified through Phase I, to include system weight, should be detailed with applicable mitigations. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Using the results from Phase I, design and build a functional prototype capable of demonstration under various simulated flight conditions, (e.g., altitude changes, representative temperature and pressure changes, etc.) with MIL and/or DoD Specification lubricants. The demonstration can use an oil tank 320–640 oz (9.46–18.93 L) in size or a splash lubricated gearbox, and should include challenging geometric features that simulate those seen with currently fielded oil tanks. The effort should focus on the accuracy, reliability, and integration of the sensor into an existing aircraft lubrication system application. Risks identified in Phase I and Phase II should continue to be tracked with mitigations identified. The size, weight, and power requirements should be detailed along with expected end item cost and any opportunities for improvements in these areas.

PHASE III DUAL USE APPLICATIONS: Install a ruggedized and calibrated prototype oil quantity sensor on a flight test aircraft and identify any hardware limitations. A cost analysis for production hardware should also be developed and presented as part of the Phase III report.
Low cost, small form-factor oil quantity measurement sensors are applicable to many commercial and military applications. This technology is applicable to oil tanks in both fixed-wing and rotorcraft applications in the commercial and military space. This development of technology under the aggressive requirements of this SBIR topic will de-risk future commercial applications that are likely to have less demanding requirements. Specific nonaviation applications may include determining quantity of hazardous and/or corrosive fluids.

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KEYWORDS: Oil; Quantity; Volume; Tank; Reservoir; Fluid

N232-088 TITLE: Multimode IR/RF Surrogate Seeker

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: Design, develop, and demonstrate a prototype multimode seeker operating as a passive RF (Radio Frequency) and passive IR (Infrared) seeker for evaluating aircraft and countermeasure performance.

DESCRIPTION: The U.S. Navy routinely evaluates the ability of sensors to acquire and track aircraft platforms and countermeasures. IR seekers have long been the preferred method of homing in the short-range class of weapons, while RF has remained the preferred method for medium-to- long-range weapons. Dual-mode guidance, a guidance structure using both IR and RF employed across these ranges, offer improved resistance to countermeasures and counter-measuring tactics.
Passive techniques are of particular interest for homing weapons systems because of the difficulty a targeted platform has in detecting and reacting to the weapon. Traditionally missile seekers have only operated in either the RF or IR domains and on separate platforms. Each has strengths and weaknesses. While RF has superior range because IR is attenuated by the atmosphere, IR has superior angular resolution because of its shorter wavelength. This SBIR topic seeks to develop a prototype, dual-mode surrogate seeker, having both a passive RF sensor and a passive imaging IR sensor, for field test evaluation purposes. The RF sensor should operate in either the Ka or Ku band, while the IR imager should operate in the mid-wave IR (MWIR) band:

(a) Ka band: 26.5–40 GHz,
(b) Ku band: 12–18 GHz, and
(c) MWIR: 3–5 µm.

Passive RF is a class of radar that detects and tracks a target based on the target's own emissions, such as communications and Identification Friend or Foe (IFF) or reflections from non-cooperative sources such as commercial broadcast and communication signals. Both types of signals are of interest for a passive RF homing weapon. A target's own emissions are a fingerprint or unique discriminator between air platforms such as a Navy E-2 Hawkeye and a Marine MV-22 that a weapon system can identify using a database lookup table. In this way, a weapons system launched from a great distance can identify the correct target. Reflective signal in combination with emissions are important as well, providing geolocation information. Many different IR imaging algorithms exist and employ five general methods or combination of methods which are, region-based, model-based, feature-based, filtering-based, and active contour-based. The most common tracking schemes used in weapons systems combine feature and filtering methods. The feature method extracts key features from the initial frame such as an edge or a corner, while filtering establishes a target's condition from one frame to the next, such as position, speed, rotation or scale. The other methods require some a priori knowledge of the target and become more cumbersome because of the many approach angles of a targeted platform.

The two sensors provide a powerful combination that allows for target identification and geolocation, leveraging the best information each sensor.

Tracking algorithms should include schemes such as:

(a) tracking using only one sensor (either RF or IR) providing the best information,

(b) cooperative tracking, using information from both IR and the RF channels to improve target geolocation,

(c) clutter rejection: a hardened track using both IR and RF information to identify a target in a cluttered environment, and

(d) the ability to differentiate between two emitting targets.

While this topic does call for sensors operating in specific bands, the overall architecture should be open, with the end prototype having the ability to swap-in and out or add additional sensors.
Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design a concept for a dual-mode surrogate seeker having both a passive RF sensor and an imaging IR sensor and demonstrate feasibility. Design concept should include required hardware, database/look up tables and types of tracking algorithms. Identifying risk and the mitigation of those risks are key. Additionally, Phase I must include limited lab testing and demonstrations of technologies to determine the most appropriate components and methods for implementing the system. The final deliverable will be a white paper on the design of the surrogate. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Using the results from Phase I, develop and demonstrate a prototype dual mode surrogate seeker, including writing the required software algorithms to bring information of the two sensors together in a viable track. Phase II will require testing of the system during field test trials to allow the identification of shortfalls, and areas for improvement. A final demonstration of the prototype system will be done at an open test range with aircraft.
Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Further refine the system design and algorithms, and incorporate additional sensors operating across the EM spectrum. Work with the Navy to transition the technology into a weapon system.

Passive RF is a developing technique for tracking aircraft without the requirement of an RF emitter. This technology is applicable in both the civilian and military aerospace industry. For the civilian, passive RF offers a relatively low-cost method of air traffic awareness, while on the military side it is of particular interest in tracking targets covertly, with the ability to identify a platform with its capabilities. With respect to developed algorithms, the fusion of sensor data and applications in machine learning have the promise of increasing accuracy in self-driving vehicles, manufacturing processes, and improve decision-making processes.

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KEYWORDS: Radio Frequency; Infrared; Tracking Algorithm; Dual-Mode Seeker; Passive Tracking; Multi-sensor tracking

N232-089 TITLE: Naval Aircrew Life Preserver Unit Automatic Inflation Device for Ejection Seat Equipped Aircraft

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

OBJECTIVE: Design and develop an innovative and affordable life preserver inflation assembly compatible with the LPU-23D/P and LPU-36A/P product lines that reduces the volume and weight, improves logistical issues of Cartridge Activated Devices (CADs), batteries, and valves, and reduces the pull force for manual inflation.

DESCRIPTION: The current Life Preserver Units (LPU) for Fixed-Wing Ejection Seat Aircraft are equipped with FLU-8B/P automatic inflation assemblies that initiate inflation automatically upon sensing water immersion. The current FLU-8B/P assembly weighs approximately 150 g without batteries or CO2 cylinder. The assembly components include a power source, CAD, water immersion sensor, compressed CO2 cylinder mount, manual inflation capability, bladder connection mount, and CO2 cylinder piercing assemblies.

The FLU-8 and its many variants are capable automatic inflator devices with a remarkable history. The original units were designed in the late 1970s and deployed in the early 1980s. Technology is now several generations ahead of the legacy FLU-8 design, making it a prime candidate for review.
A USN/USMC internal logistical constraint on the MW-14 6V alkaline batteries used to power the FLU-8B/P is that procurement control of the battery resides with Naval Sea Systems Command (NAVSEA) instead of Naval Air Systems Command (NAVAIR). Currently, the MW-14 is procured from manufacturers in a cyclic nature instead of steady state. This cyclic procurement causes a push-pull effect in the logistics chain where the end user either has too many batteries or not enough. A new commercially available power source would change logistical control and open additional procurement availability to fleet maintainers.

Proposals must describe a capability that would auto-activate LPU inflation when immersed in water. Innovative solutions should:

(a) use Berry Amendment-compliant materials and manufacturing techniques,
(b) retrofit into LPU-23D/P and LPU-36A/P product lines,
(c) reduce size and weight from current FLU-8B/P design,
(d) fully inflate within 30 s,
(e) include both automatic (primary) and manual (secondary) inflation capabilities,
(f) include an omni-directional pull for manual inflation that results in reduced pull force (objective: 15 lbf (6.8 kg) (±5 lbf [2.27 kg]),
(g) operate in brine water/freshwater/saltwater,
(h) operate in turbulent or calm water conditions,
(i) operate at a submerged depth of less than or equal to 30 ft (9.14 m),
(j) operate in cold water (32 °F [0 °C]) in brine/fresh/saltwater,
(k) operate in chlorinated swimming pool water,
(l) operate reliably in cold and hot ambient air -65–160 °F (-53.89 to 71.11 °C),
(m) operate after exposure to temperature extremes from -65–160 °F (-53.89 to 71.11 °C), mold, mildew, flame, and salt fog.
(n) Does not create hazards (injury, Foreign Object Debris (FOD), snag/trip, static discharge) in any mission or survival operations,
(o) operate after exposure to 600-knot windblast,
(p) operate after repeated exposure to altitudes of up to 70,000 ft (21.34 kg) (0.65 psi),
(q) operate after exposure to typical fixed-wing ejection seat aircraft vibration levels (frequency range of 5 Hz-2000 Hz),

(r) provide resistance to environmental contaminants (i.e., sand, petroleum, oil, lubricants, and solar radiation),
(s) not interfere with survival vest or mounted gear, armor/armor release, seat harnesses, helmets or head mounted gear,
(t) not impede water survival or land survival procedures, including raft boarding and hoisting,
(u) not contribute to wearer's burn injury hazard,
(v) not give away wearer's position in covert day or night operations,
(w) be capable of operating after 15 months in a packed state (360-day inspection cycle plus 90 day shelf life) while exposed to temperature ranges of -65 to 160°F (-53.89 to 71.11 °C),
(x) have an obvious visual indication for correct rigging, and
(y) have an obvious visual indication for Built-in Test (BIT).

The logic, data acquisition and flow, algorithm development, and the means to implement/package it with the current fixed-wing ejection seat LPU system will be key portions of the effort and will determine probability of success. It is not required, but highly recommended that performers interact with qualified naval LPU manufacturers as needed.
Note: NAVAIR will provide Phase I awardees with the appropriate guidance required for human research protocols 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 human testing work will not be authorized until approval has been obtained, typically as an Option to be exercised during Phase II.

PHASE I: Develop, design, and demonstrate the feasibility of a new and innovative automatic inflation device for retrofit and operation in an LPU-23 and LPU-36 series LPU assembly. The proposed solution must demonstrate the potential for auto-activation/inflation for aircrew who have egressed a fixed-wing ejection seat aircraft into the water. Resulting concepts should include the following: dry weight, bulk/profile, required pull force for manual inflation, time for full inflation of the LPU while immersed in a swimming pool, human operated reliability, and maintainer mean time to rig, inspect, and certify "safe-for-flight". Provide experimental work that shows the technology concept will rapidly inflate the LPU in water without user input. The Phase I effort will include prototype plans to be developed under Phase II.
Note: Please refer to the statement included in the Description Section above regarding human research protocol for Phase II.

PHASE II: Develop, demonstrate, and validate an automatic inflation device prototype based on the design concept in Phase I. Device operation and capabilities demonstrations can be conducted in a laboratory environment, with the exception of water pool activation inflations. Upon prototype delivery, a Government demonstration will be performed using Navy personnel representing the 5th percentile female and 95th percentile male human subject controlled immersions, in compliance with the requirements provided in Phase I. Provide draft engineering drawings and develop life-cycle costs and supportability estimates.

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

PHASE III DUAL USE APPLICATIONS: Finalize the developed automatic inflation device technology and provide a technical data package including a performance specification, an interface control document, and engineering drawings in accordance with military standards. Develop and assist with required qualification testing and training. Finalize all testing. Document the quality assurance test program in accordance with industry best practices. Transition the technology to the fleet as a retrofit, and new procurements as required.

This SBIR topic may benefit the private sector in recreational inflatable products for which automatic inflation are desirable or required for safety Commercial Air and Sea Safety.

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KEYWORDS: Life Preserver Unit (LPU); Auto-Inflation; Water Survival; Emergency Egress; Flotation; Aviation Life Support Systems

N232-090 TITLE: Advanced, RF Transceiver Architecture

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

OBJECTIVE: Develop a dynamically reconfigurable, minimal latency and power VPX Digital Signal Processing (DSP) hardware base to simultaneously handle thousands of diverse, possibly overlapping signals for multi-functional situational awareness as part of a high-dynamic range digitized radio frequency (RF) transceiver for multiple Digital Signal Processing capabilities on a single processing card.

DESCRIPTION: Signal intelligence (SIGINT) is the intelligence obtained by the interception of communications and electronic signals. An Electronic Support Measure (ESM) provides the passive capability to search, intercept, collect, classify, geolocate, monitor, copy, exploit, and disseminate these signals over a specific frequency range. A key sub-system to an ESM is the RF transceiver, a single device which transmits and receives with the ability to exploit, RF signals. Current three rack unit (3U) and 6U RF transceivers are limited in the exploitation of the frequency spectrum due to constraints associated with size, weight, power, and cooling (SWaPC) of the associated electronics in the processing of the collected signals.

This topic's goal is to minimize SWaPC and design the ability to increase the signal processing resources of present 3U and 6U RF transceivers. The RF transceiver must be a single processing card while maintaining the following open interface standards:
ANSI / VITA 46.0 VPX Baseline Standard, and ANSI / VITA 48.2 Mechanical Standard for VPX REDI Conduction Cooling.

The RF transceiver must be dynamically reconfigurable via a sensor open systems architecture (SOSA) with defined application programming interfaces (API) for multiple DSP capabilities. The RF transceiver must maintain operating bandwidth throughput without interrupting receive/scan while running complex applications (e.g., emitter isolation and analysis via high-bandwidth processing for signal detection and signal classification). The RF transceiver must maintain high-bandwidth processing throughput without interrupting signal detection/classification when being loaded with complex applications (e.g., not require a reset of electronics or system). The initial design should address the RF transceiver's receiver side noise figure (NF), spurious free dynamic range (SFDR), selectivity, and input third order intercept point (IIP3). In addition, the initial design should address the RF transceiver's transmit side carrier suppression, sideband suppression, output power level, and phase noise. The RF transceiver must have minimal latency while operating over multiple channels. Hardware must be delivered with software and firmware APIs and development kits for rapid integration into U.S. Government labs.

Design tasking in Phase I and Phase II will not be classified. Analysis tasking associated with hardware in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop an initial RF transceiver solution for airborne platforms in maritime environments including an assessment of the ability of the technology solution (hardware and processing

resources) to meet SWaPC form factor as referenced in the Description above. Additional interface requirement documents (ICDs) will be supplied in Phase I. A conceptual architecture of the RF transceiver is required as a product of the Phase I effort. Phase I option should layout initial design requirements for the
(a) operating bandwidth of the RF transceiver,
(b) memory architecture and memory density,
(c) RF transceiver's receiver side NF, SFDR, selectivity, and IIP3,
(d) RF transceiver's transmit side carrier suppression, sideband suppression, output power level, and phase noise, and
(e) (Objective) verification of operational performance requirements through modelling and simulation (M&S) environment.

M & S for performance and SWaPC should be performed, the final report should include the M & S plan and the results of the M & S performed. Include prototype plans to be further developed under Phase II (e.g., associated documentation; i.e., initial block diagram, schematic, capabilities description).

PHASE II: Develop and demonstrate a prototype hardware and firmware solution, or engineering demonstration model (EDM), which builds upon the proposed solution and architecture developed in Phase I with brass-board, proof-of-concept design. A design review should be conducted early in the development phase. The effort shall include a lab demonstration, that is, the prototype hardware should be delivered at the end of Phase II, ready to be tested by the U.S. Government. The final report should include a lab demonstration plan and results, and a transition plan for Phase III focusing on an integration of the RF transceiver, including further technical maturation and manufacturability of the resulting prototype for an airborne military environment.

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

PHASE III DUAL USE APPLICATIONS: Refine the design, and lab (or ground) test, and integrate the RF transceiver solution within a government systems integration lab (SIL), and flight test. If not completed during Phase II, the Phase III design should focus on the manufacturability, production, and sustainment for compliance with the military operating environment (military standards and handbooks such as MIL-STD-810, MIL-STD-704F, MIL-STD-461, MIL-STD-464C should be used as reference until exact specifications are supplied). Phase III deliverables will include documentation not addressed during Phase II such as, but not limited to, Critical Design Review (CDR), associated Qualification Testing and analysis to support Flight Testing, performance requirements, associated ICDs, and manuals. Dual use in the commercial sector is presently limited; however, some commercial companies are addressing this with the FAA. FedEx is reviewing to install self-defense systems similar to military aircraft and helicopters, and their proposal for anti-missile infrared laser countermeasures to the FAA states "in recent years, in several incidents abroad, civilian aircraft were fired upon by man-portable air defense systems". As missile protection for commercial aircraft continues to be explored, (RF transceivers in) a modified EMS system may be used as an early warning system.

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KEYWORDS: Signal Intelligence (SIGINT); (radio frequency) RF Transceiver; ESM (Electronic Support Measures); ANSI/VITA; Digital Signal Processing (DSP); High bandwidth Processing; Hybrid DSP Architectures; Signal Classification; Signal Detection; Spectral Awareness

N232-091 TITLE: Advanced Fluid Line Connectors/Fittings

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 novel fluid line connector that reduces the likelihood of fluid leaks that can result in platform downtime and affect reliability. Technology developed under this SBIR topic will ideally be used as a new standard for fluid connections and be more reliable and maintainable than our current industry standards.

DESCRIPTION: The Navy requires a novel fluid line connection that greatly improves the reliability and ease of installation for high-pressure fluid line interfaces for aerospace applications. High-pressure fluid leaks have been found to be a major maintenance driver on several programs, negatively impacting aircraft maintenance costs, readiness, and safety. New connector technologies and designs are needed to reduce the likelihood of fluid leaks and subsequent aircraft downtime. In particular, positive indication of correct installation has been a challenge in blind installations, which has led to leaks discovered during ground turns. Both in-flight and on-ground fluid leaks can lead to negative safety events by way of loss of lube, fire, or loss of flight controls. Fluid connections are regularly touched during maintenance and require a robust design. The research and design performed under this SBIR topic will need to be unlike current fluid connection technologies used in the industry in order to show significant improvements in reliability. The technology will also need to be applicable and scalable to different applications to improve reliability throughout Navy engine platforms. Existing connections include B-nuts, Rosan fittings, and two-piece elastomer seals with backing rings, which are susceptible to poor installation or disconnection during operation. Fittings are also susceptible to high-cycle fatigue that can lead to failure, as such, the design should consider installation stresses coupled with the aerospace environment of high temperature and vibration. Connections between fluid lines, which can range in size from 0.25 in. (.63 cm) to 5 inches (centimeters) in diameter and pressure from 50–5000 psi depending on the application, should be the primary focus of this topic. Innovative solutions are being sought to fully seal pressurized aerospace fluids at a connection point without adverse effects to the fluid flow. Aircraft fluids include fuel, oil, and hydraulic fluid. The installation process and procedures should be considered throughout the design process, in addition to the manufacturing process. Integration and adaptability to current fluid tube designs will aid in future transition efforts.

PHASE I: Demonstrate, through modeling or subscale testing, the ability to fully seal pressurized aerospace fluids at a connection point without adverse effects to the fluid flow. The design can focus on fuel, oil, or hydraulics but would preferably be applicable to all three. Installation procedures should be proposed and explanation of the manufacturing process should be provided for both the seals and the fluid tube components, as well as the adaptability to current fluid tube designs. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design, develop, and demonstrate functioning prototype(s) based on Phase I design concepts. Validation testing should be performed under relevant operating conditions including pressures, vibrations, humidity, and temperatures expected for the intended application. Installation should be demonstrated in various blind or hard-to-reach maintenance scenarios and appropriate mistake-proofing tests will be required. A fit check on an appropriate aircraft platform is also a possibility. Testing should demonstrate improvement over the current design for seal reliability and installation success. Consideration shall be given to aerospace quality fluid line connection standards, codes, and specifications as appropriate. Partnering with an aerospace original equipment manufacturer (OEM) is recommended—though not required—to ensure product is suitable for aircraft usage and aid in future transition opportunities.

PHASE III DUAL USE APPLICATIONS: Transition opportunities by way of partnering with an aerospace OEM or military platform is recommended to ensure a smooth and efficient transition of the technology. A partnership can allow for installation testing and fit checks on the selected aircraft platform. Engine testing can also be used to simulate the operating environment of the chosen application. An engine Acceptance Test Procedure will provide a full life cycle of the engine environment, demonstrate full life for the seal, and provide opportunities to prove out the installation process. The OEM or military platform will dictate what further testing is required for the hardware to be incorporated. Fluid connections are used throughout aerospace turbine engine, drive and mechanical systems, and aviation subsystem applications. These components in the military and commercial sector have high pressure fuel, oil, and hydraulic connections that are regularly touched for maintenance events. The technology developed under this topic is intended to be read-across to all similar high pressure fluid connections, ground ground-based applications as well, which could use improvements in reliability and ease of installation.

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KEYWORDS: Seal; Fluid; Connection; Connector; Leak; Fitting

N232-092 TITLE: Robust Maritime Target Recognition

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 robust, fully functional application from airborne electro-optics/infrared (EO/IR) imagery capable of automatically classifying combatant from non-combatant ships. The application should also be capable of target identification at a reduced range and passively compute range to target and Angle Off Bow (AOB) directly from the imagery.

DESCRIPTION: In recent years there have been a widespread embrace of a variety of deep learning techniques for automatic target recognition of ships using airborne EO/IR or radar systems. Generally, the approaches have failed to deliver robust and affordable solutions. Ship recognition requires significant examples to train the classifiers, but obtaining suitable training data is very time consuming, expensive, and impossible in many instances. These systems tend to work impressively when applied to the exact conditions to which they were trained. When faced with other conditions, even those only slightly different from those in the training data, they can react in unexpected ways. The introduction of techniques such as generative adversarial networks do begin to address this deficiency but not sufficiently in practice. A much more robust approach is a hybrid, knowledge-driven one combining an expert system utilizing template-based screeners with deep learning applied in a limited manner to elements of the classification stream where they can effectively and robustly contribute [Ref 1]. Template-based expert system classifiers have been successfully developed previously for inverse synthetic aperture radar images [Ref 2].

From a classification/identification perspective the application must provide a high probability of correct classification (> 90% threshold and > 95% objective) and identification (> 95% threshold and > 98% objective) for combatants of the world. For ships correctly classified, estimated range should be within 3% and AOB with 2°. It is estimated that the three-dimensional template database will need to represent 1,000 to 2,000 vessels. Efficient and accurate rendering of the template database is a critical element to make this approach feasible.

Investigations should consider the performance of the application as a function of pixel counts on target and image quality (i.e., target/background contrast, sensor system modulation transfer function [MTF], and noise). Overall computational resources need to be estimated for a multiple layer screening process. The merging of this expert system with deep learning techniques should be considered and pursued if justified.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Research, evaluate, and develop the overall classifier architecture. Utilizing open-source data set, develop a prototype classifier to be tested on a representative set of combatant vessels. Assess the merits of a hybrid classification approach. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop an implementation of the complete classification approach including automated techniques for template preparation. Implementation should also consider system weight and power (SWAP) since the processor will be integrated into an air vehicle. Using data sets provided by the Navy, conduct a comprehensive evaluation of classification, range, and AOB estimation performance.
Work in Phase II may become classified. Please see note in the Description paragraph.

PHASE III DUAL USE APPLICATIONS: Transition the developed technology to candidate platforms/sensors. Potential transition platforms include the MQ-8C Fire Scout, MQ-4C Triton, MQ-25A Stingray, P-8A Poseidon, and Future Vertical Lift. Potential commercial applications include land-based and airborne port surveillance.

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KEYWORDS: electro-optics/infrared; automatic target recognition; vessel classification; maritime surveillance; remote sensing; template matching

N232-093 TITLE: Small-Scale Air-Launched Hypersonic Weapon System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics;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 and demonstrate a scalable Hypersonic Surface Strike Missile airframe and propulsion system for integration onto a carrier-based strike aircraft (e.g., F/A-18, F-35).

DESCRIPTION: United States weapons development has been dependent for years on large Prime Contractors providing the majority of the design, fabrication, and testing of new systems. This approach has fielded high-quality weapons, but there are advantages in allowing smaller companies to contribute to innovations in weapons technology. Allowing for greater involvement by smaller companies will provide new innovative ideas and help speed up new technologies. This novel approach is necessary as near-peer adversaries have been investing in weapons technology at an increasing pace [Refs 2–4]. Any improvements in speeding up technology maturation and innovation would be beneficial to the United States.

Perceiving a real desire by leadership to approach future weapons development programs with a renewed effort to expeditiously develop and deliver game-changing capabilities to the warfighter at lowest cost, we must “think outside of the box”. Looking at a Non-Traditional Weapons Development strategy utilizing small business has the potential to provide much faster development to initial operational capability (IOC) and at a significant fraction of the cost as compared to the historical approach. Not only would this approach save money and time in the development cycle, it has potential to add greater agility to the needs of the warfighter than the current approach used by the Navy.

Current air-launched weapons need improvements in both range, speed, and the ability to be deployed from multiple platforms to counter threats from near-peer adversaries. Many air-launched missiles and other projectiles that meet satisfactory range needs do not have the necessary speed to fulfill current mission requirements. Often these systems use turbine propulsion technology that limits them to trans-sonic speeds [Ref 5]. Other technologies tend to be larger in size, and are therefore limited in the platforms from which they can be deployed [Ref 6]. There is a need for propulsion technologies that can be used on smaller naval air-launched platforms with strict size and weight requirements that have significant improvements in speed and range. Many current hypersonic technologies in development tend to be larger in size and are not suitable for many of the Navy’s air-launched platforms.

The weapons system being sought is expected to sustain speeds higher than Mach 4.0, and have a minimum range of 350 nautical miles (648.2 km). This system is expected to support an internal payload of 150 lb (68.04 kg) in weight, have a length less than 15 ft (4.57 m), and an overall system mass less than 2000 lb (907.18 kg). In addition, an ability to fly at a wide range of speeds is required. Multiple propulsion technologies might be employed to meet these requirements, and may include (but are not limited to) advanced turbine technologies, solid and liquid airbreathing ramjets or scramjets, rotating detonation engines, or novel hybrid technologies. For this SBIR topic, a high-speed compliment or augmentation of the Navy’s Miniature Air Launched Decoy (MALD) weapons system is desired.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design, develop, and demonstrate the feasibility of the proposed high-speed weapons system propelled by a selected propulsion technology to meet flyout requirements. A Preliminary Design Review (PDR)-level design of the vehicle and propulsion system will be expected that can meet the desired conditions, along with associated calculations, flyout predictions, and supporting analysis to assess the feasibility of the concept design. The vehicle must be designed with large-scale production and lowest life-cycle costs in mind. Subcomponent testing of key critical technologies and selected design features is encouraged during this phase. The Phase I effort will include prototype weapon system and manufacturing plans with estimated fly-away cost for five flight demonstration units to be developed under Phase III.

PHASE II: Fully develop and optimize the Phase I approach. Performance testing of the hypersonic propulsion system will be needed to validate the assumption and design proposed in Phase I. The performance testing will need to demonstrate operation in the high-speed environment for the predicted flight duration. The production/manufacturing plan will need validation through modeling and simulation. The M & S will be validated by actual component/piece part fabrication to validate the time-based prediction and Fly-Away estimated cost. Additionally, a plan and cost assessment needs to be developed to take the system into Low Rate Initial Production (LRIP).

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

PHASE III DUAL USE APPLICATIONS: Finalize development based on Phase II results for transition and integration to air-launched platforms. Conduct flight tests from Navy-provided launch platforms, demonstrating the required performance parameters in the field. Establish a pilot production capability and manufacture five airframe bodies without energetics. Provide validation on the time-based production of the propulsion system. Payload integration of government-furnished equipment (GFE) will be a consideration in Phase III.

The technologies and manufacturing approaches generated in this topic can be transferred not only into missile systems for the DoD, but into commercial/military aircraft and drones. Such technologies can be applicable to any long-range, time-critical payload delivery and/or Intelligence, Surveillance, Reconnaissance (ISR).

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KEYWORDS: Hypersonics; high-speed; long-range; propulsion; missile; weapon

N232-094 TITLE: Blockchain-based, Highly Secure, Decentralized, and Immutable (DSI) Network System Protocol for Multifunction Advanced Data Link (MADL)

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

OBJECTIVE: Design and develop a secure blockchain-based system for manned aerial platform air-to-air and air-to-ground secure communication.

DESCRIPTION: The manned aerial platform can share information two ways in combat across radio datalinks and other innovations to pass targeting data, conduct surveillance, and execute attacks; however, there is the problem of detectability by the adversaries. Radio frequencies emit an electronic signature, which can emit a potentially detectable radio frequency signal. Radio interference, jamming attempts, and electronic warfare are all obstacles to maintaining secure and undetected air-to-air and air-to-ground communication.

Another important challenge is the lack of trust between communication networks that can negatively affect the activities and interaction, as well as leading to casualties, security breaches, and other irreversible consequences. To reduce the negative effects and influence of adversarial participants in the network interaction, the Navy requires the development and demonstration of a highly-secured, decentralized, permissionless, and immutable network system protocol to integrate with the manned aerial platform's Multifunction Advanced Data Link (MADL). The network privacy and security can be achieved for air-to-air and air-to-ground networks by mitigating the link attack and detecting malicious nodes, since it can achieve a consensus without introducing a third party.

The main goal of this SBIR topic is to design and develop a low-latency and high-reliability communication blockchain-based network protocol, while taking into account the specifics of the network, the high dynamics of network topology changes and the exchange of large numbers of data.

1. Analyze the indicators of reliability, sustainability, and resource provisioning of the infrastructure facilities of the systems. The solution should maintain and not degrade current standards of bandwidth for IEEE KuBand (e.g., 548 Mbps upload and 1 Gbps download speeds).
2. Design and develop a model for the interaction of the technology in the system to ensure stable and reliable delivery of information, as well as when organizing interaction between objects of mobile edge computing and the infrastructure of the operator’s network core.
3. Design and develop a complex mathematical model of the system, taking into account the interconnection of objects and channels for air-to-air and air-to-ground information transmission.
4. Evaluate performance of the developed framework for heterogeneous scenarios.

PHASE I: Design, develop, and demonstrate a zero trust, blockchain-based, decentralized, permissionless, and immutable network communications method to integrate with the manned aerial platform's MADL that can sustain the minimum data rate of 1 Gbps. Provide simulation and experimental proof-of-concept demonstration on this blockchain-based communication's security relative to that without the blockchain protocol. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, build, demonstrate, and validate a prototype network communications method based on Phase I. Develop a network infrastructure and perform testing to explore the limits of operational reliability and latency. Experimentally demonstrate that the prototype meets or exceeds the performance specifications stated in the Description. Demonstrate the security superiority of this blockchain-based data link quantitatively relative to that of the conventional link without the blockchain protocol. Provide a production cost model.

PHASE III DUAL USE APPLICATIONS: Pursue commercialization of the technologies developed in Phase II for potential government and commercial applications. Government applications include rapid concept development and maturation for emerging military missions. There are potential commercial applications in Private sector use in telecommunication and local, urban communication that would benefit from this game-changing technology due to its blockchain-based, highly secure, decentralized, and immutable network system protocol for multifunction advanced data link.

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KEYWORDS: Blockchain; Highly Secure; Decentralized; Immutable; Network System; Protocol; Multifunction data link

N232-095 TITLE: Data Uplink Information Transfer Improvements

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 solution that enables large amounts of data to be transferred or uplinked from airborne Anti-Submarine Warfare (ASW) sensors systems, including sonobuoy sensor systems, to airborne platform receivers.

DESCRIPTION: The Navy is transitioning to digital communication links for all of its ASW sonobuoy sensors to aircraft information transfer. Digital links present limitations over traditional analog communication links, but in the end offer advantages for future Navy operations such as enabling data encryption. The Navy is seeking to overcome these limitations and increase the amount of data transferred or uplinked from airborne Anti-Submarine Warfare (ASW) sensors systems, including sonobuoy sensor systems, to aircraft receivers.

ASW is a U.S. Navy-unique mission which depends on the Electromagnetic Spectrum (EMS) to achieve its military objectives. Increased spectrum allocation for commercial enterprises has congested the EMS. Currently, transition to digital communication links for data transfer from airborne ASW sensors, including sonobuoys, is limited by the combination of limited Radio Frequency (RF) bandwidth available to use, and the need to sample and analyze large acoustic bandwidths greater than 40 kHz for transfer over the data link. It is desired that both of these areas be investigated. The current maximum data rate to the aircraft is 320 Kbps in one channel located in the 136 MHz-170 MHz VHF band. If the Navy wanted to get multiple hydrophones and/or wide acoustic bandwidth data from the buoy, then this narrow pipe is a constraint. For example, 600 kHz is the bandwidth associated with a new sensor's RF Channel, but it can be partitioned into other RF Channels. Now the principal receiver on the aircraft is the Software Defined Radio System (SDSR).

The U.S. Navy is currently transitioning to digital transmission of data on communications uplinks. The most common limitation of digital communications is the amount of RF Bandwidth available to be used to reliably transmit the data at higher and higher data rates. Due to regulatory agencies, the Navy must consider the limitations on the amount of spectrum currently approved for use by the Navy. Using multiple channels as one channel and/or modulation scheme are valid options for this SBIR topic.
The Navy is interested in studying bandwidth-efficient modulation schemes, intended to increase the amount of information that the Navy could transmit within its constraints. As a further area of study, the Navy would like to investigate how the baseband data could be compressed, transmitted, and reproduced, as close as possible, to the original data, lossless if possible. The compression of the data should allow wider baseband data to be modulated onto the Navy's existing links, transmitted, and decoded with little or no loss of meaningful information contained in the original waveforms. A demonstration and comparison of the tradeoff between lossy vs. non-lossy compression techniques would assist in determining the best method. In addition, the maximum increase in system noise after decompression should be no more than 1 dB relative to the pre-compressed data. Also, the transmit power should not exceed an average of 10 Watts over the sonobuoy band.

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

PHASE I: Determine a viable and robust method to increase the amount of data transferred or uplinked from U.S. Navy airborne ASW sensor systems to aircraft receivers. Identify technological and reliability challenges associated with the design approach, and propose viable risk mitigation strategies. Assess the capabilities of the proposed system for future expansion. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design, fabricate, and deliver a system prototype, using a SSQ101 sonobuoy, which uses the Navy's digital uplink, based on the results in Phase I. Test and fully characterize the system prototype. Work in Phase II may become classified. Please see note in the Description paragraph.

PHASE III DUAL USE APPLICATIONS: Finalize the design and fabricate a system solution that is compatible with U.S. Navy sensor systems and aircraft platforms, and assist with integration of this solution for airborne ASW purposes.
Improved data communications have application across multiple technology areas, including telecommunications worldwide.

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KEYWORDS: Anti-Submarine Warfare; ASW; Data Communications; uplink; Radio Frequency; RF; sonobuoys; sensor systems

N232-096 TITLE: Automated Fiber Optic Connector Inspection, Diagnostics, and Cleaning Tool

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

OBJECTIVE: Develop automated fiber-optic termini inspection and cleaning equipment for use on military aircraft.

DESCRIPTION: Currently automated technology exists to inspect and clean termini in military-grade connectors not installed on the aircraft. Military aircraft require that the fiber optic connectors on Weapons Replaceable Assemblies (WRAs) and disconnect panels have compact spacing that limits the usability of automated equipment. The problem is compounded by the confined working space on the aircraft.

Aerospace-grade fiber optic connectors contain multiple termini. For example, MIL-DTL-38999 connectors have up to 37 termini. Time studies have shown effective inspection and cleaning of the connector plug and receptacle with 30+ termini can take up to two hours using video inspection and manual cleaning tools currently available to the DoD. Recent aircraft modifications have seen the addition of significantly more fiber optic connector pairs containing thousands of termini. MIL-STD-1678 requires that all termini shall meet minimal optical transmissivity criteria (cleanliness) prior to final installation in the aircraft. To meet the requirement, all the termini in all the connectors must be inspected and cleaned as needed until each terminus meet the cleanliness criteria. To meet the increased demand for connector cleanliness, an innovative approach is being sought to automate the process and have the equipment fit within the perimeter of the connector and within a 6 in. clearance perpendicular to the connector. The inspection and cleaning tool can be remoted. The goal is to reduce on-aircraft maintenance time and enable inspection and cleaning within confined spaces.

The automated inspection and cleaning tool design should address the following considerations:

(a) must operate on connectors attached to WRAs, and disconnect panels meet SAE AS50881, Section 3.7.1.,
(b) have a user interface that automates termini inspection and cleaning processes,
(c) provide connectivity and data transmission, meeting Navy cyber security requirements,
(d) have only two external connections — one for 115 VAC and one for the umbilical attached to the head,
(e) operate on 115 V (50–400 Hz) or battery power,
(f) have portability per MIL-PRF-28800G,
(g) have a removable hard drive per Navy cyber security requirements,
(h) able to locate, inspect, and clean to optimize the assessment accuracy (minimum 95%),
(i) must be able to be used on connectors with no less than 37 fiber optic termini,
(j) need to adapt to MIL and ARINC shell sizes 11–25 connectors,
(k) need to adapt to ARINC rectangular connectors,
(l) capable of being qualified under MIL-PRF-28800G, and
(m) be one person carry.

PHASE I: Design and demonstrate feasibility of the inspection, diagnostics, and cleaning tool. Compare approach to existing manual and automated solutions. Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize design, fabricate, and demonstrate the prototype in a simulated aircraft maintenance environment. Deliver two prototypes for Government evaluation.

PHASE III DUAL USE APPLICATIONS: The fiber optic connector, cleaning, and diagnostics technology developed under this SBIR topic could be transitioned to industry for companies that produce and sell fiber optic support equipment to both the DoD and commercial sector. The fiber optic connector, cleaning. and diagnostics technology could be used in commercial sector data centers and internet hubs.

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KEYWORDS: Fiber optics; connector; inspection; cleaning; automation; maintenance

N232-097 TITLE: Enabling Digital Metrology and Manufacturing Through the Model-Based Enterprise

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

OBJECTIVE: Design and develop innovative manufacturing and inspection processes that leverage the tenets of Digital Thread and the Model-Based Enterprise (MBE) to enable a Digital Transformation within the Department of Defense (DoD).

DESCRIPTION: Model-Based Definition (MBD) utilizes 3D datasets to contain and convey a product's definition during the manufacturing process. The larger MBE can leverage this data in downstream processes such as production, quality assurance, and logistics to consume part-specific manufacturing information in new, innovative ways. Through a previous research effort, NAVAIR developed a custom workflow for MBD parts to tie manufacture and inspection data to the part model using the Quality Information Framework (QIF) Standard. MBD has also been leveraged in industry to analyze measurement uncertainty associated with Coordinate Measurement Machines when creating part inspection plans. Through QIF, all inspection data can be associated back to the model and utilized by logistics throughout the sustainment phase of the part's lifecycle. NAVAIR identified a number of capability gaps while developing the above workflow, some unique to the defense industry. The intent of this effort is to address the capability gaps identified for the current workflow.

There are a number of factors that impact the accuracy of a measurement such as the environment in which the measurement is taken, the system taking the measurement (such as a Coordinate Measurement Machine [CMM]), and the way the dimension was defined in the Technical Data Package. The combination of these factors contribute to the uncertainty associated with each measurement. Measurement uncertainty leverages guard banding rules to restrict the tolerance range to minimize the potential to accept "bad" parts or reject otherwise "good" parts. These limits are often based on the cost implications associated with those errors. However, any deviation from the technical requirements of a Critical Safety Item (CSI) could result in loss of life or loss of aircraft. The consequence of failure for a CSI is so much greater than the cost to produce the individual part that traditional guard banding rules do not apply. The Navy has a specific need to develop a unique set of guard banding rules and measurement uncertainty principles based on part criticality as opposed to cost.

Non-contact Articulating Arms (such as a Romer Arm) have the ability to generate point cloud data quicker than contact CMMs. The point cloud data can produce valuable quality information and help augment the workload of a CMM, a bottleneck in the Organic Industrial Base (OIB). However, the OIB does not currently leverage articulating arms as inspection tools, because the measurement uncertainty is not well quantified. This effort aims to quantify the measurement uncertainty of non-contact articulating arms for inspection purposes.

The Navy has the means to calculate measurement uncertainty for CMM inspection plans. Current techniques leverage an initial condition for the inspection plan, which requires input from the CMM operator. The CMM operator currently needs to manually add/remove inspection points to find an optimized inspection plan that meets the measurement uncertainty requirements. The downside to this approach is that it is unclear whether a local or global optimization has been achieved with respect to the time and cost required to perform the inspection. The Navy is seeking a tool that can automatically optimize the inspection plan for time and cost while maintaining the required measurement uncertainty. The goal of this effort is to modify the previously developed workflow, based on the outcome of the above objectives. Currently, there is an abundance of applications and file exchanges/handoffs. This effort will integrate the various operations into one Digital Enterprise Tool, such as DEXcenter, where various workflows could be exercised to support functionality at the enterprise-level. This effort will focus on integrating this new workflow into a Digital Enterprise Tool that the OIB can leverage.

PHASE I: Phase I will focus on addressing the previously identified capability gaps in the current workflow. This includes, but is not limited to, the development of new guard banding rules based on part criticality, measurement uncertainty principles for articulating arms, and a tool to optimize inspection plans for time and cost based on the measurement uncertainty requirements. Demonstrate the feasibility of a tool or set of tools that can address the above capability gaps in a lab environment. A lab environment may leverage a test artifact with controlled model based technical requirements captured in the QIF format to evaluate the tool's performance. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a new process workflow for the OIB that leverages the solutions developed in Phase I. This workflow shall integrate with existing manufacturing practices to reduce any burden associated with deployment of MBE to the OIB. It will also consist of the re-packaging and deployment of the new workflow to run directly on Navy databases. Phase II of this effort will integrate the various operations into one Digital Enterprise Tool. Once deployed, demonstration and validation will be performed using actual Navy data in prototype manufacturing environment.

PHASE III DUAL USE APPLICATIONS: To demonstrate the developed capability, the tool will be leveraged on production parts to fully characterize the measurement uncertainty of that inspection plan. The new capability should minimize any unique modifications of the part to complete the analysis in a production environment. Once complete, the tool will be transitioned for ownership by NAVAIR under the guidance of PEO-CS Digital Thread Team and/or NAWCAD LKE's Digital Enterprise Tools Branch. There are many industries outside of the Navy including, but not limited to, the medical field and the aerospace industry that produce critical parts where the consequence of failure cannot be easily quantified by cost. Those industries would benefit from criticality-based guard banding rules.
Manufacturers that produce a high quantity of a particular component will benefit from even a small reduction in the time it takes to perform an inspection. Specialized, expensive manufacturing techniques like a CMM can negatively impact the inspection process. Nonorganic manufacturing facilities would also benefit from quicker, cheaper, optimized inspection plans.

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KEYWORDS: Model-Based Definition; Digital Thread; Measurement Uncertainty; Guard Banding; Manufacturing; Coordinate Measurement Machines

N232-098 TITLE: Photodetector and Optical Subassembly for Digital Fiber Optic Receiver

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

OBJECTIVE: Develop and package uncooled photodetectors and optical subassemblies for military digital optical communications applications that can operate in air platforms at 10, 25, 40, 50, and 100 Gbps using binary, non-return-to-zero, on-off keyed data modulation techniques in fiber optic receivers.

DESCRIPTION: Current airborne military (mil-aero) core avionics, electro-optic (EO), communications, and electronic warfare systems require ever-increasing bandwidths while simultaneously demanding reductions in space, weight, and power (SWaP). The effectiveness of these systems hinges on optical communication components that realize high per-lane throughput, low latency, large link budget, and are compatible with the harsh avionic environment.

As digital avionics fiber-optic transmitter transmission rates increase from 10–100 Gbps, a new fiber-optic receiver will be required. A key enabling component in the fiber-optic receiver is a high-sensitivity and saturation photodetector that is compatible with 50 µm core multimode optical fiber, and various connectorized and fiber-pigtailed subassembly designs for both single-wavelength multimode fiber receivers and wavelength de-multiplexed and receiver arrays. The photodetectors should enable 15 dB receiver loss budget performance at 10 Gbps, 25 Gbps, 50 Gbps, and 100 Gbps. Photodetectors should be compatible with shortwave wavelength division multiplexing (SWDM) (844–1000 nm) and coarse wavelength division multiplexing (CWDM) (1271–1331) wavelength band ranges. Individual photodetector designs are acceptable for each wavelength band. The photodetector optical subassemblies should be compatible with 4 X 10 Gbps, 2 X 20 Gbps, 4 X 25 Gbps, 1 X 50 Gbps, 2 X 50 Gbps, and 1 X 100 Gbps transmission speeds. The optical subassemblies should be compatible with 50 µm core OM4 multimode optical fiber inputs, and 10 Gbps, 25 Gbps, 40 Gbps, 50 Gbps, and 100 Gbps receiver electronic circuits. The optical subassemblies are expected to operate over a -40° to +95° Centigrade temperature range.

PHASE I: Develop a design concept for photodetectors and their optical subassemblies for military digital fiber-optic communication applications. Demonstrate the feasibility of the photodetector design, showing a path toward meeting Phase II goals. Show optical subassembly design compatibility with fiber-optic inputs and receiver circuits. Demonstrate the feasibility of the concept to meet the described parameters listed in the Description through modeling, simulation, and analysis. The Phase I Option, if exercised, will include initial design specifications and capabilities description to build prototype solutions in Phase II. Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design and develop prototype photodetectors optimized using results from Phase I. Build and test the photodetectors and photodetector optical subassemblies and deliver to the Navy. If necessary, perform root-cause analysis and remediate photodetector and optical subassembly failures.

PHASE III DUAL USE APPLICATIONS: Transfer the photodetector and optical subassembly design to a high-speed digital fiber optic receiver supplier. Photodetector and optical subassembly technology could be used in commercial data center and/or internet provider installations.

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KEYWORDS: Photodetector; fiber optics; communications, digital; receiver; optical subassembly

N232-099 TITLE: Utilizing Mesh-Networking for Greater Maritime Situational Awareness from Vertical Lift Aircraft

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 an innovative solution utilizing low, medium, and high bandwidth mesh networking radios that could be deployed from a vertical take-off and landing (VTOL) aircraft during an anti-submarine warfare (ASW) mission to improve maritime situational awareness.

DESCRIPTION: Modern technology allows for innovative new-use cases for low-cost mesh-networking radios to perform tasks for maritime situational awareness during missions such as ASW/anti-Surface Warfare (ASuW) amongst other critical key naval activities. With availability of components to construct new innovations in communications technology that can be deployed from Vertical Lift aircraft by means such as AN/ALE-47 flare dispensers, canister configurations, or door thrown deployment methods to provide floating mesh-networking nodes; greater maritime situational awareness methods are now possible at a lower cost. In an ASW exemplary use case, types of sonobuoys can include, but are not limited to, active and passive sonar capabilities to allow a wide swath of maritime area to be monitored and a greater magazine depth of sensors per Vertical Lift platform without the use of any tethered system traditionally used. In addition, the ability for floating mesh-networking nodes, allow greater Joint All-Domain Command and Control (JADC2) across the Joint Force and coalition partners.

This SBIR topic addresses the need to design and test basic mesh-networked nodes on the ocean surface in meaningful naval use-cases. Such radios can include, but are not limited to, existing COTS/MIL mesh-networking radios that exist such as:

(a) High Frequency radios can be considered, but power and antennae analysis must be included in the design (atmospheric bounce – low bandwidth),
(b) Somewear Labs (satellite mesh-networking – low bandwidth),
(c) goTenna/Beartooth (UHF/VHF mesh-networking – low bandwidth),
(d) Doodle Labs/Trellisware/Persistent Systems/Silvus (UHF mesh networking – medium to high bandwidth), and
(e) Banshee (5G mesh networking – medium to high bandwidth).

Following deployment of maritime surface relevant payloads, the communications systems need to demonstrate their ability to mesh-network based on terrestrial limits, mesh-network via satellite/airborne node (e.g., UAV/high-altitude balloon/manned aircraft), and its ability to provide data reach back over multiple ‘hops’ to allow standoff detection capability from a distance for naval forces. The floating communications system should operate for a useful time measure in the maritime environment (e.g., 24 hrs [threshold]/7 days [objective]).

Design solutions should consider the following three areas: 1) sonobuoy payload performance objectives, 2) communications/mesh-networking performance, and 3) overall conceptual system survivability in a maritime environment. These areas are described in more detail below:
Area #1 Sonobuoy Payload Performance Objectives:

(a) Size, Weight, Power, Cost projections (SWaP-C) of the floating communications mesh networked proposed system; to include various sizes as noted previously, ALE, Canister, and hand-thrown systems, proposed CONOPs or uses-cases and description of employment and health of overall mesh-network to assist in achieving relevant maritime domain objectives, and
(b) reliably deployed in sea-state conditions 0 through 5 (international scale), with estimations of their communications ability in calm to severe weather.

Area #2 Communication/s mesh-networking performance:
(a) predicted terrestrial mesh-networking ranges and bandwidth at-sea,
(b) predicted terrestrial mesh-networking ranges and bandwidth at-sea with UAV/high-altitude balloon/satellites,
(c) range and data budgets provided at range and over multi-hop mesh-networking scenarios; graceful degradation of 'useful' notional payload information,
(d) address potential Primary/Alternate/Contingency/Emergency (PACE) combined mesh-networking options, and
(e) unique undersea communications relays will be considered, but are not primary to this topic (e.g., floating payload to unmanned underwater vehicle (UUV) to floating payload communications—acoustic).

Area #3 Overall conceptual system survivability in a maritime environment:
(a) utilizing Area #1 and Area #2 describe the overall system performance characteristics conceptually (i.e., duration of sensor, communications capabilities in various maritime environments, storage and shelf-life of sensor/mesh-network radio),
(b) complete conceptual design and employment of sensor uses for VTOL aircraft, and
(c) initial costs for low rate initial production (LRIP) and full-rate production costs.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop, initial design, and demonstrate the feasibility of a mesh-networked floating communications payload and design. Identify the three areas conceptually to understand the technological and reliability challenges of the design and approach, and risk mitigation steps. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design, fabricate, and deliver units (minimum of three) of mesh-networked floating payloads/communications systems based on the design from Phase I. Test and fully characterize the system prototype in a controlled environment to determine limitations of the system, in anticipation of greater testing in Phase III with naval forces in a relevant DoD sponsored exercise.
Work in Phase II may become classified. Please see note in the Description paragraph.

PHASE III DUAL USE APPLICATIONS: Product should be interoperable with United States Navy (USN)/United States Marine Corps (USMC) and Joint Force C4I systems and will be utilized in a greater DoD sponsored exercise held by the USN or USMC to demonstrate the capability to the naval forces. Testing will be overseen by the USN and USMC to assess the new capability in an operationally relevant test area (likely CONUS waters).) The ability to demonstrate reachback capability for USN/USMC assets

will be critical to show success of the network. Upon successful testing and demonstration in a relevant exercise, in full or in part, the prototypes should be delivered to the sponsoring agency or Program Management Activity that decides to take the final technology package forward.
Commercial and dual-use applications can include, but not limited to, emergency communications for ships in transit or in distress, monitoring of marine mammal life, and creating bandwidth in large maritime areas for communications where satellite coverage could be lacking. Such technology developed under this SBIR topic could greatly assist with not only a DoD mission of maritime awareness, but civilian and environmental research as well.

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KEYWORDS: MANET; mesh-networking; payloads; sensors; communications; JADC2; maritime domain awareness

N232-100 TITLE: Predictive Asset Rerouting and Inventory Availability for Tactical Intelligence, Surveillance, and Reconnaissance Platforms

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Space Technology;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 tool capability to incorporate automated rerouting of available taskable and fixed trajectory Intelligence, Surveillance, and Reconnaissance (ISR) platform asset inventory within a designated range of Areas of Interest (AOIs).

DESCRIPTION: The Navy relies on a mixture of space-based and tactical air/surface ISR platforms to maintain enhanced battlespace awareness in contested operating areas. Commercial and DoD space sensors (i.e., “fixed trajectory” platforms due to constraints of orbital mechanics) contribute a significant portion of the Navy’s battlespace awareness information; however, there remain substantive gaps in sensor coverage. Commanders can address coverage gaps with manned and unmanned tactical platforms which are able to be tasked to specific operating regions (i.e., “taskable” sensors).

With the advent of diverse collection platforms, the Navy is interested in developing a tool and capability to fully leverage these platforms. Existing tools provide orbitology predictions using timely data such as Earth Orientation Parameters (EOP), Leap Seconds, and up-to-date Satellite Databases. A capability is needed to coordinate between taskable and fixed trajectory platforms that optimizes taskable ISR platform inventory management to reduce coverage gaps in collection of data and provide sufficient collection of tactical data in a timely manner to meet the Commander’s intent of responsiveness during dynamic over-the-horizon (OTH) requirements. Currently there is no commercial capability that exists that can accomplish this task.

Once a fixed trajectory platform achieves a downlink for an AOI, the revisit rate could take 5-10 days for the asset to return to the same location. Other options include waiting for the next available asset. Low earth orbit (LEO) satellites take between 90 minutes to 2 hours to complete one orbit and are only communicating with a ground station for 5-10 minutes at a time. This time-consuming delay in data transfer can delay critical decisions and resource allocation. In-theater needs data transmitted quickly and reliably. By rerouting near-by taskable and tactical ISR platforms, observation gaps for the AOI will be significantly reduced or optimized. Leveraging nearby taskable and fixed trajectory platforms would improve responsiveness and effectiveness for maritime applications by maximizing the custody over the AOI. Enabling asset rerouting capabilities as well as inventory management, tactical ISR platforms can support Naval missions more effectively. The warfighter will receive data faster allowing for course of actions to be developed sooner rather than waiting for the next planned in-orbit asset or the revisit rate of the engaged asset.

The entire Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) process should be automated using Artificial intelligence (AI) and machine learning (ML) algorithms to improve the response times to request rerouting opportunities. The automation needs to be an open Application Programming Interface (API) design capable of establishing a bi-directional machine to machine (M2M) interface with diverse Command and Control (C2) software systems. In addition, the tool needs to be capable of uploading tactical system mission plans (e.g., flight plans for a manned aircraft mission), capable of assessing collection coverage gaps and opportunities to increase persistence with available taskable sensor inventory, and capable of providing sensor tasking recommendations to C2 systems. This request process could be as simple as using a smartphone to request a ride sharing service.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by 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 IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a software tool that automates rerouting of available ISR platform asset inventory within a designated range of AOIs. Demonstrate the concept meets parameters in the Description. Feasibility must be demonstrated through modeling and analysis and should include an example of how suggestive tasking or alerts of taskable assets can be modified when considered against fixed trajectory assets, with considerations for how best to depict it to the user. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype software tool from concept development in Phase I. Demonstrate that the prototype meets parameters of the Description. The prototype will be tested to demonstrate coordination between various tactical ISR platforms to de-conflict flight paths while rerouting the most feasible option in a designated range of the AOIs.

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 use in wartime environment. Develop software for MTC-A/X that integrates tactical ISR mission planning with fixed trajectory collection feasibility so the Navy and Marine Corps can evaluate the tool’s effectiveness in optimizing availability of these platforms in operationally relevant scenarios. Support MTC-A/X for testing and validation to certify and qualify the capability for Navy use.
Ground based maps use rerouting opportunities via applications such as Google Maps or Waze. FAA uses Air Traffic Control Systems to reroute flights as needed to prevent collision. Leveraging these technologies to enable the ability to reroute taskable and ISR platforms will increase opportunities to view AOI in a timely fashion. Areas suffering from natural disasters would have more opportunities to observe changes to develop a course of action to prevent further disasters.

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KEYWORDS: Intelligence, Surveillance, and Reconnaissance; taskable trajectory platforms; Inventory Management; Fixed Trajectory; Artificial Intelligence; Machine Learning.

N232-101 TITLE: Expedited Commercial Imagery Delivery through Reduced Ground Processing Time

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Space Technology;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 capability for edge node image processing latency reduction in the overall tasking to exploitation timeline.

DESCRIPTION: Units and organizations located in austere and/or denied locations require timely receipt of imagery to conduct operations. Recent advances in the ability to directly downlink raw imagery from commercial high resolution imaging satellites to Navy edge nodes located in the field promises to dramatically cut the time between when the image is taken and when it is available for exploitation. Units and organizations with little data connectivity can receive timely imagery and exploit it locally; however, even after the reductions provided by direct imagery delivery, processing time at the local edge nodes remains a bottleneck in this process. Current commercial edge node imagery processing often takes longer than 15-20 minutes to complete. The Navy seeks a solution that will shorten the processing time for imagery from tasking to imagery exploitation. There is currently nothing on the commercial market that can solve this issue.

The Navy needs a software solution that can reduce edge node processing times to below 5 minutes with a goal of sub minute processing times. The solution must run on local hardware at the edge node location, except in the case that processing occurs on-orbit before direct downlink (DDL). Software is expected to run on commodity hardware consisting of either CPU’s and/or GPU’s. A limited amount (1-2 rack units) of additional hardware, such as FPGA’s, may also be proposed in conjunction with the software. If additional hardware is added it must be rack mountable. Any modifications to the final processed image must not impact or reduce its exploitation potential.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by 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 IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for edge node image processing time reduction tool in the overall tasking to exploitation timeline that meets the parameters in the Description. Feasibility must be demonstrated through modeling and analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype edge node image processing time reduction tool from concept development in Phase I. Demonstrate that the prototype meets parameters of the Description. The prototype will be tested to determine the capability meets performance goals of Navy requirements.
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. Refine the prototype for use in Navy edge nodes. Support the Navy for testing and validation to certify and qualify the capability for Navy use.

Faster processing of images directly delivered to customers would be very helpful to first responders in disaster areas. The techniques used could also be applied to commercial applications to overall reduce processing time such as accidents, natural disasters, flooding and other rapidly changing situations with first responders.

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2. Hitchens, Theresa, "Army NRO Pioneer Direct Sat Imagery Downlink in Scarlet Dragon," 11-October 2011, Breaking Defense. https://breakingdefense.com/2021/10/army-nro-pioneer-direct-sat-imagery-downlink-in-scarlet-dragon/

KEYWORDS: Imagery Processing; Edge Node; Latency; Ground Processing; Imagery Exploitation; direct imagery delivery

N232-102 TITLE: High-Performance, No-Helium Cold Spray for Structural Repair Applications

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

OBJECTIVE: Develop a high-performance cold spray system which can deposit structural quality repair material for aluminum and titanium without using helium as the carrier gas.

DESCRIPTION: High-performance cold spray systems require helium carrier gas to achieve required particle deposition velocity and high-performance deposits of aluminum, titanium, and high-strength steel that have lower than 1% porosity [Ref 1]. Helium is a limited resource, expensive and highly sensitive to changes in market supplies, some of which come from Russia and other foreign countries. The cost of helium is currently about 100 times more than nitrogen, which is used in cold spray systems, but produces material with up to 10% porosity [Ref 2]. As such, the cost of helium for most repairs under consideration is a large percentage of the overall repair cost and reduces the cost-benefit for many applications. In addition, access to helium can be restricted, impacting testing and repair schedules.

A cold spray system that does not use helium and can deposit aluminum, titanium, and high-strength steel with the properties of these materials deposited using today's high-pressure, helium-based systems is needed.

PHASE I: Develop a concept for a cold spray system that can deposit aluminum, titanium, and high-strength steel at lower than 1% porosity without using helium. Demonstrate feasibility of meeting pressure, operating temperature, transfer efficiency, interfacial adhesion, tensile and elastic modulus, static and fatigue strength, elongation, and hardness properties against the threshold and goal targets provided by the Naval Air Warfare Center Aircraft Division (NAWCAD). Model powder deposition parameters. Prepare a report to ONR and NAWCAD on design(s) and modeling and prepare a Phase II testing plan.

PHASE II: Construct a prototype non-helium cold spray system and assess the material properties of the deposition of aluminum 7050-T7451, Ti6-4, and AerMet 100 powders. Assess the properties of repaired 7050-T7451, Ti6-4 and AerMet 100 substrates using cold spray-applied powders of the same alloys. Provide a report that documents the design of the prototype system, results of system performance and results of material testing for the three alloys. Provide a Phase III plan to ONR and NAWCAD for prototype evaluation. Provide a prototype non-helium cold spray system to NAWCAD for evaluation.

PHASE III DUAL USE APPLICATIONS: Assemble a full non-helium cold spray system and demonstrate output meeting key deposition and material parameters. Deliver a full non-helium cold spray system to NAWCAD and report containing designs and test data to ONR and NAWCAD. Dual use applications may include light metal repairs in the aviation industry.

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KEYWORDS: Cold spray, aerospace alloys, non-helium, repair, maintainability, metals

N232-103 TITLE: Machine Readable Contextual Understanding and Drilldown

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems;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: Machine reasoning logic and semantic interoperability for contextual understanding, auto-alert cuing, and drilldown of anomalous events and activities in multidomain littoral zones. Domain independent ontologies for seamless unambiguous knowledge representation with spatiotemporal tags and tracks associated with events, entities, relations, and transactions.

DESCRIPTION: Context is considered as any information that can be used to characterize a situation that is relevant to the interaction between entities in their environment, for example, detecting the preparation signs of hostile amphibious warfare or sea-lane blockade. Lack of context significantly hinders effective decision-making, command, and control. Providing context dramatically facilitates accurate interpretation. Contextual understanding allows an increased level of interoperability for human-machine and machine-machine interactions. Effective collaboration requires proper information formats that can be exchanged between devices without a loss of contextual meaning. Decision-makers and analysts supporting naval missions on the Ops-Floor develop actionable intelligence from an extensive array of decentralized multi-intelligence (multi-INT) and Open Source intelligence OSINT data sources varying in size, modalities, velocities, and types (i.e., structured and unstructured data). The challenge is to develop a trusted Artificial Intelligence (AI) perception method that will significantly reduce the Ops-Floor course of action decision timeline to less than an hour (currently it takes about a day) to support Pacific Command Counter Intelligence Surveillance and Reconnaissance and Targeting (PACOM C-ISRT) or Joint Interagency Task Force (JIATF)-South counter-narcotics operations.

Distributed systems today often use the Web Ontology Language (OWL) as a mechanism to convey the meaning and context of information sources. OWL allows for the description of classes and logical relationships in an ontology for use by machines. OWL is used to explain references and descriptions in a data feed, encoded using the Resource Description Framework (RDF). RDF is extensively used in Business-to-Business e-commerce exchanges. It provides a mechanism to explain the precise meaning of particular parts of an XML chain concerning conventional definitions.

Based on this success, several prototypes have sought to extend the methodology for use in distributed analytic applications in the defense community. So far, the success has been limited to applications that use a relatively static ontology. A rapid change in ontology makes it difficult for constituent systems to adhere to a set of representations of context and the meanings that will change quickly. For example, machine-readable ontologies have worked well in pharmaceutical fields where the underlying DNA strands are relatively stable over time or in the air traffic controls where the flight rules do not change. However, when applied to specific military activities like monitoring the enemy's course of action, the ontologies require a precise method to update and synchronize across relevant distributed systems. Each system manages its ontology while requiring significant software development to transform information at system boundaries. By doing so, risking a considerable loss of information during the transfer that leads to incorrect analysis.

Note 1: Work produced in Phase II may become classified. The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures have been implemented and approved by the Defense Counterintelligence Security Agency (DCSA). The selected contractor must be able to acquire and maintain an appropriate security-level facility and Personnel Security Clearances to perform on advanced phases of this project as set forth by DCSA and ONR to gain access to classified information about the national defense of the United States and its allies. This will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

Note 2: Phase I will be UNCLASSIFIED and classified data is not required. For test and evaluation, an awardee needs to define the ground truth for the scenarios and develop a storyboard for each to guide the test and evaluation of this SBIR technology in a realistic context. Supporting datasets must have acceptable real-world data quality, content, and complexity for the case studies. For example, an image/video dataset of at least 4000 collected images and frames for a case study is considered content rich.

Note 3: Awardees must provide appropriate dataset release authorization for use in their case studies, tests, and demonstrations. They must certify that there are no legal or privacy issues, limitations, or restrictions with using the proposed data for this SBIR project.

PHASE I: Machine contextual understanding or “perception” will consist of four key functional components: 1) contextual multi-INT/OSINT data acquisition and content recognition (i.e., video, multispectral imagery, audio, text), 2) contextual learning and representation (“modeling”), 3) contextual reasoning and classification logic, and 4) contextual human-machine collaboration and query. Develop an ontological framework consisting of “Scene Ontology” and “System Ontology” for cross-domain contextual representation that enable rich context expressions and strong validation. Develop geospatial models to represent the physical space and location of the entities and sensors with spatiotemporal ontologies expressing contextual information. Develop knowledge graphs to reason over multimodal data sources for latent contextual feature representation of entities and relations. In other words, the ontological reasoning logic must overcome data impurities and scene ambiguities manifested through spoofing, deception, clutter, and noisy environments.) Develop question-answering methods to probe, query, and share machine spatiotemporal contextual insights. Develop three compelling maritime cross-domain scenarios of naval concerns. Develop each scenario with at least ten complementary events that evolve. Demonstrate the extendibility of the ontologies.

Phase I baseline performance metrics for evaluating machine perception algorithms against the multimodal datasets (video, multispectral imagery, audio, text) are:

- Machine Performance Accuracy: Structured Data Translation and Distillation - Accuracy 90% over 95% captured content; Unstructured Data Translation and Distillation – Accuracy 85% over 90% captured content.
- Precision: Proportion of retrieved machine perception material that is relevant; Precision = TP/(TP+FP), True Positives (TP) and False Positives (FP). Maximizing Precision minimizes FP.
- Recall: Proportion of relevant perception material that is retrieved; Recall = TP/(TP+FN), False Negatives (FN). Maximizing Recall minimizes FN.
- Fi Measure = [(1+i2) x Precision x Recall] / [i2 x Precision + Recall]; allows variation of Fi to shift importance of Precision vs. Recall, e.g., F0.5: makes Precision more important; F1: balances the Precision and Recall; F2: makes Recall more important.

• Novelty: Precision and recall having same values but calculated for novel information retrieved.
• Accurate Perception Retrieval Rate = (TP+TN)/(TP+TN+FP+FN); True Negatives (TN).
Deliverables (in addition to standard Phase I contract deliverables): end-to-end initial prototype technology, T&E, demonstration, a plan for Phase II, and a final report.

PHASE II: Develop a prototype software and supporting hardware system incorporating the candidate technologies from Phase I. Incorporate the three scenarios developed in Phase I with representative operational data sources for the prototype design. Demonstrate synchronization of at least ten disparate data-feed streams in real-time, with relationship information relevant to mission scenario models. Apply datasets provided by the end-users (i.e., Pacific Fleet [PACFLT] or JIATF-South) for Phase II development. This will show a well-established relationship for a potential transition. By the end of Phase II, validate and verify the overall technology performance against the end-user-defined tests, evaluations, and demonstration benchmarks. Test and demonstrate the prototype software against the benchmark datasets. Validate and verify the overall accuracy of software tools based on the performance metrics detailed for Phase I in addition to the following performance enhancement metrics. Phase II Machine Performance Accuracy: Structured Data Translation and Distillation - Accuracy 95% over 95% captured content; Unstructured Data Translation and Distillation – Accuracy 90% over 95% captured content. Demonstrate that Ops-Floor end-to-end processing and execution timelines are in-step with operational requirements. Develop a plan for Phase III with a transition path to a program of record. Deliverables: prototype software, systems interface requirements for mobile and stationary devices, design documentation, source code, user manual, and a final report.

Note 4: It is highly likely that the work, prototyping, test, simulation, and validation may become classified in Phase II (see Note 2 in the Description for details). However, the proposal for Phase II will be UNCLASSIFIED.
Note 5: If the selected Phase II awardee(s) does not have the required facility certification for classified work, ONR or the related DON Program Office will work with the awardee(s) to facilitate certification of a related facility.

PHASE III DUAL USE APPLICATIONS: Advance these capabilities to TRL-7 and integrate the technology into the Maritime Tactical Command and Control POR or Intelligence, Surveillance, and Reconnaissance (ISR) processing platforms at Marine Corps Information Operations Center. Once validated conceptually and technically, demonstrate dual use applications of this technology in the financial/banking sectors and relevant data centers.

This technology has broad applications in government and private sectors to monitor and discover unlawful transactions, commerce, and national security threats. In government, it has numerous applications in military, intelligence communities, law enforcement, homeland security, and state and local governments to counter a variety of threats or natural crises. In the commercial sector, the technology has applications in the healthcare industry, financial sectors, and security services.

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KEYWORDS: Machine-Contextual-Learning; Machine-Recognition; Contextual-Reasoning; Contextual-Understanding; Machine-Perception; Classification-Logic

N232-104 TITLE: Mid-Wave Infrared Detectors with Tunable Narrow-Band Spectral Response

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): 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 mini-array of optical detectors that combine narrow spectral response (= 200 nm) with enhanced specific detectivity for all polarizations, and which can be tuned across at least 500 nm of the 3 – 5 µm midwave infrared (MWIR) spectral band.

DESCRIPTION: Navy requirements for advanced MWIR and longwave infrared (LWIR) detectors have typically been subdivided into two application classes. The first is broadband thermal imaging by a focal plane array (FPA), to provide high-resolution vision and identification in near or total darkness. This requires a broad spectral bandwidth that maximizes the net signal within a given atmospheric window such as the MWIR (3-5 µm) or LWIR (8-12 µm). Cryogenics are generally required to reach background-limited performance (BLIP). The second application class requires high sensitivity only within a narrow spectral bandwidth. This occurs when the signal to be detected is produced by an infrared (IR) laser or for passively detecting optical emission at known spectral lines. Examples include active imaging, multispectral/hyperspectral imaging, target designation, free-space communications, laser spectroscopy for chemical/biological/explosives sensing, laser/beacon detection, and Light Detection and Ranging (LiDAR).

The goal of this SBIR topic is to combine the benefits of both applications by enabling the development of larger format MWIR detector arrays that have high sensitivity within a dynamically tunable narrow spectral bandwidth. To achieve this goal, the Navy is seeking MWIR detectors that display enhanced specific detectivity (D*) within a narrow spectral bandwidth. This is in direct contrast to the state-of-the-art approach that lowers detectivity through the use of a narrow bandpass filter placed in front of a broadband detector. A further goal is to provide the ability to tune the peak response wavelength while maintaining enhanced D* for applications such as hyperspectral imaging.

One potential approach that could be used to address this problem involves placing a very thin detector absorber region within a resonant cavity tuned to the wavelength bandwidth of interest [Ref 1]. High quantum efficiency is retained due to numerous passes of the incident light through the cavity, while clutter associated with wavelengths outside the spectral region of interest is rejected. The resonant cavity infrared detector (RCID) architecture can also enhance the frequency response, since photogenerated carriers are collected much more rapidly from the very thin absorber. RCIDs are relatively mature at telecommunication wavelengths, where the primary motivation is to maximize the speed for high data rate [Ref 1]. However, RCIDs operating at MWIR wavelengths beyond 3 microns have previously performed poorly compared to conventional broadband detectors. Only quite recently have more encouraging results been reported [Refs 2,3], which confirm a promising pathway to substantial reduction of the dark current noise while maintaining high peak quantum efficiency for enhanced sensitivity within the resonance bandwidth.

A second potential approach is to incorporate a plasmonic metamaterial grating [Refs 4,5]. These architectures can also maintain high quantum efficiency when the absorber is very thin by redirecting the normal-incidence IR signal to propagation in the plane. For grating resonance wavelength in the LWIR, this has led to enhancement of D* in type-II superlattice nBn devices at operating temperatures in the thermoelectric cooler range [Ref 5].

Both RCIDs and plasmonic gratings can enhance D* within a narrow spectral bandwidth by reducing the diffusion current noise generated in the very thin absorber. This may allow both laser detectors and multi-spectral imagers to display background-limited performance at higher operating temperatures than is currently possible, leading to substantial reduction of the size, weight, and power (SWaP) of Navy systems. Both architectures are also suitable for fabricating devices displaying different resonance wavelengths on the same chip, which may potentially provide multi-spectral imaging by scanning a 1D array. Other architectures may allow simultaneous dynamic tuning of the resonance wavelengths of all devices in a 2D array.

Overall goals of this SBIR topic are to: (1) Enhance the sensitivity and overall performance of single-element narrow-band IR detectors for all polarizations of the incident radiation; (2) Demonstrate small arrays with nominal dimensions of at least 4 × 4 or 16 × 1 by the end of Phase II, which can be scaled to a 64 × 64 format mini-camera in a Phase II option and higher format wavelength tunable cameras in Phase III; and (3) Demonstrate controlled tuning of the resonance wavelength over at least 500 nm and return back to the initial wavelength within 0.1 ms, for an effective hyperspectral revisit rate of = 5 kHz.

CLARIFICATIONS:

For those companies who wish to use GFE furnished materials in Phase I, the wafer material offered will be 1/4 wafer of an nBn structure with cut-off wavelength about 5.1 um and 100-nm-thick Ga-free absorber (InAsSb-InAs superlattice), which is grown on a GaSb substrate. No distributed Bragg reflector (DBR) mirror is included as part of the provided wafer material. The material will be delivered no later than 80 days after the beginning of Phase I. If requested, further wafer material can be provided under Phase I option and Phase II to any performer who is awarded contracts for those phases.

PHASE I: Develop a proof of principle approach to fabricating narrow-band (= 200 nm) detectors with tunable resonance wavelength. The design should be capable of reaching D* > 4 x 1011 [cm – sqrt(Hz) / Watt] for a resonance wavelength of 4.5 µm and all polarizations when operated at 200 K. Process and deliver a single fixed-wavelength narrow-band detector for evaluation by the Offeror and/or NRL.
In the Phase I Option, if exercised, demonstrate via experiment and/or modeling the feasibility of a tunable narrow-band mini-array for development in Phase II. The mini-array will have dimensions at least 4 × 4 or 16 × 1, and variable resonance wavelength spanning at least 500 nm of the MWIR band.
In Phase I, MWIR detector wafer materials can be provided by the Naval Research Laboratory (NRL), or the awardee may employ its own source of material.

PHASE II: In the first 18 months of Phase II, optimize D* of the narrow-band MWIR detectors. By the end of Year 2, fabricate and deliver a narrow-band mini-array with dimensions of at least 4×4 or 16×1, and which provides variable resonance wavelength spanning at least 500 nm of the MWIR band. The spectral bandwidth should be = 200 nm, but may be much narrower and its value is optional because different widths are optimal for different applications. Delivery will include a cooler/dewar as needed, electronic controls, and input/output optics. If the awardee chooses to employ detector wafer materials from NRL, those materials can be provided as needed.

PHASE III DUAL USE APPLICATIONS: Fabricate and deliver a narrow-band camera with array dimensions of at least 128 × 128 and resonance wavelength spanning = 500 nm of the MWIR at a rate = 5 kHz. Delivery will include a cooler/dewar, read-out integrated circuit (ROIC), and input/output optics, with input lens providing = 8° field of view. The manufacturing technology for producing the array should be at least MRL 4 [Ref 6]. The narrow-band arrays should be suitable for hyperspectral imaging, remote chemical and biological detection, or free space optical communications for DoD missions.

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KEYWORDS: MWIR, resonant cavity devices, plasmonic metamaterials, laser detection, spectroscopy, remote sensing

N232-105 TITLE: Liquid Crystal on Silicon (LCoS) Micro-Displays for Deep Learning Acceleration

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;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: Research, develop, and fabricate micro-scale, high-resolution, high-refresh rate liquid-crystal-on-silicon (LCoS) micro-displays.

DESCRIPTION: The Office of Naval Research (ONR) is currently developing a range of electro-optical compute accelerators (EOCAs) for small-scale, low-power, lensless computer-vision applications. To create the next-generation versions of EOCAs, we are seeking proposals aimed at the fabrication of custom liquid-crystal micro-displays. We are interested in micro-scale, high-resolution liquid-crystal displays, similar to what would be found in commercial virtual-reality headsets.

The micro-displays we need have several requirements not found in existing commercial offerings. Some additional research is hence needed. The micro-displays must be small (20 millimeter diagonal length or less) and high resolution (2048x1080 pixels or higher). The micro-displays should be grayscale-only and capable of supporting and implementing 8-bit grayscale values with the option to potentially support 16-bit values. A low response time (about 3 milliseconds or lower), and hence high frame rate (240 frames per second or higher), is needed to perform sensing and processing tasks at a level needed for realizing certain autonomy capabilities. The micro-displays should also come in back-lit and non-back-lit, transparent variations. In the latter case, the display should be made as transparent as possible so that light can travel through the liquid-crystal layer and be predominantly attenuated by the point-spread functions that will be shown on them. The EOCAs will have active-pixel sensors placed almost immediately behind the transparent liquid-crystal layer of the micro-displays, so no occluding materials can be present; any electronics should be located at the periphery of the displays and incorporated into the baffling. Both the back-lit and non-back-lit, transparent displays should interface with printed-circuit driver boards that will be developed and fabricated by the awardee as part of this SBIR topic.

Design Requirements:

- Size: < = 20 millimeter diagonal length
- Resolution: > = 2048x1080 pixels
- Display Color: Monochromatic
- Refresh Rate: > = 240 frames per second
- Pixel Bit Depth: > = 8 Bits
- Cell Gap Uniformity: < = 5%
- Back-lit Display Brightness: > = 1000 candela per square meter
- Interface(s): Multi-lane Mobile Industry Processor Interface (MIPI DSI) with High-Definition Multimedia Interface (HDMI) 2.1, or better, to provide inputs to the printed-circuit driver board

Technical challenges: Ideally, the displays should be as low power as possible. An integrated driver will likely be necessary to achieve power draws of under 400 milliwatts while the display is active. The

displays may be used for applications in harsh environments not currently considered by the acquisition program. A path forward for high-temperature operating conditions (greater than 70 degrees Celsius) should be established in the design stage, even if it is not implemented in the prototypes.
Supporting incredibly high frame rates will not be feasible with present HDMI standards. Pre-buffering many image frames may not always be an option. The displays will hence, practically, be limited to the rates and resolution supported by the current HMDI 2.1/2.1a standard, which will be approximately 240 frames per second, during evaluation by the Navy. The designed displays will eventually be merged with a custom application-specific integrated circuit (ASIC) chip to drive them at the highest frame rate offered by a multi-lane MIPI connection.

PHASE I: Produce a LCoS design that satisfies the above criteria. If the design cannot meet the design objectives an analysis or discussion of the potential should be included in the Phase I report. Modeling, simulation, or comparison to similar developments should be used to justify design decisions.

PHASE II: Fabricate two to three prototype systems for evaluation. The prototype demonstration should achieve or show potential for meeting the design requirements. Perform detailed analysis on ruggedness and compatibility with Navy unmanned underwater vehicle handling, storage, and environmental operating conditions. Testing will be conducted by both the performer and by Navy personnel. Cost effectiveness and manufacturability feasibility should be addressed as part of the prototype test and evaluation. The appropriate acquisition program office will be consulted for any additional evaluation metrics needed for Phase III.

PHASE III DUAL USE APPLICATIONS: Build an advanced LCoS prototype that meets appropriate technology readiness level (TRL) metrics set by the acquisition program office. Support the Navy for test and validation of the system for certified Navy use. Explore the potential to transfer the LCoS technology for commercial use. Commercial applications might include visual detection and tracking systems, low-power processing for commercial UxV systems, and large-scale supercomputing resources. Develop manufacturing plans to facilitate transition to a UUV program of record.

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KEYWORDS: Liquid-Crystal Display, Optical Processing, Machine Learning, Computer Vision, Deep Network, Frame Rate

N232-106 TITLE: Machine Learning Database to Guide Development of Low Flammability Polymer Matrix Composites

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

OBJECTIVE: Develop an active machine learning (ML) database to aid the Navy in the development of polymer matrix resins and composites that have low flammability. as demonstrated under ASTM E1354 (heat release rates) by cone calorimeter. The Navy has very strict flammability requirements for composite materials to qualify for use below deck (MIL-STD-2031), which must meet metrics for time to ignition, maximum heat release rate, and smoke density (IAW ASTM E662).

DESCRIPTION: Use of polymers and composites below deck on a ship is very limited because the polymer matrix resins potentially provide fuel to a fire. Use of composites in general could save weight and reduce maintenance. In applications such as pressure vessels, there is potential to save costs as well. However, the epoxy matrix resins typically used are too flammable and the composite vessels will not meet Navy flammability requirements. Polymer resins that have reduced flammability typically leave more char when burned. They are highly crosslinked materials that are brittle and must be cured at higher temperatures making them more expensive than metal pressure vessels. Addition of flame retardants to the epoxy resins can reduce their properties.

A composite is a system composed of a matrix resin, reinforcement, and possibly other additives. The reinforcements and additives can improve the flammability performance of the composite by restricting oxygen flow to the resin as an inert filler or as an active filler promoting the formation of a blocking layer. The mechanical properties of a polymer composite (i.e., modulus, strength) can be predicted based on resin properties, fiber/filler properties, and fiber volume fraction and orientation. Addition of flame retardants provides a new variable as generally these decrease mechanical properties, though some types could enhance properties.

Working through these variables to identify composites systems that could be used below the deck on Navy ships has proven to be difficult. A ML database could help and could make use of the fairly plentiful data on composites as building materials to predict avenues for the Navy to pursue.
ML databases can be constructed such that they can take many inputs, either experimental or computational, which may be used directly as descriptors to correlate to a desired predicted property, or used to calculate a descriptor through physical or empirical relationships. It is a learning process to see which descriptors yield or correlate to predicted properties which best match experimentally determined properties. When this happens, then reverse design is possible. With this learning process in mind, we would like to start at a fairly simple level with composite component materials on the input side and Navy performance metrics on the output side to evolve an effective ML database for composite materials with low flammability that meet Navy performance needs (modulus, strength, thermal stability). Work will start in Phase I with trying to estimate the flammability of a composite. The Navy has performance requirements based on ASTM E1354 testing with limits given in MIL-STD-2031 [Refs 1-2].

PHASE I: Develop an expandable ML platform that can use: (1) literature data and; (2) first principle calculations to predict the flammability index from the chemical structure of a neat resin. Develop an approach toward predicting ASTM E1354 Cone calorimetry results for maximum heat release rate, time to ignition, and smoke density.

PHASE II: In year one of the Phase II, composite properties will be added based on typical glass fiber and carbon fiber compositions/geometries/volume loading of Navy composites and commercial structural composites. In consultation with the Navy, neat resin and composite samples will be tested to ASTM E1354 and the data will be used to both evaluate the ML database and to add to it. In year two of the

Phase II, common flame retardants will be added to neat resins and composites in a second round of ASTM E1354 testing, again to test this capability of the ML database and to add to it. In Phase II Option, if exercised, mechanical properties of the composites with resin/fiber/flame retardants could be added or other ML database maturation based on discussions with the Navy team.

PHASE III DUAL USE APPLICATIONS: Make the system user friendly, allowing the users to add their own databases and to prioritize various data sources already incorporated into the model. Transition the platform to the technical warrant holder for flammable structural materials and to material engineers trying to improve materials.

The database is dual use as low flammability structural materials are needed for commercial and residential buildings, for aircraft and automobile interiors, and other applications in addition to being used on pressure vessels, storage tanks, hatch doors, and so forth below deck on Navy ships.

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2. "ASTM E1354-22b Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter." https://www.astm.org/e1354-22b.html
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KEYWORDS: ASTM E1354; composite; heat release rate; machine learning; database; flammability

N232-107 TITLE: Shipboard Carbon Capture and Storage

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

OBJECTIVE: Develop and demonstrate methods to capture carbon dioxide emissions from a ship's exhaust and store it onboard until it can be offloaded.

DESCRIPTION: The Department of the Navy's recently released strategy, Climate Action 2030 [Ref 1], established aggressive targets to reduce Department-wide emissions of greenhouse gases. Despite recent advances in energy efficient technology, the Navy is still heavily reliant on fossil fuels for propulsion and power generation on its ships and aircraft, with surface ships consuming more than 12 million barrels of marine diesel annually. Achieving net zero emissions will require a combination of approaches including alternative fuels, increased hybridization, and direct carbon capture both on installations and at-sea. The latter requires adaptation of stationary carbon capture technology for shipboard application. A number of post-combustion carbon captures technologies have been employed in terrestrial power plants, with chemical adsorption being the most mature. Exhaust gas is first cooled, passed through a filter, and then reacted with the absorbent, typically an amine-based solvent, to separate carbon dioxide before the exhaust is released to the atmosphere. The absorbent then goes through a regeneration process in which the CO2 is released by heating, and the absorbent is recycled to the absorption process. In addition to requiring large machinery, the solvents are toxic and can degrade in the presence of other components common to a marine exhaust. Adsorption of CO2 into a solid matrix can alleviate the need for such solvents, but is less selective as absorption. Membrane separation systems are potentially more compact and efficient, but long-term durability has not been demonstrated. Another challenge is shipboard storage of the captured CO2. Storage in gaseous form is often not practical due to space requirements and conversion to liquid or solid require significant power.

Innovative research is sought to develop compact approaches to capture and store carbon directly from shipboard exhaust, while minimizing impact to current ship systems. Systems resulting in a net reduction in carbon emissions greater than 75% are sought, while minimizing impact on efficiency. Net carbon reduction includes extra emissions from power needed to run the system. The most common propulsion system used in Navy surface combatants is F76 fueled LM2500 gas turbines that produce up to 150 lbs/s of 1050 °F exhaust. The system must be able to store at least two weeks' worth of removed carbon for transfer during ship refueling. Storing captured CO2 as a liquid or solid (dry ice) has significant volumetric advantage, but requires additional power. Possible alternatives such as liquid mixtures or mineral carbonization could be evaluated.

PHASE I: Develop an innovative, compact, and energy efficient approach to capture and store carbon dioxide from post-combustion exhaust from a gas turbine engine typical of Navy surface combatants. Analyze the size, weight, and power consumption of complete system. Perform an initial estimate of system cost.

PHASE II: Demonstrate a working prototype of the system sized at least 1/50th of an LM2500 exhaust at full power. Experimentally validate the unit's performance over a variety of exhaust conditions. Assess operational impacts of proposed technology. Complete a cost and scalability analysis of full-scale system.

PHASE III DUAL USE APPLICATIONS: Optimize the concept design for manufacturability, performance, and military requirements using the knowledge gained during Phases I and II. Perform a detailed integration study for installation on a Navy surface combatant. Develop a commercialization strategy for dual use on commercial maritime vessels.
The system could be used in commercial maritime vessels.

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KEYWORDS: climate; carbon capture; combustion, absorption, membrane separation

N232-108 TITLE: Low-Cost Electronic Warfare Training Hardware

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems;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 low-cost hardware to remotely manipulate command and control (C2) gear to mimic Electronic Warfare (EW) attacks during Marine Corps training and exercises, especially those conducted in home station.

DESCRIPTION: Infantry Marines at Battalion level and below do not have organic training capabilities for EW. A key problem is the availability and affordability of EW training equipment that can be used by the units or support organizations conducting training scenarios. These training scenarios need to include realistic EW effects but are prevented in many cases due to classification or restrictions involved with employing actual attacks.

A low-cost remotely controlled hardware device which can mimic different EW attack effects is desired. Devices should easily interface with operational equipment such as tactical radios, GPS, networking gear, and computers. The device shall be interoperable with, and not hinder, range control and other communication and position location identification (PLI) systems that link and integrate other safety networks. The device should be man-portable, or transportable by an unmanned system (e.g., ground) and be capable of supporting a 5-day training event within a mission duration of 8 hrs/day. External power and different levels of activity mode (e.g., active, sleep, etc.) may be used to address training timeframe. Ideally, the total system cost is below $1,500. Control of the device should be enabled via standard Internet Protocol (IP) network messaging (e.g., Transport Control Protocol / User Datagram Protocol) on a separate network (wired or wireless) from tactical gear and support machine to machine control from other systems. Documented control interfaces to allow third-party control, integration, and testing (e.g., software API) must be provided with prototypes. Specifically, the goal is to enable remote management of the device to allow scenario managers or adjuctors/referees the ability to simulate EW effects on the training unit. Examples of attacks to be mimicked include jamming, deceptive signal broadcast, and data injection. Candidate solutions may be based on low-power close-in electromagnetic emmisions or hardware-based signal attenuation (i.e., in-line software-controlled signal attenuation devices), however alternate strategies will also be considered. SBIR submissions should, at a minimum, have capabilities of affecting frequencies supported by AN/PRC117G, including VHF and UHF SATCOM. Candidate devices may be reconfigurable or include heterogeneous components to enable compatibility with alternate frequencies or waveforms. The overall expectation is that a number of prototypes would be used to create an affected area in which the training unit would experience synthetic EW effects realistic enough to enhance training.

PHASE I: Construct a single non-hardened prototype device to support at least one attack vector. Attack vectors include, but are not limited to, jamming, deceptive signal broadcast, and data injection. Research and market analysis documentation generated by SBIR performers will be evaluated in partnership with transition office, ONR SBIR technical POCs, and training communities evaluate and prioritize attack vectors and methods during early technical development phase.

Prototype device will demonstrate ability to generate electromagnetic (EM) signals or EW capability that mimics realistic effects within training community objectives. For example, EM Signals will match characteristics of realistic operational equipment (i.e., signal waveform) at an acceptable emission power level that will allow training range or home station EW sensing training (Order of Magnitude emission power should be greater than 1 Watt and no more than 50 Watts). Multi-waveform emission capability via Software Defined Radio or similar technology (e.g., FPGA) that demonstrates multi-role utility is preferred for low-power emmision devices. Components of prototype and production process should reflect technical and manufacturing approach that will enable cost per unit objective (below $1,500), however, higher costs reflecting greater system capability or adaptability are also acceptable. Prototype will be able to operate on battery power enabling long-duration standby (but can be supplemented by shore power for extended use). Ideally, the system would be compatible with program of record USMC battery or standalone electricity systems (e.g., 2590 batteries or SPACES-II solar kit). Prototype kit should be man-portable (i.e., hand-carry), fitting into a common ‘briefcase sized’ protective case (e.g., Pelican 1550 or similar).

PHASE II: Construct training-ready (i.e., hardened) devices that support multiple EW attack or signal effect vectors.

Prototype will demonstrate downstream capability to network with program of record exercise control systems in distributed manner (i.e., multiple devices can be controlled at once), and provide sense/replay capabilities (if applicable) to be executed within training-relevant timelines (i.e., processing for replay fast enough to enable tactical mimic of signals). Prototype will be hardened physically and electromagnetically to meet acquisition-office deployment requirements (i.e., field-deployable with modest adjustments). Hardware will demonstrate ability to operate in the field within training-relevant timelines (hours-days+) in low-power mode to extend training time. Hardware will demonstrate ability to receive control messaging with existing exercise control (EXCON) systems via stakeholder selected IP-based messaging protocol to enable centralized control of many devices from a central EXCON station. Software controls enable dynamic control of signals to align with mobile training unit (i.e., emit power can be controlled to enable dynamic jamming effects, different frequencies for emission and waveform can be selected). Hardware configuration includes approvable sources electronics (i.e., no blacklisted hardware). Vendors will work with government identified program of records such as Marine Corps Live Virtual Constructive-Training Environment, Electromagnetic Warfare Ground Instrumented Range, and potential others.

PHASE III DUAL USE APPLICATIONS: Establish at-scale manufacturing pipeline able to produce EW training hardware devices in limited runs. Demonstrate production equipment using approved components, software ATO, etc. Contracting method with the appropriate acquisition office established to enable purchase of standalone units (or block-purchases). LVC-TE program able to purchase equipment to field tied into selected next-generation range communication systems (e.g., 5G backhaul).
Outside of the DoD Marine Corps Infantry end user population, it is expected that the hardware developed under this SBIR topic can be used for testing or training by mimicking EM signals produced by civilian infrastructure. Potential end users that would be tested and trained include those working within commercial communications – e.g., first responders, cellular provider technicians, and others. Specific tasks may include equipment installation normally requires load-testing and interference testing during installation to characterize network performance envelope – this hardware can create realistic representation of single or multi-band users by generating signals within civilian frequency bands. Additionally, the device will be able to create temporary communications-degraded environments on channels used by civilian emergence or disaster-relief response teams. The device would be able to create

a training environment simulating limited or loss communications emulating limited infrastructure expected under a Humanitarian Assistance and Disaster Relief scenario.

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KEYWORDS: Training; Electronic Warfare; Marines

N232-109 TITLE: Data Exfiltration and Communication Architecture for Cooperative, Autonomous, Underwater, Long-endurance Sensors

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

OBJECTIVE: Develop a communication and data exfiltration architecture with related algorithms to support a spatially-distributed and depth-varied field of long endurance Underwater Autonomous Sensors (UAS) operating in a cooperative network in an ocean environment.

DESCRIPTION: Long endurance, autonomous sensors such as gliders, profiling floats, sonobuoys, and Autonomous Underwater Vehicles (AUVs) continue to provide critical measurements in oceanographic surveys and experimentation. Individually, these sensors can be deployed to provide a basic understanding both spatially and temporally of oceanographic phenomena. However, a comprehensive underwater monitoring approach would be possible if a fleet of autonomous, underwater sensors were capable of underwater communication, networking, and cooperatively exfiltrating data back to a central node/platform for aggregation. This SBIR topic takes advantage of continued technological advances in communication networks and autonomous systems to develop algorithms for UAS synchronization and communication architectures. The objective is to develop a communication and data exfiltration architecture with related algorithms to support a spatially-distributed and depth-varied field of long endurance UASs operating in a cooperative network in an ocean environment. The architecture should be sensor-agnostic to allow for synchronization and communication between multiple platform types (e.g., Sonobuoy to glider). The algorithms should assume 10s to 100s of sensors at multiple depths, which can span from 60 ft. to > 1500 ft. and spatially separated by 1-10nmi between platforms with a data exfiltration component to specialized nodes. Initial data collected and communicated should include latitude, longitude, pressure, and temperature with future options including acoustic data. A-sized sonobuoys will function as the initial platform for algorithm and physical architecture development. The proposed prototype hardware that will host the developed algorithms must be subject to the size (< 1100 cu in.), weight (< 24 lbs.), and power requirements to fit in the lower unit of a traditional A-size sonobuoy.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop the initial concept design and algorithms, and model key components to demonstrate proof of concept. To support multiple potential optimal configurations, indicate the trade/risk space on cost/feasibility/component maturation for capability to achieve a spatially distributed network of UASs at a variety of depths, spacing (1-10nmi), and operational life (8hrs – 14days). Perform an estimate of component costs and fabrication estimates for new technology to be developed in subsequent phases of the effort.

PHASE II: Construct a prototype system based on the Phase I design(s) for demonstration and validation. System development should include development/maturation of the communication and data exfiltration algorithms, as well as prototypes for collection, exfiltration, and aggregation of oceanographic data. Software should rely on open-source languages and libraries. Multiple demonstrations in operationally

relevant environments should be planned, including in coordination with a larger research field exercise with additional autonomous sensors. Prototype(s) should 1) be run in near-real time, 2) test communication and networking at a variety of spatial, temporal, and depth scales/spacing, and 3) validation criteria include accuracy, latency, and processing time. Upon completion of Phase II, the prototype(s) and a technical report outlining function and validation/verification of performance should be delivered to the Department of Navy (DON) ready for demonstration at sea.
Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will align with the program of record to integrate the results of the Phase II work. This includes manufacture of multiple units, incorporation of algorithms to systems (where feasible), and adjusting requirements based on needs of the operational environment.

Dual-use applications include coordination with other governmental partners for oceanographic monitoring and data collection (such as National Oceanic and Atmospheric Association (NOAA)), university partners using data for pedagogical and/or research purposes, and industry partners with needs for autonomous, underwater monitoring or survey.

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KEYWORDS: environmental monitoring; cooperative network; Underwater Autonomous Sensors; distributed field; underwater monitoring; sonobuoys

N232-110 TITLE: Multidirectional, Multifrequency Ship-based Meteorological Satellite Receiver Using a Virtual Gimbal

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

OBJECTIVE: Develop a cost-effective direct broadcast satellite data receiver system with no moving parts (i.e., virtual gimbal), capable of receiving environmental data streams across multiple transmission bands from a shipboard environment in open ocean.

DESCRIPTION: Direct reception of meteorological satellite data in a maritime environment relies on ship-mounted antennae whose directionality is governed by a rotating gimbal. The rotating gimbal is a common point of mechanical failure for these antennae. While at sea and when broken, there may not be spare parts to repair and restore the gimbal to restore functionality. Further, older antennae may not be equipped to receive at frequencies commonly used by the legacy as well as the latest generation meteorological satellites (typically L through X bands). Such data are high value for operations and their absence diminishes overall performance. This SBIR topic takes advantage of continued technological advances and miniaturization of electronics to reexamine new, cost-effective methods to reliably receive satellite-based meteorological data feeds across multiple frequencies.

The objective is to develop an innovative multiband antenna whose directionality is governed by a virtual gimbal to help reduce incidences of mechanical failure and broaden the pool of available data. The antenna should have no moving parts, be reasonably maintainable with off-the-shelf parts, and be capable of operating in a seaborne environment. This includes accounting for reasonable size, weight, and power requirements and operating on a moving vessel subject to wind and waves. The antenna should receive at a reasonable subset of microwave downlink bands to receive meteorological satellite data broadcasts. A data rate of up to 40 Mbps is required to facilitate representative Joint Polar Satellite System (JPSS) direct broadcast and Geostationary Operational Environmental Satellites (GOES) Rebroadcast capabilities. The antenna should receive Level 0 satellite data in its native format which can then be processed onboard by existing software into a human readable format. Reception of [Advanced] High-resolution Picture Transmission data ([A]HRPT) from the National Oceanic and Atmospheric Administration (NOAA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) is encouraged. Design and specifications should also consider direct downlink of novel and future capabilities, such as from commercial weather data vendors and National Aeronautics and Space Administration (NASA) satellites.

PHASE I: Determine technical feasibility of a cost-effective, ship-based direct readout data system using a virtual gimbal able to meet the technological specifications listed in the Description. Develop the initial concept design and model key components to demonstrate proof of concept. To support multiple potential optimal configurations, indicate the trade/risk space on cost/feasibility/hardening for capability to use multiple frequencies and/or wider frequency ranges, various antenna sizes, and windows for viewing the sky including an option to cover all azimuths and altitudes from horizon to zenith. For the top scenarios, perform an estimate of component costs and fabrication estimates for new technology to be developed.

PHASE II: Construct prototype(s) of Phase I design(s) for demonstration and validation. For multiple candidate configurations, clearly indicate comparative criteria for testing and evaluation of final candidate system, including cost, performance, and robustness metrics in real world conditions. For a single candidate configuration, testing thresholds should clearly indicate milestones for evaluating and improving new system technology.

System development should include development/maturation of the direct broadcast hardware system, as well as an end-to-end software prototype for converting received signals into calibrated products that are useable by downstream applications (such as forecaster usage, numerical model ingest). Software should rely on open-source languages and libraries (such as python) and be aligned with current and/or planned production standards for meteorological satellite data in Naval production centers.

Multiple demonstrations in operationally relevant environments should be planned, including in coordination with a larger research field exercise. Prototype(s) should 1) be run in near-real time along with shipborne operations, 2) test reception of multiple satellites at different broadcast frequencies, and 3) validate Level 1/calibrated brightness temperature data records against existing operational sources. Validation criteria include accuracy, latency, and processing time.

Upon completion of Phase II, the prototype(s) and a technical report outlining function and validation/verification of performance should be delivered to the Department of Navy (DON) ready for demonstration at sea.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will align with the program of record to integrate the results of the Phase II work. This includes manufacture of multiple units, alignment of broadcast system into the meteorological operations processing chain, and adjusting requirements based on needs of the operational environment.

Dual-use applications include coordination with other governmental partners for low latency meteorological data (such as USAF, NOAA, and NASA), university partners using data for pedagogical and/or research purposes, and industry partners with needs for improved/cheaper/smaller direct readout of satellite data.

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KEYWORDS: satellite; receiver; gimbal; antenna; direct readout; direct broadcast; satellite based environmental monitoring; phased array; software defined radio; electronically steered beam

N232-111 TITLE: Indirect Fire Navigation without GPS or Civilian Infrastructure

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 low-cost, Indirect Fire Navigation (IFN) architecture that will provide the Navy and Marine Corps with a common, ubiquitous method of all-weather communication and guidance for a Diverse “Community” of Interceptors and Launchers. With respect to existing weapons, the proposed IFN system must have the potential to reduce the size, weight, power, and cost of engagements by an Order of Magnitude with a commensurate increase in the number of simultaneous engagements and stored kills. Moreover, IFN systems must also be capable of network-centric cooperative engagements between platforms with IFN capabilities with the ultimate goal of making “every ship a shooter” and achieving distributed defense among all ship classes.

DESCRIPTION: Existing systems are characterized by large, powerful, and expensive radars, illuminators, missiles, and launching systems. Low bandwidth communications links, single channel illuminators, and volumetrically inefficient magazines limit the ability of these systems to effectively address large, multi-axis raids and project power to ranges beyond line-of-sight. IFN architectures will radically alter these metrics by building on existing technology and applying it to both existing and new weapon systems which have been designed to maximize the benefits of the IFN concept. IFN constructs will support surface to surface and surface to air engagements at long range (over-the-horizon) and must have low size, weight, and power (SWaP) requirements. Concepts shall be applicable to both existing missile and projectile systems and new, compact, low-cost interceptors. The IFN architecture may contain off-board targeting systems and must be capable of accepting a targeting “Cue” from any higher-level Search and Track sensor without consuming additional sensor resources.

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 DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). 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 IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Conduct a study that develops at least one system concept for IFN meeting the features listed above in the Description. The basic physics of critical elements within the proposed IFN system must be characterized and modeled. Parametric studies are acceptable where performance characteristics vary widely or are unknown. If more than one concept is studied, compare, contrast, and rank the attributes of each and recommend the best path toward further investment, study, development, and experimentation. Prepare a report to ONR detailing the IFN design(s) complete with a Phase II testing plan.

PHASE II: Fabricate and demonstrate brass board versions of key elements in the IFN system developed during Phase I. The system model may require additional fidelity to adequately define the test objectives of Phase II testing, which will measure key metrics affecting system performance. The effort will be classified due to the design and testing of IFN subsystems and critical components demonstrating system performance and matrices. Prepare a report to ONR detailing the results of the Phase II design, fabrication, and testing. Develop a Phase III plan for prototype evaluation.
Work in Phase II will become classified. Please see note in the Description.

PHASE III DUAL USE APPLICATIONS: Design, fabricate, and demonstration test a complete IFN prototype system. Document the design features of the IFN system and the results of demonstration testing in relevant environments associated with Navy and USMC missions. The evolved IFN prototype and Phase III Report will be deliverables to ONR/NSWCDD at the conclusion of each Phase III task. IFN nodes can and should be networked together. As such, they will not only form a support structure for robust communications and engagement systems for self-defense and power projection but also provide a relative navigation system between each node and of the entire network of nodes. As a consequence, dual use opportunities exist for military and civilian applications where there is a need for, as examples, network health monitoring with self-healing, auto-drive, autonomous landing and docking, and collision avoidance.

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KEYWORDS: Low-Cost, Low-Power, Over-the-Horizon (OTH), Network Centric Cooperative Engagements, Guidance and Navigation, self-defense, power projection

N232-112 TITLE: Electromagnetic Manipulation of Plasma on Hypersonic Reentry Bodies

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): 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: The plasma layer from hypersonic reentry serves to further propagate heat into the reentry vehicles while also increasing its radar visibility and causing what's known as a "communications blackout", a period in which no communications can be exchanged with the vehicle. The Navy seeks to implement developed technologies to manipulate or suppress the effects of environmental plasma with electromagnetic forces to mitigate the environments presented by environmental plasma layers upon atmospheric reentry.

DESCRIPTION: For the future of hypersonic vehicles carrying sensitive payloads into the atmosphere of earth or any other planet, the presence of a communications blackout is of utmost concern. It entails the causes of any catastrophe being rendered unknown, the lack of the period's test data, and limitations in the innovation of reentry vehicles. The obvious candidate for improvement to these vehicles is in expanding upon plasma manipulation; in mitigating or eliminating the plasma frequency on the vehicle's exterior, communications blackout can be mitigated, heat transfer can be reduced, and the craft's electromagnetic signature can be minimized.

These concerns can be alleviated by a system well equipped to manipulate the inevitable accumulation of plasma from surfaces including the aeroshell and antenna window. It's important in this design to consider the importance of mitigating the plasma oscillation effects on outgoing radio signals. Plasma oscillation, or the frequency of electron density oscillations, will control which frequencies may be received by the vehicle's antenna; it's important to consider it a primary goal to mitigate the effects of such a plasma layer by either reducing or eliminating this oscillation of electron density outside the intended emission point of the incoming radio signal, as the only radio frequencies allowed to pass through the plasma layer are those with frequencies higher than the plasma layer's oscillation frequency. Furthermore, a goal of this solution should include the minimizing of plasma density on the exterior of the vehicle.

Considerable research has been conducted on possible systems that can create "windows" in a plasma layer for radio waves to be transmitted through [Refs 1,2]. The utilization of magnetic fields has evidence of being effective in dispersing plasma "sheaths," but the concept of a "magnetic window" has not yet been fully explored [Ref 3].Recently there has been some experiments reducing the plasma sheath using pulsed magnetic fields, however for smaller time frames than what is required for communications [Ref 5].

In the application of magnetic fields for plasma manipulation, weight-conscious designs are imperative for the operation of hypersonic vehicles. The system should be optimized for breadth in radio frequency, quickly-initiated operation sustained for extended periods of time, and minimal load to the vehicle. Proposals are solicited that address the following capabilities:

- Develop plasma manipulation concept implementation for 6-minute atmospheric reentry
- Assessment of other limiting factors and areas of concern

• Design, build, lab test scaled model of plasma manipulation system prototype
Proposed solutions should support the following:
• System operation for up to 6-minute reentry time
• Capable leverage use of existing power supply or the specifications and requirements of an alternative power solution
• MIL-STD-461G (EMI)
• MIL-STD-464D

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

PHASE I: Develop a proof of concept of a system that will be able to manipulate or mitigate the effects of a plasma layer so that radio waves can be transmitted uninterruptedly. Model the system's feasibility and energy usage. It should include initial design specifications and capabilities description to build a prototype solution in Phase II if chosen.

PHASE II: Mature the concept system and develop a prototype able to be tested in a laboratory to display the system's capabilities to receive radio communication from beyond the plasma layer. Demonstrate the feasibility of the solution and delay time of effective operation from activation.
It is probable that the work under this effort will be classified under Phase II (see Description for details).

PHASE III DUAL USE APPLICATIONS: Perform detailed design of a scaled plasma manipulation system, validating lab mockup communications through manufactured plasma layer. Develop a process for future use of the framework.

Dual-use applications will entail implementation on hypersonic vehicles, including manned and unmanned spacecraft, requiring safe reentry into planetary atmosphere. Dual use applications include more efficient testing of new exo-atmospheric spacecraft and aerospace technologies, ensuring safety of testing equipment and spacecraft communication devices, and more efficient means of developing advancements to Reusable Launch Vehicles (RLV) and Vertical Takeoff, Vertical Landing (VTVL) spacecraft.

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KEYWORDS: Plasma manipulation; Electromagnetic; Hypersonic; Re-entry; RF; Plasma density reduction

N232-113 TITLE: On-Chip Optical Isolation for Integrated Photonics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;Nuclear;Quantum Science

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 on-chip optical isolators at telecom wavelengths with a high isolation ratio, wide bandwidth, and low insertion loss.

DESCRIPTION: A complete integrated photonics toolset requires optical isolators and circulators. These components improve the routing of optical power on chip by blocking light from entering chosen ports [Refs 1,2]. Such a component is crucial to the performance of on-chip lasers. While in-line fiber-optic versions of these components are available, on-chip integration has been a major challenge.
Optical isolators and circulators rely on the breaking of Lorentz reciprocity. This can only be achieved using one of three approaches: nonlinear effects, magneto-optical effects, and spatio-temporal modulation [Ref 3].

In the past two years on-chip optical isolation in the C-band has been demonstrated for the first time in two separate approaches. First, advances in the deposition of cerium-doped yttrium iron garnet (Ce:YIG), a magneto-optical material, have allowed for the integration of thin-films onto the sidewalls of both silicon (Si) and silicon nitride (Si3N4) waveguides. Optical isolation in both transverse electric (TE) and transverse magnetic (TM) polarizations has been demonstrated in these platforms [Ref 5]. Second, two separate groups simultaneously demonstrated optical isolation with spatio-temporal modulation of piezoelectric modulators integrated on waveguides [Refs 3,4].

SSP calls for the development of an on-chip optical isolation capability at telecom wavelengths. Among other capabilities, this technology will enable integration of sensitive optical sources on photonic integrated circuits. Both spatio-temporal and magneto-optic solutions are encouraged to respond to this SBIR topic. As the technology is matured, performers will collaborate with SSP and government contractors to integrate the technology into relevant platforms. This collaboration will also seek to develop a technology transfer plan for commercial-scale photonics foundry fabrication.

PHASE I: Perform a design and fabrication analysis to assess the feasibility of the proposed technique or material development for on-chip isolation in the telecom wavelength range for use in integrated photonic devices. Include the expected isolation ratio (ideally > 30 dB) for the technique, expected die area required, insertion loss introduced (< 3 dB insertion loss preferred), and bandwidth. Identify risks and risk mitigation strategies. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build prototype solutions in Phase II.

PHASE II: Fabricate and characterize five (5) prototypes that demonstrate the on-chip isolation capability. Variability of key metrics (isolation ratio, bandwidth) < 3% and optical insertion loss < 3 dB should be addressed with a mitigation plan to enable highly reliable performance as the system matures. The final report will include a discussion of potential near-term and long-term development efforts that would improve the technology's performance and ease of fabrication. It will also include an evaluation of the cost of fabrication and how that might be reduced in the future. The prototypes should be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes and continual advancement of photonics capabilities, on-chip isolation technology should lead to dramatic improvements in the feasibility of achieving fully integrated photonic devices. Support the Navy in transitioning the technology to Navy use. The prototypes will be evaluated through optical characterization and testing with relevant adjacent devices. The end product technology could be leveraged to bring photonic imaging and sensing towards a more mature state with a lower size, weight, and power (SWaP) profile that could make it more attractive for optical communication and Light Detecting and Ranging (LIDAR) as well as in the biomedical, navigation, and vehicle autonomy markets.

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KEYWORDS: Photonic integrated circuits; optical; isolation; magneto-optics; spatio-temporal; telecom; photonics

N232-114 TITLE: Miniaturized, High-accuracy, Radiation-hardened Rotary Angle Sensors

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: Develop miniaturized rotary angle sensors (e.g. resolvers or encoders) of high accuracy that are radiation hardened and capable of performing in space flight in a contested environment.

DESCRIPTION: Requirements driving the reduction of size of the next-generation, guidance systems dictate the need for size-reduction of all componentry without a relaxation of performance requirements. These competing concerns drive the need for innovation in the componentry used throughout the system. One component technology that is of chief interest is rotary angle sensor technology; this component measures the angular position and rotational speed and direction of a rotating member. The technology must be precise, accurate, and stable over a long product lifetime, capable of surviving shock, vibration, and radiation characteristic of space flight through a contested environment, as well as small, lightweight, and low in power dissipation.

There are a variety of technology approaches that may prove viable for improving currently employed capabilities, some examples include capacitance encoders, optical encoders, inductive encoders, magnetic encoders, ultrasonic encoders, and rotary resolvers [Refs 1-5]. Many devices, across this range of technologies, are available commercially and have found widespread use in both industrial and defense applications on the ground as well as in space. Miniaturized rotary angle sensor technology sought by this SBIR holds the promise, provided that smaller variants can be developed that meet the both the unique accuracy and packaging and environmental requirements. The following is a list of these requirements:

- Measurement range: 360 degrees
- Measurement type: Absolute
- Accuracy: < 20 arc second
- Max Rotation Speed (at full accuracy) = 25 rpm
- Interrogation rate = ~2.5 kHz
- Power (Total)= < 2 watts
- Power (Sense Head) = < 0.25 watts
- Size (sense head): 1 inch diameter x 0.5 inches height (max)
- Size (electronics): 0.5 in3 (max)
- Operation Temperature Range: 5º C to 60º C
- Storage Temperature Range: -40º C to 80º C
- Operating Pressure: 0 to 75 psia
- Humidity: 0 – 90% RH

Outline path toward meeting the performance requirements of a space launch environment for vibration and shock and a space radiation environment

PHASE I: Develop a design for a miniaturized rotary angle sensor based on the above requirements. Perform a study/analysis and show how the design should be able to fulfill the requirements. Define a test plan that will be used in Phase II to test the rotary encoder that exceeds the accuracy requirement listed.

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

PHASE II: Based on the design and results from Phase I, build a small lot of three functional, highly accurate, miniaturized rotary angle sensors and control electronics. Characterize the performance of the batch of sensors according to the test plan outlined in Phase I. Delivery of not less than two (2) devices to the government for additional testing at the conclusion of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continue development leading to productization of highly accurate, miniaturized rotary angle sensors suitable for a variety of applications for the defense, aerospace, and commercial markets. Such sensors would be applicable for use in seeker heads, radar fire controls, stabilized platforms, robotic joint feedback, vehicle surface feedback and/or flight control surface feedback. Specific detailed design guidance will be provided during Phase III.

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KEYWORDS: rotary angle sensor; encoder; rotary resolver; capacitance encoder; optical encoder; inductive encoder; magnetic encoder; ultrasonic encoder

N232-115 TITLE: Radiation Tolerant Fiber Optic Communication

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

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: Investigate and demonstrate radiation tolerant transmission and receiving for single-phase fiber optics.

DESCRIPTION: The radiation effects and subsequent mitigation strategies for both traditional Integrated Circuits and Fiber Optics can be well understood and protected against an individual component level [Ref 1]. When scaling outward to a System level that integrates both, greater considerations must be taken to ensure general system survivability against radiation. The effects particularly can manifest themselves at the interfaces that combine both types of components in a potentially sensitive system.

There are several existing products and methods that may meet the requirements of a radiation tolerant transmission and receiving of optical signals [Ref 2], however, it is yet unknown if these types of devices used for civilian applications can fully meet strategic program needs. A comprehensive study and development effort is required to understand the feasibility of using fiber optics for communication within missile sub-systems. The cable system (i.e., transmitter, fiber, and receiver) will need to withstand radiation environments analogous to natural space, as well as man-made hostile conditions for a prompt high dose rate range of 1E11 to 1E13 rad(Si)/s, a Total Ionizing Dose range of 1E5 to 5E5 rad(Si), Neutron Displacement Damage maximum of 5E12 to 1E14 n/cm2, and X ray fluence range of 0.1 to 10 cal/cm2. Additional success criteria will be an improvement (i.e., reduction) of size, weight, and power (SWaP) as compared to traditional copper. In addition to a possible reduction in SWaP characteristics, the fiber cables themselves are inherently immune to EMI/EMP, whereas copper has to be shielded in order to reduce the effect to acceptable levels.

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

PHASE I: Perform a feasibility study. All applicable environments will be considered and a plan developed detailing how each environment will be verified and, if necessary, mitigated. Feasibility will be evaluated in consideration of the aforementioned radiation environments as well as the increase/decrease in SWaP over common copper cables. Initial design specifications and capabilities description to build test articles will be developed or procured. The Phase I Option, if exercised, will entail prototype or procurement of the test articles, as well as further definition of the tests to be conducted in Phase II. These task suggestions are notional, and all qualifying and reasonable proposals will be considered.

PHASE II: Subject the test articles to the applicable environments. If certain tests are cost prohibitive, simulations may be developed and/or utilized to show compliance to requirements, however, a physical test is the preferred method of verification. Simulation methodology and data will be independently verified by the same standard as physical testing. Additional testing and/or analysis may be needed to verify reliability, robustness, etc. Commercialization strategy will be further refined.
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: Transition the technology to be used for the Trident D5 Life Extension II program. This technology will then be evaluated against the Defense Logistics Agency's Qualified Manufacturing Listing which will properly verify the different aspects of the technology, from its development and manufacturing to its field use, meeting strategic requirements. The aspects of the technology that don't meet standards may be adjusted and re-qualified. Once fully vetted and qualified, the technology may be purchased and integrated into the parts library of the program to be further tested and designed. At this stage it is expected that the company will have defined cost and manufacturing requirements and define the Intellectual Property needs, as well as meet with Naval financial experts to define a reasonable price for fielding the technology. In the commercial sector, this technology would apply towards producing high fidelity systems for space applications. These could include the advanced satellite systems as well as autonomous delivery systems that would require high speed, radiation tolerant system level data transfer.

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KEYWORDS: Fiber Optics; Radiation Effects; Optics; Single-Phase Fiber; Reliability; Optoelectronics; Space

N232-116 TITLE: Direct Etched Silicon Wafer Bonding for Micro-Electromechanical Systems (MEMS).

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Microelectronics;Nuclear;Space Technology

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OBJECTIVE: Develop a reliable direct silicon wafer bonding process with etched wafers.

DESCRIPTION: Direct silicon wafer bonding is the process of adhering two wafers together without any intermediate layers. Although this process is employed currently, it necessitates high standards in both surface geometry and roughness. Etched silicon wafers are often not considered for direct wafer bonding because of those standards. Adhesion layers, such as a eutectic metal layer, may overcome the stringent geometry standards required for direct bonding, but the mismatches of coefficient of thermal expansion (CTE) between the adhesion layer and the silicon device may lead to performance impacts for high stability sensors, such as long-term creep. Examples of existing research for direct wafer bonding can be found in the referenced articles [Refs 1-4].

MEMS sensors are more frequently being considered as alternatives to conventionally machined sensors in order to meet performance requirements in a low size, weight, and power (SWaP) package. This process is likely to bring value to multiple industries as the need for stability and reliability become more important.

PHASE I: Design a direct wafer bonding process with the desired goals of 1) forming a complete bond with at least one etched silicon wafer (bond areas no less than 100 µm x 100 µm, etch depth no greater than 200 µm); 2) demonstrating a hermetic seal with both an inert gas (such as dry nitrogen) or vacuum after dicing into separate devices; 3) ensuring reliability of the bond through thermal environments (between -55ºC to 85ºC) and mechanical environments such as vibration, shock, bond strength, and constant acceleration (see MIL-STD-883-2 for reference). The Phase I study shall assess all aspects of the bonding process and justify the feasibility and practicality of the designed approach. The Phase I Option, if exercised, will include the initial design specifications and capabilities to build a prototype solution in Phase II.

PHASE II: Based on the Phase I design and execution plan, fabricate and characterize a small lot (up to Qty: 5 wafers) of silicon articles. This characterization may include hermetic leak checking, bond strength tests, and wafer uniformity for sample MEMS devices. Wafers will need to be etched, bonded, and diced to resemble a typical MEMS device process. The prototypes, test samples, and characterization results should be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continuing development must lead to productization of the direct wafer bonding process. Qualify this product by inserting and demonstrating the bonding process into a known microfabrication process for a MEMS design. If required, subject the devices incorporating the wafer bonding process to several common test environments, including radiation and vibration environments.

While this technology is aimed at multiple national interest applications, wafer bonding is used more broadly in the MEMS industry. A direct bonding process for etched wafers is likely to bring value to existing commercial applications such as space and autonomous vehicle navigation to improve both the reliability and performance of high-end MEMS sensors.

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KEYWORDS: Direct wafer bonding; MEMS; micro-electromechanical; systems; microfabrication; wafers