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

IMPORTANT

- **The following instructions apply to topics:**
    - **N242-070 through N242-104**

- Submitting small business concerns are encouraged to thoroughly review the DoD Program BAA and register for the DSIP Listserv to remain apprised of important programmatic changes.
    - The DoD Program BAA is located at: https://www.defensesbirsttr.mil/SBIR-STTR/Opportunities/#announcements. Select the tab for the appropriate BAA cycle.
    - Review the Attachments of the DoD Program BAA and ensure the correct versions of the following MANDATORY items are uploaded to the Supporting Documents, Volume 5:
        - Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1)
        - Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Attachment 2)
    - Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

- 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.

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	Navy SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil or appropriate Program Manager listed in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic. 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	DoN SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil

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

Topic Numbers	Point of Contact	SYSCOM	Email
N242-070 to N242-071	Mr. Jeffrey Kent	Marine Corps Systems Command (MCSC)	sbir.admin@usmc.mil
N242-072 to N242-086	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil
N242-087	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N242-088 to N242-099	Ms. Lore-Anne Ponirakis	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil

Topic Numbers	Point of Contact	SYSCOM	Email
N242-100 to N242-104	Mr. Jon M. Aspinwall III (Acting)	Strategic Systems Programs (SSP)	ssp.sbir@ssp.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

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

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

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

Proposal Volumes. The following 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 ten (10) pages, regardless of page content
    - Single column format, single-spaced typed lines
    - Standard 8 ½” x 11” paper
    - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
    - No font size smaller than 10-point
    - Include, within the ten-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified. Phase I Options are exercised upon selection for Phase II.
    - Work proposed for the Phase I Base must be exactly six (6) months.
    - Work proposed for the Phase I Option must be exactly six (6) months.

  - Additional information:

- 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)
    - **Cost Sharing: Cost sharing is not accepted on DoN Phase I proposals.**

  - 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
  - **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
- Details of Request for Discretionary Technical and Business Assistance (TABA), if proposed, is to be included under the Additional Cost Information section if using the DoN Supporting Documents template.
- Do not include documents or information to substantiate the Technical Volume (Volume 2) in Volume 5 (e.g., resumes, test data, technical reports, or publications). Such documents or information will not be considered.
- A font size smaller than 10-point is allowable for documents in Volume 5; however, proposing small business concerns are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD requires Volume 6 for submission. Please refer to the 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 criterion and will not be considered during the evaluation process; the DoN will only do a compliance review of Volume 3. Due to limited funding, the DoN reserves the right to limit the number of awards under any topic.

  The Technical Volume (Volume 2) will undergo a compliance review (prior to evaluation) to verify the proposing small business concern has met the following requirements or the proposal will be REJECTED:
  - Not to exceed ten (10) pages, regardless of page content

- Single column format, single-spaced typed lines
- Standard 8 ½” x 11” paper
- Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
- No font size smaller than 10-point, except as permitted in the instructions above.
- Include, within the 10-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified.
- Work proposed for the Phase I Base must be exactly six (6) months.
- Work proposed for the Phase I Option must be exactly six (6) months.

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

- **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. The Due Diligence Program to Assess Security Risks will be implemented for all Phases.

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

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

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

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

TABA must <u>NOT</u>:

- Be subject to any indirect costs, profit, or fee by the SBIR proposing small business concern
- Propose a TABA provider that is the SBIR proposing small business concern
- Propose a TABA provider that is an affiliate of the SBIR proposing small business concern
- Propose a TABA provider that is an investor of the SBIR proposing small business concern
- Propose a TABA provider that is a subcontractor or consultant of the requesting small business concern otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider)

TABA requests must be included in the proposal as follows:

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

Proposed values for TABA must <u>NOT</u> exceed:

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

If a proposing small business concern requests and is awarded TABA in a Phase II contract, the proposing small business concern will be eliminated from participating in the 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 Navy STP Kickoff during the first or second year of the Phase II contract. While there are no travel costs associated with this virtual event, Phase II awardees should budget time of up to a full day to participate. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program.

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

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

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

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

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

Notice of NIST SP 800-171 Assessment Database Requirement. The purpose of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 is to protect Controlled Unclassified Information (CUI) in Nonfederal Systems and Organizations. As prescribed by DFARS 252.204-7019, in order to be considered for award, a small business concern is required to implement NIST SP 800-171 and shall have a current assessment uploaded to the Supplier Performance Risk System (SPRS) which provides storage and retrieval capabilities for this assessment. The platform Procurement Integrated Enterprise Environment (PIEE) will be used for secure login and verification to access SPRS. For brief instructions on NIST SP 800-171 assessment, SPRS, and PIEE please visit https://www.sprs.csd.disa.mil/nistsp.htm. For in-depth tutorials on these items please visit https://www.sprs.csd.disa.mil/webtrain.htm.

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

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

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

SELECTION, AWARD, AND POST-AWARD INFORMATION

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

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

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

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

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

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

Contract Types. The DoN typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In addition to the negotiated contract award types listed in the section of the DoD SBIR/STTR Program BAA titled 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. The maximum Phase I proposal/award amount including all options is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $2,000,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $2,000,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

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

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

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

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

PHASE II GUIDELINES

Evaluation and Selection. All Phase I awardees may submit an **Initial** Phase II proposal for evaluation and selection. The evaluation criteria for Phase II is the same as Phase I (as stated in this BAA). The Phase I Final Report and Initial Phase II Proposal will be used to evaluate the small business concern's potential to progress to a workable prototype in Phase II and transition the technology to Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding SYSCOM either in the Phase I contract or by subsequent notification.

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 Navy STP).

PHASE III GUIDELINES

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

Navy SBIR 24.2 Phase I Topic Index

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N242-070 TITLE: Hydrogen Generation Salt-water Electrolysis with Chemical Compression

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

OBJECTIVE: Develop a hydrogen generation system that uses salt water to produce one to five kg of hydrogen over a 24-hour period in an austere environment. All components of the system shall be stored, transported, and operated in quad-con ISO containers. The system shall be required to leverage Onboard Vehicle Power (OVP), currently fielded tactical generators, and alternative power sources (e.g., solar or mobile nuclear power generation).

DESCRIPTION: As part of its future force modernization efforts, the Marine Corps seeks to deploy small, disaggregated hydrogen generation units to foreign locations where access to energy sources will be limited or unavailable. These units are to specifically support the U.S. Marine Corps' Expeditionary Advanced Base Operations (EABO), a form of expeditionary warfare that involves the employment of mobile, low-signature, naval expeditionary forces that operate from a series of austere, temporary locations.

Definitions:
Systems must meet Threshold requirements = (T)
It is highly desirable that the system meet Objective requirements = (O)

- The system shall produce 1-3 kg (T) or 3-5 kg (O) of Hydrogen over a 24-hour period.
- The system shall accept a water source with up to 60K PPM of Total Dissolved Solids (TDS) (T=O).
- The system will be powered by 28 VDC; 208VAC, 3 -phase; or 120VAC, single-phase (T=O).
- Can fit and be secured in a Quadcon (T) or a JMIC (O) ISO containers.
- The system will be transportable via MTVR or JLTV Trailer (T=O).
- Applicable MIL-STD 810 standards (T=O).
    - o Hi/Low Temp
    - o Environmental
    - o Shock and Vibration
    - o Transportability
- Applicable MIL-STD-1472 standards (T=O).
    - o Weight
    - o Lifting
    - o Displays
    - o Alarms

PHASE I: Develop concepts for Hydrogen Generation via Salt-water Electrolysis with Chemical Compression that meets 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 Hydrogen Generation Salt-water Electrolysis with Chemical Compression 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. The technology should reach TRL 6/7 at the conclusion of this phase.

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. The prototypes shall by TRL 8 at the conclusion of testing.
Commercial applications may include, but not be limited to: fuel cells, automotive applications, alternative energy, home power systems, humanitarian aid, disaster relief, homeland security, and emergency services.

REFERENCES:

1. Mohammed-Ibrahim, Jamesh. "Recent advances on hydrogen production through seawater electrolysis." Materials Science for Energy Technologies. Volume 3, 2020, Pp. 780-807
2. "Advances in Electrochemical Hydrogen Compression and Purification." Peter Jaime Bouwman. The Electrochemical Society. 2016
3. Department of Defense. MIL-STD-810H, Environmental Engineering Considerations and Laboratory Tests. 31 January 2019
4. Dept of Defense. MIL-STD-1472H, Human Engineering. 15 September 2020

KEYWORDS: Hydrogen; Electrolysis; Energy; Compression; Water; Electrochemical

N242-071 TITLE: Intelligent Hydrogen Filling System

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

OBJECTIVE: Develop an intelligent hydrogen filling system that safely and quickly fills hydrogen storage tanks in an austere environment. All components of the system shall be stored, transported, and operated in man-portable containers. The system shall be required to leverage Onboard Vehicle Power (OVP), currently fielded tactical generators, alternative power sources (e.g., solar), or energy storage devices (batteries or fuel cells).

DESCRIPTION: As part of its future force modernization efforts, the Marine Corps seeks to deploy small, disaggregated intelligent hydrogen filling units to foreign locations where access to energy sources will be limited or unavailable. These units are to specifically support the U.S. Marine Corps' Expeditionary Advanced Base Operations (EABO), a form of expeditionary warfare that involves the employment of mobile, low-signature, naval expeditionary forces that operate from a series of austere, temporary locations. Intelligent hydrogen filling systems will provide a capability to distribute hydrogen to Expeditionary Advanced Bases from tactical hydrogen generation and storage system locations.

Definitions:
Systems must meet Threshold requirements = (T).
It is highly desirable that the system meet Objective requirements = (O).
• The system shall be capable of metering and tracking the hydrogen transferred bi-directionally, either into or from, the hydrogen storage/compressor or generation system (T=O).
• The system shall be capable of metering and tracking the hydrogen transferred into the portable hydrogen tanks (T=O).
• The system shall be capable of filling Type 4 (T), Type 3 or conformal tanks (O).
• The system shall be capable of leak testing the portable storage tank and provide a "go/no go" indication to the user (T=O).
• The system shall provide a display to provide users with system performance and status information. This will include, at a minimum:
  o Flow rate
  o Pressure
  o Portable storage tank fill percentage
  o Time to fill
  o Leak check status
• The system shall utilize a HGV2 standard fitting.
• The system shall fill any 500 gram hydrogen storage tank, without pre-cooling, at a fill rate of 50 g/min (T) or 100 g/min (O).
• The system shall provide overflow protection to restrict hydrogen flow to protect equipment being filled (T=O).
• The system shall be able to fill tanks at an operational pressure up to 10k PSI (T=O).
• The system shall be powered by 28 VDC or 120VAC, single-phase (T=O).
• The system shall fit and be secured in a 12 cubic foot container (T) or 3 cubic foot container (O).
• The system shall not exceed the requirements of a 2-person lift/carry (T) or 1-person lift/carry (O).
• The system shall be operable by personnel with limited training (plug and play (T) or no training (plug and play) (O).
• Minimum applicable MIL-STD 810 standards (T=O).
  o Hi/Low Temp
  o Environmental
  o Shock and Vibration

o Transportability
• Minimum applicable MIL-STD-1472 standards (T=O).
o Weight
o Lifting
o Displays
o Alarms

PHASE I: Develop concepts for Intelligent Hydrogen Filling that meets 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 3-5 prototype Intelligent Hydrogen Filling 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. The transition plan shall address commercialization and manufacturing. The technology should reach TRL 6/7 at the conclusion of this phase.

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. The prototypes shall be TRL 8 at the conclusion of testing.
Commercial applications may include, but not be limited to: fuel cells, automotive applications, alternative energy, home power systems, humanitarian aid, disaster relief, homeland security, and emergency services.

REFERENCES:
1. “An Introduction to SAE Hydrogen Fueling Standardization.” Department of Energy. 11 September 2014. An Introduction to SAE Hydrogen Fueling Standardization (energy.gov)
2. Department of Defense. MIL-STD-810H, Environmental Engineering Considerations and Laboratory Tests. 31 January 2019.
3. Dept of Defense. MIL-STD-1472H, Human Engineering. 15 September 2020.

KEYWORDS: Hydrogen; storage; filling; fueling; energy; tank

N242-072 TITLE: Improved Heat Blanket Technology for Aircraft Composite Bonding Operations

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

OBJECTIVE: Develop technology capable of providing a militarized heat blanket available in various sizes that have uniform heating as far up to the edge as possible, with no heat sinks or dead spots.

DESCRIPTION: Composite hot bonder repair sets are used to apply heat and vacuum pressure to composite patches via heat blankets to achieve structurally sound repairs of aircraft structural components in the fleet. Composite aircraft structural repairs at the I-level typically are compromised due to dead spots and uneven/inadequate distribution of heat towards the ends of the blankets, leading to improperly cured repairs if the users do not know the actual heating area of the blanket in relation to the size of the repair. Lack of uniform heating leads to premature failure of bonded parts. Present composite hot bonding technology is unable to properly cure complex geometries, leading to heat sinks or improperly cured parts. The objective of this SBIR topic is to seek technical solutions from industry to this problem. The technology must be capable of providing a militarized heat blanket available in various sizes that have uniform heating as far up to the edge as possible, with no heat sinks or dead spots. Additionally, the Navy desires a system that can be used with all of the material combinations/geometries for composite components on current Navy aircraft. The radome window repair requires a cure at 365 °F (185 °C) for five hours, and then a cure at 400 °F (204.44 °C) for four hours.

PHASE I: Develop, design, and demonstrate feasibility of how the chosen technology works, how it could be adapted for the military environment, Develop a test plan. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Perform a current required high-temperature hot-bonded repair at a Navy site, evaluate results, determine next steps/path forward. The radome window repair requires a cure at 365 °F (185 °C) for five hours, and then a cure at 400 °F (204.44 °C) for four hours.

PHASE III DUAL USE APPLICATIONS: Successfully perform a range of high-temperature repairs on five separate layup combinations. The commercial airline industry has the same issues with heat sinks during composite structural repair and could benefit from this technology.

REFERENCES:

1. Wright Aeronautical Laboratories. “MIL-HDBK-337: Military standardization handbook: Adhesive bonded aerospace structure repair.” Department of Defense, 1 December 1982. http://everyspec.com/MIL-HDBK/MIL-HDBK-0300-0499/MIL_HDBK_337_1865/
2. “AC_43-214A: Repairs and alterations to composite and bonded aircraft structure.” U.S. Department of Transportation, 23 July 2016. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_43-214A.pdf
3. Baker, A. “Bonded composite repair of fatigue-cracked primary aircraft structure.” Composite structures, 47(1-4), 1999, pp. 431-443. https://doi.org/10.1016/S0263-8223(00)00011-8
4. Katnam, K. B.; Da Silva, L. F. M. and Young, T. M. “Bonded repair of composite aircraft structures: A review of scientific challenges and opportunities.” Progress in Aerospace Sciences, 61,2013, pp. 26-42. https://doi.org/10.1016/j.paerosci.2013.03.003
5. “Composite Bonding & Repair Benefits and Solutions.” Composites World, 8 September 2020. https://www.compositesworld.com/articles/composite-bonding-repair-benefits-and-solutions

KEYWORDS: Aircraft; composite; structural; heat-sink; heat blanket; hot bonder

N242-073 TITLE: Transient Voltage Suppressor (TVS) for F/A-18 E/F and EA-18G

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): FutureG; 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 Transient Voltage Suppressor (TVS) that will limit the overvoltages to avionics components to 150 volts root-mean-square (Vrms) maximum, instead of the MIL-STD-704E requirement of 180 Vrms.

DESCRIPTION: F/A-18 E/F and EA-18G use MIL-STD-704E Aircraft Electric Power Characteristics, the electrical power interface specification. MIL-STD-704E requires avionics to withstand overvoltage transients to 180 Vrms, but many avionics components were not tested to the 180 Vrms causing reduced avionics reliability.

MIL-STD-704E requires avionics to withstand overvoltage transients to 180 Vrms, but many Avionics were not tested to the 180 Vrms transients, and are failing in the fleet as a result. The reason testing was not performed for F/A-18 was because in 1999 when aircraft went into full-rate production, there was no test method for MIL-STD-704E; the test method was not implemented until 2010. The most economical solution per aircraft is to place the TVS on two electrical busses instead of inside 50 avionic boxes. The TVS needs to limit the overvoltages to 150 Vrms maximum instead of the MIL-STD-704E of 180 Vrms requirement. The TVS needs to start limiting when the voltage gets to between 130–140 Vrms, and clamp at a maximum of 150 Vrms.

PHASE I: Perform a study to design a TVS that meets F/A 18- E/F and EA-18G capabilities. Use MIL-STD-704E Aircraft Electric Power Characteristics, the electrical power interface specification, as a basis for the design. The Phase I effort will include prototype plans to be developed under Phase II. The TVS needs to limit the overvoltages to a maximum of 150 Vrms instead of the MIL-STD-704E of 180 Vrms requirement. The TVS needs to start limiting when the voltage gets to between 130–140 Vrms, and clamp at a maximum of 150 Vrms.

PHASE II: Development of two TVS prototypes that should meet the following test requirements:
1. Joule dissipation at 25 °C < 2625 Joules,
2. Joule dissipation on infinite heatsink at TL = 75 °C < 2625 Joules,
3. Peak forward surge current, 1025ms single half-sinasoidal wave (bidirectional only) 350 amperes root mean square (Arms),
4. Operating and storage temperature range -55 °C to +175 °C,
5. Vrms minimum range 130 to maximum range 140,
6. Arms maximum reverse leakage 5 mA to 2 µA at Voltage Reverse Working Maximum 108 Vrms,
7. Voltage Reverse Working Leakage of a Vrms 108,
8. Maximum Reverse Surge Current I peak to peak Amps rms 172.9 Ipp, and
9. Maximum Clamping Voltage 150 Vrms at Ipp.
Navy Military Standards & Testing:
10. MIL STD 704 Electrical interface,

11. MIL STD 810 needs to be environmentally qualified,
12. MIL STD 461 EMI

PHASE III DUAL USE APPLICATIONS: Perform laboratory testing and then install the prototype(s) in an aircraft for an aircraft ground and flight test.

Commercial electrical system developers that use the electrical power interface specification can use TVS. Commercial aircraft requires avionics to withstand overvoltage transients to 180 Vrms, but many avionics components were not tested to the 180 Vrms.

REFERENCES:

1. Lepkowski, J. and Lepkowski, W. “Evaluating TVS protection circuits with SPICE.” Power Electronics Technology, 32(1), 44, 2006. https://www.electronicdesign.com/technologies/power/power-supply/power-electronics-systems/article/21188592/evaluating-tvs-protection-circuits-with-spice
2. Digitron Semiconductors. (n.d.). “Digitron semiconductors 30KP28A–30KP320CA.” Digitron Semiconductors. https://digitroncorp.com/getmedia/76286f69-0dc6-42ce-bc16-cb25c6dd46a3/30KP28A-30KP320CA
3. Davis, N. “An introduction to transient voltage suppressors (TVS).” All About Circuits, 24 May 2019. https://www.allaboutcircuits.com/technical-articles/transient-voltage-suppressors-tvs-an-introduction/
4. “MIL-STD-704F(1) NOT 3 (w/Change-1): Department of Defense interface standard: Aircraft electric power characteristics (05-DEC-2016).” Department of Defense. https://quicksearch.dla.mil/qsSearch.aspx
5. “MIL-STD-810H: Department of Defense test method standard: Environmental engineering considerations and laboratory tests (31-JAN-2019).” Department of Defense, MIL-STD-810 Working Group. / http://everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810H_55998/
6. “MIL-STD-461G: Department of Defense interface standard: Requirements for the control of electromagnetic interference characteristics of subsystems and equipment (11-DEC-2015).” Department of Defense, MIL-STD-461 Working Group. http://everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-461G_53571/
7. “Wiring aerospace vehicle AS50881 SAE International. https://www.sae.org/standards/content/as50881h/
8. “MIL-E-7016F: Electric load and power source capacity, aircraft, analysis of (24-JUL-2019).” Department of Defense. https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=6249
9. Naval Air Systems Command. (1998). MIL-W-5088 Rev. L(1) NOT 2: Military specification: Wiring, aerospace vehicle. Department of Defense. https://quicksearch.dla.mil/qsSearch.aspx

KEYWORDS: Electrical; transient; voltage; suppressor; avionics; MIL-STD-704

N242-074 TITLE: Infrared Window/Dome Refurbishment and Repair

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

OBJECTIVE: Design and develop methods to refurbish and/or repair infrared (IR) sensor or missile seeker system windows and domes that have been damaged through their operational environments to their pristine optical and physical/mechanical condition.

DESCRIPTION: Over the course of the last 50 years, the Military Services have increasingly relied on sensors, trackers, and seeker systems operating in the IR spectrum. Windows and domes for such systems, exposed to rain, sand, salt spray, contaminants, and other degraders in their intended operational environments, typically erode with the resulting surface damage degrading optical quality and limiting their serviceable lifetime. Consequences include degraded sensor system performance and significant yearly investment for replacement.

Environmental damage to IR windows and domes may include optical coating full or partial delamination, pitting and/or gouging, both shallow and deep scratching, wide-area abrasion, and smudging from contaminants typical of operational environments. Coating remnants may be uneven, as dielectric coatings are sometimes applied over a sparse metallic mesh on the window/dome surface. Additionally, coating remnants on damaged windows and domes may contain trace amounts of hazardous materials (e.g., heavy metals such as cadmium and chalcogenides). To date, no approach has satisfactorily demonstrated removal or repair of damaged surface layers in single or poly-crystalline (e.g., sapphire, spinel, Silicon (Si) or Germanium (Ge)) optical windows or domes, to include maintenance of the original optical quality (i.e., transmission, absorption, and wavefront error) of the pre-damaged material. Past limited attempts to fill pits or provide spot repairs have resulted in optical quality degradation and limitations due to mismatches in indices of refraction, stress, or thermal expansion.

The integrated circuit and solar cell industries, however, routinely cut and polish single and poly-crystalline window materials such as Si, Ge, and gallium arsenide (GaAs) from boules via slicing and chemical-mechanical processing (CMP) to a level of surface quality, with the absence of defects and underlying strain/stress, that far exceeds current requirements for IR windows and domes. Surface finish, as measured via the bi-directional reflectance distribution function (BRDF), for instance, routinely approaches 1 x 10E-7 sr-1 without any further processing or treatment. It is postulated that damaged optical windows and domes made of these or other single-boule grown crystalline materials could be restored in a multi-step process that includes removal of the damaged surface layers, CMP or other processing to restore a pristine surface with undamaged underlayer, and epitaxial, chemical vapor deposition (CVD), or other deposition mechanisms to "grow" a new top layer to the optical window/dome using the same material and crystalline structure as the original substrate. The result would be a window/dome of a single optical material, eliminating prior barriers to window/dome repair, such as thermal mismatch, refractive index mismatch, mechanical stress, and sub-surface defects. In the case of single-crystal sapphire, use of the same material, deposited in the same crystallographic orientation, would also eliminate impacts to design and performance due to single-crystal sapphire’s inherent birefringence.

Further processing of the restored window/dome blank would be limited to final polishing/shaping and surface coating, with no changes required to polishing methods, coating materials, or coating design currently employed in the window/dome production process.

Innovative sources and methods are sought for the repair/refurbishment of sapphire, Ge, and Si IR windows and domes that have experienced damage as described above to the strength (i.e., Young's modulus, Poisson's ratio, Knoop hardness), shape (including original thickness), material (sapphire, Ge, or Si, depending on the substrate), crystallographic orientation, and optical quality (i.e., absorptivity, transmissivity, refractive index) of a pre-damaged, pre-coated (i.e., no anti-reflective coating), pre-polished window or dome blank, with the project goals of a final per-unit refurbishment cost not to exceed $30,000 and 3 months for flat sapphire windows, to 10 in. (25.40 cm) across, and for hemispheric Ge domes to 9 in. (22.86 cm) in diameter. The notional approach described above serves only as an example; providers are free to explore approaches that may or may not be similar. All proposed methods, however, must explicitly address the challenges of thermal and mechanical stress, possible separation of the repair layer and understructure, and impacts to optical performance, birefringence, and current processing/polishing techniques and coating designs.

PHASE I: Design and demonstrate feasibility of novel approach(es) to repair/refurbish single-boule-grown IR optical windows and domes that have surface damage characterized by pitting, scratches, abrasions, oil-based and salt spray contamination, and fragmented/delaminated surface coatings and/or coating remnants. First demonstrations will include optical grade flat single-crystal sapphire substrates of 0.75 in. (1.9 cm) diameter or larger, with no fundamental physical barrier to later applications of similar approaches to dome or ogive shapes, or other common boule-grown crystalline IR window material systems listed in the references. Selected methods and materials must have no intrinsic limitations to scaling to sizes of 100 square in. (254 square cm) (flat sapphire window) or 10 in. (25.4 cm) in diameter (hemispherical Ge dome). The Phase I effort will include selection of measurement and assessment techniques to evaluate the repaired window internal structure, stress/strain, refractive index, mechanical strength, and optical quality, as well as development of prototype plans to be implemented under Phase II.

PHASE II: Optimize processes developed under Phase I and demonstrate restoration of a scratched, eroded, partially-coated 5-in. (12.7 cm) (minimum) diameter, 0.25 in. (.635 cm) thick sapphire flat to the optical quality (i.e., absorptivity, transmissivity, lack of surface/subsurface defects), strength (i.e., Young's modulus, Poisson's ratio, Knoop hardness), and thickness of a pristine, unpolished, uncoated 0.25 in. (.635 cm) thick sapphire window blank, with nothing to preclude extension of the technology to larger sizes and to Ge dome materials systems, at a per-unit cost below $30,000. Process may be demonstrated on either government-furnished damaged single-crystal sapphire window pieces, or a supplier-produced surrogate made with at least one dielectric layer deposited over an uneven or partial metallic deposition layer on a single-crystal sapphire substrate.

PHASE III DUAL USE APPLICATIONS: Demonstrate the repair/refurbishment of up to 8 damaged optical windows or domes provided as government furnished equipment (GFE), at a per unit repair cost below $30,000, and time to repair below 3 months. GFE units will be 0.25 in. (.635 cm) thick boule-grown Ge (to 9 in. [22.86 cm] diameter) or Si (to 4 in. [10.16 cm] diameter) hemispherical domes or 0.25 in. (.635 cm) thick single crystal sapphire flats to 100 square in. (254 square cm) in size, with damage that may include surface pitting, scratching, abrasion, contamination/smudging, and full or partial delamination of metallic micro-mesh and/or multilayer dielectric surface coatings. Repair must be to the full original substrate thickness, allowing for additional material removal during a subsequent GFE polishing step (i.e., substrate will maintain 0.25 in. [.635 cm] thickness after polishing), with material hardness, optical quality, index of refraction, and internal stress commensurate with that of a single uniformly-boule-grown flat or dome of the same substrate material. Repaired/refurbished items will be delivered to the U.S. Government for further testing.

Sapphire windows are routinely used in grocery store check-out lines as a durable optical quality material through which laser scanners may read barcodes over long durations, without fear of degradation or damage. Being able to repair/refurbish such windows could have a marked impact on the grocery store infrastructure suppliers. Of greater impact, the ability to repair optical-grade windows will have a tremendous effect on the cost and availability of laboratory-grade sensors, cameras, and laser optics.

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KEYWORDS: infrared windows; infrared domes; IR windows; IR domes; infrared sensors; IR sensors; missile seekers; missile warning; optical window

N242-075 TITLE: Alternative Navigation System for Hypersonic Vehicles in Global Positioning System (GPS)-Degraded and GPS-Denied Environment

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

OBJECTIVE: Develop a navigation system that can provide precise navigation for the entire flight trajectory of hypersonic vehicle operating under GPS-degraded/denied environments.

DESCRIPTION: Naval aerial platforms traditionally rely on GPS signal technology for positioning, navigation, and timing (PNT) system application. When a hypersonic vehicle is traveling at hypersonic speed through the atmosphere, a plasma sheath envelops the aerial vehicle because of the ionization and dissociation of the atmosphere surrounding the vehicle [Refs 1-3]. The plasma sheath prevents radio communication, telemetry, and GPS signal reception for navigation [Ref 4]. This radio "blackout" period poses a serious challenge for GPS-enabled PNT for the hypersonic vehicle.

This SBIR topic seeks the development of non-GPS-based technology solutions for hypersonic vehicles that utilize systems taking advantage of alternate signals that enable precision navigation comparable to GPS, but without GPS in a GPS-denied environment. Such solutions include, but are not limited to magnetometer aided navigation [Ref 5], micro-electromechanical gyroscope for Inertial Navigation System (INS) [Ref 6], integrated optic inertial navigation system [Ref 7], Electro-Optical/Infra-Red (EO/IR) imaging sensors [Ref 8], and so forth. The proposed solution can be a single system solution or an integrated system with the fusion of two orthogonal signal systems for improved PNT.

The proposed system solution should have minimized size, weight, and power (SWaP) compatible with current and future SWaP-constrained hypersonic vehicles. It should also be able to be sufficiently ruggedized to withstand harsh hypersonic high-velocity and high-g environmental and operating conditions. The system technologies should produce accuracy for the vehicle's entire flight trajectory comparable to, or better than, current GPS technologies. The hypersonic vehicle's terminal navigation success metrics are: (a) a miss distance less than 5 m and a terminal speed of at least 1,700 m/s at the target; and (b) navigation path constraints are satisfied while performing divert and evasive maneuvers to the target. The hypersonic vehicle's terminal phase begins at a distance of 200 km at an altitude of 25 km and a speed of 3,000 m/s.
The initial terminal hypersonic vehicle flight conditions are:
(a) Range (km) min 200, max 200,
(b) Azimuth min 10°, max 10°,
(c) Heading Error min 10°, max 10°,
(d) Altitude (km) min 24.8, max 25.2,
(e) Speed (m/s) min 2,900, max 3,100,
(f) Flight Path Angle min -5°, max 0°,
(g) Angle of Attack min 1°, max 3°,
(h) Bank Angle min 2°, max 2°,
(i) Sideslip Angle min 2°, max 2°,
(j) Crosswind Wind Speed (m/s) min 0, max 20,
(k) Longitudinal Wind Speed (m/s) min 0, max 10, and
(l) Atmospheric Density (kg/m^3) min 1.293, max 1.210.

It is also required that the system should produce signals similar to GPS output codes. The system is also required to maintain compatibility with the DoD's security, environmental, and other requirements for autonomous aviation navigation systems.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop PNT system concept solutions for use in hypersonic vehicles. Specify the signal systems for the proposed approach that will meet the specifications stated in the Description. Perform modeling and simulation and preliminary experimental demonstration to demonstrate the feasibility of the proposed design that will meet the required navigation success metrics in the Description in the hypersonic vehicle terminal phase. Simulations are to be run in three different scenarios to verify the effectiveness of the proposed navigation system. In Scenario I, the noise conforms to the Gaussian distribution. In Scenario II, the pseudo range and pseudo range rate measurement information are interfered by pulses. In Scenario III, the navigation information is interrupted intermittently. The Phase I final report will detail all methods studied plus evidence of their feasibility on an aerial platform. The final report will also include an initial prototype design to be implemented in Phase II. All hardware and software requirements should be defined.

PHASE II: Develop a prototype based on the design of Phase I and demonstrate a navigation system based on the proposed signal systems. Evaluate, test, and validate the system’s feasibility to meet the project objective. The final test and evaluation of the system should be carried out under relevant operation conditions as close to hypersonic flight conditions as possible.
Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Integrate and install the navigation system prototype onto a representative hypersonic vehicle for demonstration and evaluation in Advanced Naval Technology Exercise (ANTX) events.

As a new type of high-speed, large-range, and fast-response aircraft, the Airbreathing Hypersonic Vehicle (AHV) must not only cruise at high speed in the atmosphere, but also travel through the atmosphere as a space transportation vehicle. It has a wide range of applications in the military and civilian fields.
In the military field, its advantages are embodied in large combat airspace, wide range, fast flight speed, high maneuverability, strong penetration ability, flexible deployment and launch methods, high mission execution efficiency, large flight kinetic energy. Because it flies in the near space above 20 km altitude, which has low atmospheric density and low aerodynamic drag, it can effectively and quickly strike various long-range targets around the world. Meanwhile, it can shorten the enemy’s radar detection time and defense system response time. The above mentioned advantages determine that the hypersonic vehicle can be used as a long-range assault weapon launch platform or a direct strike weapon to efficiently complete various military tasks such as surveillance, reconnaissance, and strike operations.

In the civil field, the hypersonic vehicle can be used as a new type of intercontinental passenger/cargo transportation vehicle to improve human lifestyle and living standards. Hypersonic cargo vehicle can easily realize the rapid and accurate remote delivery of high-value materials, improve transportation efficiency, and stimulate global economic growth. Hypersonic passenger vehicles can shorten passenger travel time to improve work efficiency.

Hypersonic flight is attracting attention beyond civil aviation. The space industry is eyeing the technology to build craft that can take off like a plane, a development that could reduce the need for expensive rocket launches.

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KEYWORDS: Hypersonic; missile; navigation; terminal; guidance; global position system (GPS)

N242-076 TITLE: Wireless Integrated Network—High-Capacity Low-Probability-of-Detection (WIN-HL)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software; 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 waveforms designed to address gaps in current tactical waveform technology. These waveforms shall include high-capacity throughput and Low-probability-of-Detection/Identification/Tracking/(LPx) features to counter rapidly evolving threats with an open architecture digital interface to minimize application integration risks, and challenges. These waveforms should be power efficient and portable across multiple hardware instantiations for beyond line of sight and omni-directional line of sight (threshold) and directional communications (objective).

DESCRIPTION: Current Radio Frequency (RF) communications systems have become common in both infantry dismounted and mounted operations used to communicate beyond line of sight (BLOS) and line of sight (LOS) with maritime vessels, air assets, ground command and control, and with adjacent units. Trusted secure communications are required to ensure elements are employed effectively. Having the ability to communicate without being detected, intercepted, or tracked is highly desired to protect a high-risk element that may be compromised by threat electronic warfare assets. Ground elements need to pass authenticated mission critical data and voice traffic to share situational awareness data, command and control, targeting data, and voice traffic. It is desirable for the new waveforms to defeat current and anticipated threat systems. High-data throughput waveforms are designed to transmit large volumes of data at near-real-time to real-time rates within line of sight and are essential to support combat operations. Waveforms will be designed to run on the Field Programmable Gate Array (FPGA) environment. Digital data interface will leverage IEEE standards that are easier to interface with (e.g., Internet Protocol). The waveforms developed should not interfere with other aircraft subsystems inside the aircraft or other systems over RF. Existing systems are based on hardware designs that operate a single waveform and any updates/modernization requires replacing hardware. The design should enable adding updates to existing waveforms or completely new waveforms into the system without requiring new hardware or being returned to the factory/depot for the update.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain at least a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security

Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Design and develop a framework that supports development of FPGA hosted waveforms. Provide a detailed description of the system architecture and necessary input and output interfaces. Identify key components necessary for operation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Build, test, and validate a prototype waveform that successfully defeats realistic threat vectors and demonstrate the prototype operating in a relevant environment. Identify code framework that allows for easiest integration in a modeling and simulation environment (Threshold) and an operational type of system (Objective). Develop an implementation plan. At the conclusion of Phase I NAWCAD will coordinate with Fleet Users and Operational Testers to designate a suitable threat vector(s) against which the waveform will be evaluated. Demonstrate the waveform passing data two-way using government selected software suites (e.g., ATAK). Produce and deliver a final Technical Data Package (TDP) that includes system and subcomponent specifications, interface descriptions and definitions, and operating instructions/procedures for the prototype. Prepare the prototype for transition to deployment.
A representative operational scenario will be defined for Phase II in the appropriate classified environment. Please see note in Description section. Joint Interoperability tests will be planned and coordinated for the end of Phase II demonstrations.

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

PHASE III DUAL USE APPLICATIONS: Conduct government verification and validations, including the design development conducted in the initial phases to show the technical feasibility of the idea and lay the groundwork for the demonstration in the next phase. Demonstrate that the design is technically and operationally feasible with test points that will validate the waveform and lay the groundwork for transitioning to appropriate laboratories and/or platforms to bring the capability to the Fleet. The system will be assessed against existing systems operating the same waveform(s) to verify they meet the appropriate interoperability standards as the existing baseline systems do with the applicable Navy, Joint Tactical Networking Center (JTNC), and Defense Information Systems Agency (DISA) tests.

Software Defined Radios (SDR) are widely in use in DoD and commercial communications systems, as are efforts to develop Open Systems Architecture (OSA) designs. These software-driven designs support rapid updates and incorporation of new technologies to enable addition of future requirements and to grow to address evolving threats.

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KEYWORDS: Tactical-Data-Link; Secure; Robust; High-Capacity; Low-Probability-of-Detection; Communications

N242-077 TITLE: Scalable Wideband Multifunction Radio Frequency (RF) Payloads

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

OBJECTIVE: Design, develop, and demonstrate wideband multifunction Radio Frequency (RF) payloads using an innovative Modular Open Systems Approach (MOSA) that is scalable across Unmanned Aerial Systems (UAS) Groups 1 through 3 with Electronic Warfare (EW); Radar; Command, Control, Computing, Communications, Cyber, Intelligence, Surveillance, Reconnaissance, and Targeting (C5ISRT); and edge-based High-Performance Computing (HPC) capabilities.

DESCRIPTION: UAS require Rugged Small Form Factor (RSFF) multifunction payloads adhering to the MOSA that conform to stringent Size, Weight, and Power and Cost (SWaP-C) constraints. The American National Standards Institute/VMEbus International Trade Association (ANSI/VITA) standards based on the 3U Printed Circuit Board (PCB) dimensions of 100 mm X 160 mm (e.g., VERSAmodule Europe (VME), Virtual Path Cross-Connect (VPX), and OpenVPX) have been very successful in military applications for larger UAS (Groups 3–5). However, 3U is too large in most SWaP-C aspects for Groups 1–2 UAS. To address smaller-than-3U implementations, the Sensors Open Systems Architecture (SOSA) Consortium is provisioning for two different approaches: Short VPX (sVPX) and VNX+.

sVPX leverages just about all of the VPX/OpenVPX standard by adding an additional printed circuit board (PCB) dimension option of 100 mm x 100 mm. While sVPX does shrink the module to smaller than 3U, the primary motivation for this additional PCB option is to support VPX/OpenVPX integration into cylindrical/tubular platforms such as 8 in. (20.32 cm) diameter or larger pods/fuselages. VNX+ proposes an entirely different backplane/module/connector definition that does not provide any inherent interoperability with the 3U VPX/OpenVPX ecosystem but is capable of smaller SWaP-C than sVPX, enabling possible integration into 5 in. (12.7 cm) diameter pods/fuselages. Both sVPX and VNX+ are immature at the moment, with very few commercial-off-the-shelf products available. Ultimately, the commercial marketplace will determine the success of sVPX and VNX+ as a solution for the smaller-than-3U space. However, solutions are required now for advanced Science & Technology (S&T) and Research & Development (R&D) efforts aiming to deliver advanced capabilities to the warfighter in a variety of custom and standard form factors.

A highly-scalable MOSA methodology is needed that enables HPC, mixed-signal acquisition/generation, and RF front-end building blocks to be combined to provide solutions that span across UAS Groups 1–3, without having to use completely different hardware/software solutions for each group. While sVPX, VNX+, or 3U VPX/OpenVPX may be the ultimate form factor utilized, the desired building blocks should be modular and able to be integrated into any of these standard form factors. The ANSI/VITA community has leveraged the use of mezzanine cards (e.g., PMC, XMC, FMC, etc.) to perform digital and mixed-signal processing functions for decades; this approach could be further explored to accomplish the modularity and scalability objective, such as Single-Board Computer (SBC), System-on-Chip (SoC), and Field Programmable Gate Array (FPGA) mezzanine cards that can be integrated onto a standard VNX+, sVPX, or 3U module, or into a custom form factor. A similar approach must be applied to the RF sub-systems as well, likely incorporating the latest Multi-Chip Module (MCM) and System-In-Package (SIP) technologies. As SWaP-C constraints are alleviated, additional building blocks can be added to improve digital/mixed signal processing capabilities and/or RF performance specifications. For instance, the number of RF channels or additional frequency bands can be added to the system as more SWaP-C is available. Other examples include improving maximum power output by adding additional stages of amplification or in-band/out-of-band spurious performance by incorporating better RF filter sub-components.

Specifications for the desired scalable wideband multifunction RF payload include, but are not limited to, the following:
a. Total Payload Volume: scalable from 40–6,550 cubic cm (2.5–400 cubic in.)
b. Operating Frequency: scalable across multiple frequency bands from 0.01–40 GHz
c. Instantaneous Bandwidth: configurable based on the function up to 2 GHz wide as the threshold with goal of 4 GHz or more
d. Number of full-duplex phase-coherent TX/RX channels: scalable from 1 up to 4 as the threshold with 16 as a goa,
e. Radar and Electronic Attack (EA) Digital RF Memory (DRFM) RF front-end performance considerations (i.e., coherency, latency, sensitivity, flatness, receive/transmit gain, RF/digital tuning, etc.)
f. Power Output: scalable from 1 W–100 W depending on application and frequency band
g. Heterogeneous Processing Elements: combinations of Single Board Computer (SBC), General Purpose Processor (GPP), Graphical Processing Unit (GPU), Artificial Intelligence/Machine Learning Accelerator, Field Programmable Gate Array (FPGA), System-on-Chip (SoC), Microprocessors, and other advanced processors
h. Designed for rugged operating environments including sub-sonic/super-sonic flight

The following will be used as evaluation criteria of the proposal and at each phase:
a. satisfying the modularity and scalability objectives while adhering to Modular Open Systems Approach (MOSA) principles
b. maximizing the incorporation of open standards and commercial-off-the-shelf solutions
c. potential to become a U.S. Government or Industry standard (e.g., MIL-STD, ANSI/VITA, etc.)
d. satisfying the wideband multifunction RF payload technical specifications

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a highly-scalable MOSA methodology and system architecture that supports multifunction EW, Radar, C5ISRT, and HPC capabilities using digital/mixed-signal processing and RF modules targeting the following payload form factors: Custom (2.5 cm x 2.5 cm x 10 cm), VNX+ (78 mm x 89 mm x 19 mm), and 3U VPX/OpenVPX (100 mm x 160 mm x 25.4 mm). Evaluate through modeling and simulation and/or laboratory testing of the anticipated digital/mixed-signal processing and RF performance characteristics of the three payloads while detailing power, cooling, and environmental requirements, assumptions, and considerations. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Produce a prototype of the custom form factor payload, with primary focus on developing the sub-systems that are novel and critical to the approach. For non-critical sub-systems, commercial-off-the-shelf or other solutions can be utilized, but feasibility on how these sub-systems can be modified and integrated must be addressed in detail. Demonstrate the modular and scalability of the approach by producing a VNX+ payload (threshold) and a SOSA-aligned 3U VPX/OpenVPX payload (goal). Quantify digital/mixed-signal processing and RF performance improvements/gains between the payload prototypes.

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

PHASE III DUAL USE APPLICATIONS: The prototype(s) generated in Phase II will be further developed for the intended mission(s) and aerial platform(s), and then tested to ensure environmental and EMI/EMC qualification requirements are satisfied.

The U.S. Government desires the private sector provide MOSA solutions that adhere to standards such as ANSI, VITA, and SOSA. Developing digital/mixed-signal processing and RF sub-system solutions that can be integrated into different industry standards such as VNX+, sVPX, and 3U VPX/OpenVPX will enable wider use of the technology/capability. Commercial industries that can leverage this technology include: very small and low-power wireless devices for the Internet of Things (IoT); mobile/fixed 5G and 6G cellular technologies; commercial satellite and digital land mobile radio (DLMR) communications/datalinks; portable RF test and measurement devices; and radar for automotive and UAS applications.

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KEYWORDS: Modular; Open; Unmanned; radio frequency; RF; Radar; electronic warfare; EW; System

N242-078 TITLE: Artificial Intelligence Tools for Autonomous Counter-Countermeasures

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

OBJECTIVE: Develop novel methods to identify and mitigate vulnerabilities in autonomy agents designed to carry out Department of Defense (DoD) missions and develop software tools to automatically assess and identify vulnerabilities prior to deployment in government systems.

DESCRIPTION: Rapid advancements in Artificial Intelligence (AI) have resulted in increased development of autonomous agents that perform complex tasks previously requiring human operators. In the academic domain, AI agents have been used to defeat world-class experts in games such as Go and Shogi, and more recently, multiplayer games such as Quake III, Starcraft II and DOTA II. The DoD has rapidly adapted these technologies for a variety of tasks including mission planning, air combat operations, missile defense, and so forth. As with any rapidly advancing technology, identifying the weakness and vulnerabilities of the technology are as important as advancing the technology itself, which exploit the fragility of AI models often underpinning these autonomy solutions. However, these efforts typically focus only on perturbation in input data received by an AI model and not the autonomy system as a whole.

In this effort, the Navy intends to analyze the entire autonomy development, integration, and deployment process to develop methods that can identify strategies to counter opponent autonomous systems, as well as development of red-teaming methods to mitigate the effectiveness of potential counter autonomy techniques developed by adversaries.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Analyze existing autonomy approaches for relevant air combat missions. Identify potential attack surfaces in which counter autonomy could potentially be employed to defeat the autonomy and determine the risk potential of these vulnerabilities. Using information from all missions and analysis develop a counter autonomy ontology and suggested approaches. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Extend the research toward government provided reference scenarios. Develop and refine prototype algorithms for identifying high-risk vulnerabilities in autonomy agents. Demonstrate the ability to identify multiple types of vulnerabilities in deployable agents. Ensure that developed prototype can be integrated with Navy systems in Phase III.

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

PHASE III DUAL USE APPLICATIONS: Develop operational capability for use in Navy DevSecOps air worthiness framework including user and design documentation.

This research on decomposing the Autonomy and AI software supply chain aims to identify vulnerabilities from a security perspective, offering significant dual-use potential for both the DoD and private sectors. Industries such as telecommunications, transportation, and critical infrastructure can leverage these insights for enhanced cybersecurity measures. The findings will inform improved software development practices, aiding tech companies in creating more secure AI systems. Additionally, sectors handling sensitive data, like finance and healthcare, can benefit from advanced risk management strategies. While the research has broad commercial applications, particularly in AI safety and ethics, the dissemination of sensitive findings will be carefully managed to maintain a balance between public sector innovation and national security. This approach ensures the strategic advantages of the research are preserved while supporting technological advancement in various industries.

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KEYWORDS: Artificial Intelligence; A.I.; Machine Learning; Counter-counter measures; Autonomy; Reinforcement Learning

N242-079 TITLE: Material and Manufacturing Technology Solutions for Advanced Composite Cases for Tactical Solid Rocket Motor Applications

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

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

OBJECTIVE: Develop advanced material and manufacturing composite case technologies for high supersonic and hypersonic air, land, and sea launched missile systems.

DESCRIPTION: The Navy currently employs tactical missile polymer composite motor case structures that are moderately lightweight and thick walled to meet pressure containment, but they are generally relegated to surface launched systems [Ref 1]. Evolving capability gaps require significant improvements to current state-of-the-art composite cases, including lighter composite case, greater damage tolerance, external thermal protection, and external attachments/joints. These advanced composites need to develop technologies and databases that will allow integration onto naval aircraft, as no current composite case rocket motors are used on naval aircraft despite previous efforts.

Key Technology Goals:
1. Environments include: platform loads (platform vibration, eject shock, etc.), flight loads, aerothermal environments, internal heating environments, rain/salt, fog/humidity, lightning/E^3, lifecycle packaging, handling, storage, and transportation (PHS&T), etc.
2. Reduce mass from traditional filament wound graphite/epoxy composite technology by 10% threshold (THR)/30% objective (OBJ). May include mass savings from advanced internal insulation, novel attachment/fitting designs, alternate polymer composite materials and manufacturing methods, and new thermal protection materials.
3. Support ability to incorporate nonsymmetrical features and attachments onto safety critical pressure vessels that contain high-pressure gases (up to 3,000 psi) up to 6500 °R in temperature.
4. Strong preference to support aircraft carry and launch environments. Navy tactical weapons incorporate rails or lugs on rocket motor segments, therefore the composite structures and attachments must withstand high g-loads and fatigue in temperature and moisture extremes.
5. Impact and handling tolerance or provide indication and/or warning when critical flaw size is exceeded. Navy requires composite structures meet MIL-M-8856B “barely visible impact damage” [(Ref 4] and still have 100% structural capability. Composite structures must withstand pressure loads, flight loads, and captive carry loads with such damage.
6. Provide path to B-basis and A-basis material properties under relevant material architecture, application load environments, and material knockdown (e.g., hot-wet) environments, within 1 year after achieving Technology Readiness Level (TRL) 5. It is desirable to have S-basis properties at TRL-4 level maturity.
7. Support rapid development cycles (can start with TRL-3 technology, but must show path to support a < 2 year tactical composite case development cycle, after maturation).

PHASE I: Develop an advanced composite case concept relative to 10 in. (25.4 cm) diameter air-launched missile airframe structures that serve as rocket motor combustion chamber pressure vessels during missile operation and solid propellant storage vessels during the rocket motor lifecycle. Outline compliance to the Key Technology Goals listed above including advanced materials and manufacturing methods. Identify key technology risks and perform initial feasibility testing and/or analysis of high-risk areas to develop risk reduction plans. Prepare a report to the Navy on designs and simulations and a Phase II testing plan. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Demonstrate feasibility and capability of the selected technologies for application in a 10 in. (25.4 cm) diameter tactical missile rocket motor/airframe application. These demonstrations can include analysis, laboratory, subscale composite test item build/test, and rocket motor composite case or case simulant build/test activities.

Activities shall be scoped to mature selected innovative material/manufacturing solutions to at least a TRL of 4 (component validation in a laboratory environment), for implementation in future high-speed tactical missile rocket motor/airframe applications. Demonstration to a TRL-5 (component demonstration in relevant environment) or above is preferred. Demonstrate prototype of the applied material/manufacturing solutions to demonstrate compliance to the Key Technical Goals. A final report will be provided to the Navy that outlines the prototype design, fabrication, and testing. The report will also outline the low maturing aspects of the technology and provide a plan to further mature the technology in Phase III.

PHASE III DUAL USE APPLICATIONS: Demonstrate scalability of the selected technologies in a relevant production environment, Manufacturing Readiness Level (MRL) 5. Demonstrate prototype integration of the technology into a complete missile system.

Rocket motors are proliferating in the private sector to launch satellites into earth's orbit. NASA and some aerospace companies are pushing the limit of high-velocity atmospheric flight. Composites offer low weight for efficiency, but require special attention to be suitable for these uses. Technology developed in this SBIR topic has the potential to improve composite performance in these extreme environments. Furthermore, composites in general are weak when struck through the thickness, that is, impact damage. Solutions in this topic could affect not only the aerospace industry, but also automobiles, boats, wind energy, sporting goods, and some drilling/mining operations.

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KEYWORDS: Composites; rocket motors; hypersonic; impact damage; thermal protection; missile attachments

N242-080 TITLE: Portable Test Equipment for Wavelength Division Multiplexed (WDM) Optical Interconnects

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): FutureG; 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 portable light source and an optical power meter capable of simultaneously measuring the optical power in optical fiber cable at multiple wavelengths in the range of 850 nm to 1500 nm.

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 replacement of shielded twisted pair wire and coaxial cable with earlier generation, bandwidth-length product, multimode optical fiber has given increased immunity to electromagnetic interference, bandwidth, throughput, and a reduction in size and weight on aircraft. 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.

In the future, data transmission rates of 100 Gbps and higher will be required. Substantial work has been done to realize data rates approaching this goal based on the use of multilevel signal coding; but multilevel signal encoding techniques trade off link budget and latency to achieve high digital bandwidth. To be successful in the avionic application, existing non-return-to-zero (NRZ) signal coding with large link budget and low latency must be maintained. The Navy requires advances in optical receiver designs that leverage novel photo-detector technology, semiconductor process technology, circuit designs, architectures, and packaging and integration techniques. One approach to meeting the 100 Gbps threshold utilizes wavelength division multiplexing in the 850 to 1050 nm shortwave wavelength division multiplexing (SWDM) band or the 1260 nm to 1400 nm coarse wavelength division multiplexing (CWDM) band. Traditional optical light sources and power meters cannot separate the power in each of the wavelengths. Portable support equipment is needed to quantitatively assess fiber-optic cable performance at discrete optical wavelengths in the SWDM and CWDM bands.

PHASE I: Design an optical system and instrumentation capable of simultaneously transmitting and measuring the power in each of the SWDM and CWDM wavelengths. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Finalize the optical, electrical, and mechanical design of the optical multiwavelength light source and power meter. Develop prototype devices for testing and evaluation by the Navy.

PHASE III DUAL USE APPLICATIONS: Collaborate with defense avionics industries, as well as support equipment companies to accelerate transition to production.

Commercial sector telecommunication systems, fiber-optic networks, and data centers will benefit from the development of the WDM-based test equipment that is portable. These applications will be able to easily test the performance of WDM-based links operating at a higher speed.

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KEYWORDS: Wavelength Division Multiplexing; coarse wavelength division multiplexing, CWDM; shortwave wavelength division multiplexing; SWDM; 100 Gbps; link budget support equipment

N242-081 TITLE: Electronic Threat Detection for Countermeasure Support

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

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

OBJECTIVE: Demonstrate a technology capable of extracting actionable information from in real-time and wideband electronic threats including low-probability-of-intercept (LPI)/low-probability-of-detection (LPD) transmissions to support electronic attack countermeasures. For this technology, develop a set of performance metrics to identify which threats may be identified, and what information may be extracted from the detected threat.

DESCRIPTION: Knowledge of the electromagnetic battlefield is imperative for any situational awareness (SA) system. Monitoring persistent threats allows for appropriate countermeasures and the development of effective tactics to neutralize or exploit them. Such threats may include unauthorized communication signals in our networks or red force communications, radar emissions, and other forms of electronic warfare signals. These SA systems must be able to identify threats quickly and accurately in dynamic operational environments to provide meaningful information to an operator or Electronic Warfare (EW) system. These environments may include adverse conditions such as dense, irrelevant signals density (a “noisy environment”), weak signals with low-signal-to-noise ratios, LPI/LPD transmissions, heavy cosite interference, and jamming. LPI/LPI threats can include waveforms that employ fast frequency hopping or Direct Sequence Spread Spectrum techniques (DSSS).

Proposals must define a detailed path to an experimental demonstration of the proposed threat detection mechanisms during the Phase I period and an expanded plan for demonstrating a functional prototype platform before the end of the Phase II period. Phase I should include a detailed synopsis of the technology’s threat information extraction capabilities, its limitations, a roadmap to overcome these limitations, and a feasible proposed platform for Phase II execution. A successful Phase II should include a non-hardened prototype capable of ingesting real-time data and characterize the prototype in terms of the performance metrics defined in Phase I. It is anticipated that the hardware elements sufficient to develop, test, and demonstrate electronic threat detection already exist. Therefore, the proposed effort should utilize Commercial Off-the-Shelf (COTS) hardware as much as practical.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security

Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Demonstrate the feasibility of the proposed wideband threat detection mechanisms of countermeasure support functionality. The threshold and objective performance of wideband threat waveform are 1 GHz and 2 GHz respectively. A successful Phase I should include a detailed synopsis of the technology's threat information extraction capabilities, its limitations, a roadmap to overcome these limitations, and a feasible proposed platform for Phase II execution. Prepare a preliminary Phase II plan that describes how to scale the performance metrics explored within the Phase I feasibility study. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype system that can demonstrate the threat information extraction performed in Phase I. Include a non-hardened prototype capable of ingesting real-time data and characterize the prototype in terms of the performance metrics defined in Phase I. Phase II shall overcome the technical limitations outlined in Phase I, and further quantify which limitations are insurmountable and therefore bound the scope of system capabilities.

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

PHASE III DUAL USE APPLICATIONS: Include the demonstrated prototype in an end-to-end receiver demonstration for a classified program.
The importance of encrypted communications has become obvious to many industries after their demonstration by the criminal world. If the signals are hard to detect, the pressure on the robustness of password keys is sharply reduced.

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KEYWORDS: Low-probability-of-detection; low-probability-of-interception; situational awareness; EW counter-measures; threat recognition; digital signal processing

N242-082 TITLE: Selective Stripping of Cadmium and Zinc-Nickel Coatings

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

OBJECTIVE: Develop a method for selectively stripping cadmium (Cd) and zinc-nickel (Zn-Ni) coatings from small areas (i.e., several square inches/centimeters) on high-strength steel components, without generating dusts that pose an inhalation risk.

DESCRIPTION: Cadmium (Cd) coatings and Zn-Ni coatings are used on many high-strength steel components on aircraft, such as landing gear assemblies on fixed-wing aircraft and the rotor masts of rotary aircraft. These coatings prevent corrosion and protect the integrity of the underlying steel. However, over time as the coating gets damaged or worn, the coating must be removed and repaired. For parts that are overhauled at the depot level (D-level), spent Cd or Zn-Ni coatings can be stripped by immersing the part in a chemical tank. After the coatings are stripped, the underlying metal can be inspected, repaired as necessary, and then recoated with fresh Cd or Zn-Ni coatings. Depot level facilities have chemical processing plants that allow for this type of work to be performed safely.

However, this chemical process is not feasible to perform at intermediate (I-level) or organizational (O-level) level maintenance facilities. Dozens of I-level and O-level facilities around the world perform touch-up repairs of Cd or Zn-Ni coatings on aircraft components, often to fix localized damage that requires stripping and recoating several square inches (centimeters) of surface area. To remove the old coating when a chemical processing plant is not available, maintainers use methods such as hand sanding, wet sanding, or abrasive blasting to abrade away the Cd or Zn-Ni layer. Unlike with full immersion in a chemical processing tank, using abrasive methods to remove coatings generate inhalation and exposure risks to the maintainer, as well as to the surrounding environment. Particularly with Cd coatings, Cd is carcinogenic and long-term exposure can increase the risk of various cancers and other health effects. There have also been cases where maintainers use an incorrect abrasive that is too aggressive, inadvertently causing damage to the component they are processing. This results in increased rework costs and delays in returning the component to the fleet.

This SBIR topic seeks a method for stripping Cd and Zn-Ni coatings that generate no inhalation exposure risks for maintainers, eliminates the possibility of Cd dust release into the maintenance hangar or surrounding environment, and a method that is repeatable and easy for maintainers to use with no risk of causing inadvertent damage. An ideal solution should be able to remove both Cd and Zn-Ni coatings, be simple and cost-effective, and be easy to deploy to I-level and O-level maintenance sites around the world. The method must selectively strip Cd and Zn-Ni coatings without damaging other coating types, such as primers and topcoats. The method must also not damage the underlying steel component, such as through corrosion or hydrogen embrittlement.

PHASE I: Develop a concept for a Cd and Zn-Ni removal system that can selectively remove these coatings from selected areas of aircraft components, while reducing worker and environmental exposure to toxic or carcinogenic materials. Demonstrate the feasibility of the stripping method, evaluating parameters such as stripping effectiveness, stripping duration, hydrogen embrittlement risks, and the overall ease of use. Prepare a report on the designed method, as well as a Phase II test plan. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Prepare a prototype system for Cd and Zn-Ni removal that reduces exposure to toxic or carcinogenic materials. Assess and optimize key parameters such as system portability, material compatibility, impact to the underlying substrate, process costs, and maintainer ease-of-use. Evaluate and ensure that there are no adverse effects to the substrate through the use of this method, such as inadvertent pitting, etching, corrosion, or hydrogen embrittlement. Provide a report that documents the design of the prototype system, results of system performance, and the results of the material testing. Provide a prototype stripping system to NAVAIR for evaluation.

PHASE III DUAL USE APPLICATIONS: Ensure that product functions as intended, stripping Cd and Zn-Ni coatings within a reasonable amount of time (~1–2 hr), and does not produce any detrimental effects to the base substrate. Have the product made into a commercial product that is available for widespread distribution. Create a National Stock Number (NSN) for the product so that it can be easily procured by Department of Defense (DoD) maintenance activities worldwide.

This product has applications both in military and in commercial aviation maintenance activities. Cd and Zn-Ni has widespread usage as coatings for corrosion protection on high-strength steels, including on commercial airliners, passenger helicopters, corporate jets, and general aviation aircraft. Removal of these coatings is a common maintenance task on all types of aircraft, and a method of removing these coatings without producing hazardous dusts is highly desirable.

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KEYWORDS: Cadmium; Cd; Zinc-Nickel; Zn-Ni; Stripping; Coatings; Corrosion; High-Strength Steel

N242-083 TITLE: Recovery System for Group 3–5 UAVs for Sea-Based Operations

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

OBJECTIVE: Develop a novel recovery system for arresting Group 3–5 fixed-wing Unmanned Aerial Vehicles (UAVs) aboard air capable ships that minimizes required deck landing area and footprint on the ship.

DESCRIPTION: The Navy needs to operate fixed-wing UAVs from ships other than aircraft carriers—a capability that, if introduced, would significantly increase lethality, ability to project force, and the range of Intelligence, Surveillance, and Reconnaissance (ISR) [Ref 1]. A key enabler is recovery of UAVs spanning a large recovery envelope, that is, varying in weight, size, and approach velocity. The recovery system should be capable of arresting Group 3–5 [Ref 2] fixed wing UAVs (objective) or UAVs with a weight range of approximately 500–10,000 lb (454–4536 kg) (threshold), wingspan of approximately 15–70 ft (4.5–21.5 m) (threshold), and approach velocity of approximately 50–150 knots (92.6–277.8 kph) (threshold). Rotor-borne flight solutions (e.g., deploying rotors for landing, or tail-sitters) are not within the scope of this SBIR topic.

The Navy is interested in novel approaches to recovery that minimize required deck landing area and footprint on the ship. Respondents are encouraged to consider a total systems approach that includes novel flight control techniques as part of the proposed total concept. For example, solutions may consider putting the aircraft into a stall prior to capture/arrestment to reduce velocity. Solutions are not limited to a particular ship class or installation methodology. Concepts that utilize permanent installation (e.g., recovery equipment embedded within/under the flight deck) are acceptable, as are nonpermanent concepts (e.g., those temporarily attached to the top of the flight deck, above the flight deck, or extending out from the side of the ship). Non-permanent concepts should consider portability, stow-ability, and modularity, and should not impede safe movement of people, aircraft, and other equipment across the flight deck. Potentially relevant air capable ships (ACS) may include the Destroyer (DDG), Expeditionary Sea Base (ESB), Amphibious Transport Dock (also known as Landing Platform Dock [LPD]), or a new ship class or sea-based platform entirely. Relevant flight decks may be approximately 50–200 ft (15.2–61 m) long and 40–100 ft (12.2–30.5 m) wide. Solutions should consider deck dynamics and ship motion, including ship air-wake and related aerodynamics/aeromechanics, wind-over-deck, ship direction of travel, operation in sea state 5, survival in sea state 8 (including ship motion and flexure), and associated trim, list, pitch, roll, and heave requirements.

Given variable ship and aircraft sizes, concepts may be modular or include a family of systems that scale for higher and lower energy vehicles. Designs that follow a system-based approach, where the system is composed of the aircraft and recovery method, are preferred. Although the recovery system should be capable of arresting a range of UAVs, concepts that include a new, clean-sheet aircraft that integrates with a new recovery methodology are acceptable to promote compatibility between future UAVs and future UAV Aircraft Launch and Recovery Equipment (ALRE). In addition, solutions that provide the recovery system with initial conditions (UAV weight, velocity, approach vector) of the arrestment as the aircraft approaches, are allowable and encouraged. Strategies for collecting/sharing this information (e.g., avionics, communication between aircraft/recovery system, sensors aboard ship, etc.) are within the scope of this SBIR topic.

UAVs utilizing the recovery system may be low cost and attritable (i.e., affordable mass), potentially enabling higher risk acceptance than carrier-based, manned ALRE. Increasing automation is also desirable to minimize additional manning requirements. Solutions should take into account time for recovery and boarding rate as they will impact energy absorption and thermal/cooling requirements. A sortie rate of 25 arrestments per day per recovery system (objective) or 15 arrestments per day per recovery system (threshold) is acceptable. Military standards should be referenced for environmental factors (MIL-STD-810H [Ref 3]), electromagnetic interference (MIL-STD-461G [Ref 4]), shock (MIL-DTL-901E [Grade A] [Ref 5]), and vibration (MIL-STD-167-1A [Type 1] [Ref 6]) since the recovery system must be rugged to be viable.

In the interest of promoting ALRE that is common to multiple aircraft and multiple ships, the Navy recommends a holistic/systematic approach. In other words, although design of a launch system is not within the scope of this SBIR topic, the need for launch and recovery systems to both fit and work together on a single ship should not be ignored. Concepts should also consider pre-launch and post-recovery storage of UAVs and ALRE. Solutions that use shared equipment for launch and recovery and modular/scalable concepts will reduce overall ALRE weight, deck space, and volume. There are also potential impacts to topside weight, ship storage tradeoffs, power, and cooling water requirements driven by congruous versus incongruous designs.

PHASE I: Develop a conceptual design and provide proof-of-concept analysis in a computer simulated environment. Analysis should include both recovery system functionality and flight control dynamics. Specifically address areas of technical risk such as aircraft/recovery system interfaces and absorption of aircraft kinetic energy. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Provide more detailed design and digital analysis of all components, potentially including, but not necessarily limited to, mechanical, electrical/power, controls, thermal, and communications subsystems. Deliver a subscale prototype of the recovery system with adequate representation of the geometries and functioning major subsystems. Demonstrate that the prototype is capable of recovering a subscale UAV, or representative vehicle in terms of scaled size, weight, and velocity. Report results of the demonstration, including next steps, improvements required, and detailed plans for how to construct a full-scale prototype.

PHASE III DUAL USE APPLICATIONS: Design, develop, and fabricate a full-scale working prototype of the recovery system based on work completed during earlier phases. Determine a safe and effective means of testing the recovery system using aircraft-representative deadload(s) in a land-based test environment and work with relevant stakeholders to coordinate instrumentation, data collection, and metrics of success. Conduct deadload testing to validate and verify performance. If successful, plan and perform initial aircraft testing.

A recovery system (and launch system) for fixed-wing UAVs has secondary applications in the delivery, shipping and receiving, and transportation industries. Autonomous, unmanned aircraft can assist with package delivery, whether over long distances or the last mile. An efficient and effective launch and recovery solution for fixed-wing aircraft enables delivery of retail packages, food, medical equipment, and other cargo at greater speed, range, and endurance. As demonstrated by Zipline in Rwanda, fixed-wing UAVs can provide a useful solution for quickly shipping medical supplies to remote areas. In congested urban environments, replacing gas-powered delivery trucks (e.g., FedEx, UPS, and Amazon) and personally owned vehicles (e.g., DoorDash) with electric UAVs can also reduce traffic congestion and pollution. Although vertical takeoff and landing (VTOL) UAVs present an alternative, they may only be viable for a limited range and present noise pollution challenges.

Expanding launch and recovery technologies to higher UAV weights can increase cargo capacity for deliveries over longer distances. Introducing ALRE allows the aircraft to take off and land over a shorter distance, reducing reliance on airports, which can decrease land area used for runways, and the time and logistics footprint associated with sending packages from a warehouse to an airport. ALRE also does not need to be situated on land or stationary structures, but could be used to launch/recover aircraft off of trucks, cars, tractor trailers, trains, ships, barges, or other aircraft. For example, a larger UAV could be launched from a warehouse; then, while in the air and near a delivery location, it could deploy a high quantity of smaller UAVs for final delivery; those smaller UAVs could be recovered by the larger UAV to return to the original warehouse, or the smaller UAVs could be recovered on land at a location near the delivery location.

Systems that meet safety requirements and have acceptable G-forces at launch and recovery could also be used for transportation of people. There is a long history of launch and recovery of manned aircraft aboard aircraft carriers; however, a system used for mass transportation would need to significantly reduce acceleration and deceleration forces to be acceptable for the general public. Some concepts may be capable of significantly reducing these forces to permit transport of people.

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KEYWORDS: Recovery; arrestment; unmanned aerial vehicle; UAV; aircraft; attritable; affordable mass

N242-084 TITLE: Modular Open Architecture Assured Positioning, Navigation, and Timing (PNT) Hub

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

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

OBJECTIVE: Develop a modular device that integrates non-GPS sources of position, velocity, attitude, and time to enable operations in GPS-denied environments. The device should align with Modular Open Systems Approach principles and support open architecture technologies (e.g., SOSA, OpenVPX, pntOS, ASPN, etc.)

DESCRIPTION: Assured PNT capability provides continuous access to position, velocity, attitude, and time (PVAT) information of confirmed integrity and of sufficient accuracy to complete the mission in the complete spectrum of GPS threats. Currently, there is no common scalable and reconfigurable solution that delivers continuous access to PVAT information in GPS denied environments. Developing a modular device to integrate non-GPS source PVAT information enables easy reconfiguration to platform specific needs, avoids unnecessary development cost by reusing the same device, and removes intellectual property limitations.

This SBIR topic seeks to leverage commercial off-the-shelf technologies, and government-owned or open interfaces to produce a device with the following capabilities:
1. Platform I/O:
Configurable hardware/software module(s) to interface with aircraft avionics interfaces such as MIL-STD-1553 [Ref 1], ARINC-429 []Ref 2], Ethernet, and so forth.
2. Sensor I/O:
Configurable hardware/software module(s) to interface with non-GPS sources of PVAT.
3. PNT Application Space:
A configurable software hosting environment and software development kit (SDK) using non-proprietary application programming interfaces (APIs) to deploy the following functionality:

* Input / output abstraction:
Conversion of platform/sensor specific data structures to a common application data structure (e.g., ASPN2023.)
* Integrity Module:
Logical or statistical input/output validity test of PVAT and time information. Depending on the non-GPS input modality, this module(s) should conduct fault detection, exclusion, and alerting.
* Sensor Fusion:
Configurable state estimation algorithms to compute GPS- and non-GPS-based navigation solutions (e.g., Extended Kalman Filter, Particle Filter, etc.).
* Logging:
Log of system status, system performance, and alerts for performance evaluation, system maintenance, and troubleshooting.

PHASE I: Develop, design, and demonstrate feasibility of a Functional Architecture design of the proposed approach. Deliver a Physical Architecture design of the proposed approach. For proposed non-GPS PNT sources:
deliver performance prediction via modeling and simulation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Deliver a working device prototype with necessary operation documentation. Support technology demonstration. Conduct limited-scope environmental qualification tests.

PHASE III DUAL USE APPLICATIONS: Collaborate with other defense agencies and prime contractor to determine transition opportunity. Verify and validate the performance of the technology developed under Phase II to enhance its TRL.

This topic will benefit defense contractors and navigation-based platforms. This technology will align with SOSA principles and allow private sectors to interchangeably and interoperably integrate their technologies without intellectual property limitations.

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KEYWORDS: SOSA; OpenVPX; pntOS; ASPN; GPS-denied; Kalman filter

N242-085 TITLE: High-Power Digital Fiber Optic Transmitter Laser

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

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

OBJECTIVE: Develop and package a high-power vertical cavity surface emitting laser (VCSEL) and VCSEL transmitter optical subassembly capable of operating at up to 50 Giga Bits per Second (Gbps) non-return-to-zero (NRZ) in the wavelength range of 850 nm to 1000 nm.

DESCRIPTION: Current airborne military (mil-aero) core avionics, electro-optic (EO) communications, and electronic warfare (EW) systems require ever-increasing bandwidths while simultaneously demanding reductions in space, weight, and power (SWaP). The replacement of shielded twisted pair wire and coaxial cable with earlier generation, bandwidth-length product, multimode optical fiber has given increased immunity to electromagnetic interference, bandwidth, throughput, and a reduction in size and weight on aircraft. 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.

In the future, data transmission rates of 100 Gbps and higher will be required. Substantial work has been done to realize data rates approaching this goal based on the use of multilevel signal coding, but multilevel signal encoding techniques trade off link budget and latency to achieve high-digital bandwidth. To be successful in the avionic application, existing NRZ signal coding with large-link budget and low latency must be maintained. Advances in optical transmitter designs are required that leverage novel laser technology, semiconductor process technology, circuit designs, architectures, and packaging and integration techniques. In particular, the avionic passive loss link budgets would benefit from higher power laser transmitters that are compatible with the current fiber infrastructure. Vertical Cavity Lasers have been widely deployed in the systems, but have limited optical power output. There are several approaches to increasing the available optical power, including multi aperture VCSELs and multijunction VCSELs. The focus of this SBIR topic is to increase the available power from a VCSEL to +10 dBm, while simultaneously operating across all of the environmental requirements.

The proposed avionic transmitter must operate across a -40°C to +95°C temperature range, and maintain performance upon exposure to typical naval air platform vibration, humidity, temperature, altitude, thermal shock, mechanical shock, and temperature cycling environments. The transmitter must support at minimum a 12 dB link loss power budget when paired with a receiver meeting similar environmental requirements, as well as applicable electro-optic performance restrictions. The transmitter must be compatible with receivers in the 850 nm–1000 nm band operating at greater than 50 Gbps NRZ and capable of operating with multimode 50 µm multimode optical fiber while maintaining a bit error rate less than 1x10-12.

The electrical input of the transmitter must be differential current mode logic with an equalization mechanism to allow transmission of the electrical output across at least 2 in. (5.08 cm) of board-level interconnect. The proposed transmitter design must be capable of being demonstrated to perform reliably over the stated environmental, functional, and performance requirements with an Objective aggregate data rate of 50 Gbps. A Threshold performance level of 25 Gbps would represent an attractive option for near-term system deployment in concert with available digital fiber optic transmitter technology.

PHASE I: Design and develop a high-speed and high-power VCSEL with optical output power of +10 dBm and bandwidth compatible with 50 Gbps NRZ signaling. Identify laser driver requirements for 50 Gbps NRZ operation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the VCSEL, transmitter optical subassembly, and package designs. Build and test the transmitter circuit and packaged prototype to meet performance requirements. Characterize the transmitter over temperature, and perform highly accelerated life testing. If necessary, perform root cause analysis and remediate circuit and/or packaged transmitter failures. Deliver two packaged transmitter prototypes for 50 Gbps digital fiber optic communication link application.

PHASE III DUAL USE APPLICATIONS: Finalize the prototype transmitter laser design. Verify and validate the laser performance in an uncooled 50 Gbps fiber optic transmitter that operates from -40 °C to +95 °C. Perform environmental testing to increase technology readiness. Demonstrate additional laser wavelength options for the 850 nm to 1000 nm wavelength band. Develop manufacturing tooling and supply chain infrastructure to increase manufacturing readiness. Transition to applicable naval platforms. Dual use applications include telecommunication systems, data centers, and campus networks.

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KEYWORDS: Laser; Transmitter; 50 Gb/sec; Multimode Fiber; Loss Budget; Non-Return-to-Zero Signaling

N242-086 TITLE: All-Aspect Maritime Automatic Target Recognition

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

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

OBJECTIVE: Develop a method to exploit the unique characteristics of large shipboard radar antenna systems to classify combatants at long range regardless of the aspect angle.

DESCRIPTION: Inverse Synthetic Aperture Radar (ISAR) is the primary means to classify ships from airborne platforms from hundreds of kilometers away. ISAR images are generated by the ship's rotation around any of the three principal axes. In order to form an ISAR image the Navy requires that any relative motion between the airborne radar and the ship be compensated for, with only the rotation of the ship on the ocean remaining. This is generally done by tracking a point, or multiple points, on the ship that provides a consistent, strong radar return. The resulting range-Doppler image is most informative when the viewing angle is along the length of the ship since features that inform classification are separated in range. If the ship is broadside relative to the radar, then there will be very little range extent, and a mostly range-unresolved range-Doppler image will be produced making classification more difficult or impossible. Reorienting the aircraft to obtain a more favorable viewing geometry can be time consuming, or given airspace restrictions, impossible. However, ISAR has the ability to detect a rotating object and estimate its physical properties regardless of the view geometry (within reason), as long as the rotating structure is observable. Typically, these rotating objects observed on ships are radar antennas. For commercial and non-combatant ships these radar antennas are almost exclusively marine navigation radar such as those produced by Furuno. While combatants also utilize similar navigation radars with comparable antennas, the mission demands of combatants require much larger antennas to service powerful surface or air search radar systems. Some combatants utilize fixed active electronically scanned arrays (AESAs). However, a significant percentage of combatants have large rotating reflector antennas or rotating AESAs. Exploitation of the ISAR return from a rotating antenna can provide information on its position on the ship, its rotation rate, the width of the antenna structure that is rotating and in many instances information on the detailed configuration of the antenna system and pedestal.

ISAR capable radar systems on U.S. Navy aircraft may have many hundreds to several thousand ships under track when operating in dense operational environments such as areas of the western Pacific Ocean. Classifying those ships, particularly when full trust cannot be placed on ship Automatic Identification System (AIS) broadcasts, requires high levels of automation, advanced radar techniques, and operator aids. Still, all of this works best when favorable near-bow or near-stern viewing geometry exists. This SBIR topics seeks to open the viewing geometry to enable probable combatant level classification, or if the antenna structure ISAR signature is sufficiently unique to a ship class, to achieve fine naval-level classification. Aspect independent classification, even at the probable combatant level is extremely valuable as it informs mission execution priorities and planning for ISAR imaging when more favorable viewing geometry exists.

Three critical issues must be addressed in this research. The first is demonstrating the level of ship type separability that rotator exploitation information will provide. Second, identifying additional ISAR-based features in rotator and fixed hard-body returns that supplement the features described in the preceding paragraphs at near-broadside viewing geometries. Finally, sourcing and cataloging a feature database to support classification.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop, design, and evaluate ship separability using ISAR-based rotator exploitation in both general terms, and for the range of combatants of the Pacific Rim nations. Assess additional features, which might supplement primary rotator features and other hard-body features at near-broadside view geometries. Develop plans to complete the exploitation tool set in Phase II that will address the exploitation chain from feature database development through exploitation and classification support. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the complete near-broadside exploitation tool set whose general approach was defined in Phase I. Work with the Navy to conduct a comprehensive evaluation using existing ISAR image libraries.

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

PHASE III DUAL USE APPLICATIONS: Integrate the near-broadside exploitation tool set with an ISAR capable radar and demonstrate its effectiveness using live data.

Identification of maritime traffic is also important to civilian and private organizations that are responsible for scheduling and monitoring that traffic, especially in heavily congested areas. Expanding the fields of view from which quality images can be collected simplifies the problem. Another scientifically interesting and compelling application of ISAR is deep space imaging of asteroids.

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KEYWORDS: Inverse Synthetic Aperture Radar; ISAR; Radar; Doppler; Maritime; Identification; Classification

N242-087 TITLE: Theater Naval Wargame for Strategy Refinement

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

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

OBJECTIVE: Develop an embedded capability that enables realistic Theater-level Naval wargaming within tactical and strategic systems used by Theater commands and combatants.

DESCRIPTION: A wargame is a strategy game in which two or more players command opposing armed forces in a realistic simulation of an armed conflict. Prussia's victory over France in 1870 was broadly attributed to Prussia's wargaming culture rather than any superiority in actual numbers or armaments. Wargaming has subsequently become an important element of military strategy development and refinement.

Future conflicts with peer competitors may involve Naval forces to a greater degree than at any time since World War II. Naval wargames are often conducted as multi-day events where teams "command" so-called blue (friendly) and red (hostile) forces. The conflicts are typically overseen by an umpire who determines the probabilistic outcome of individual encounters. Some such wargames are computer-based while others are conducted using physical markers and dice.

Given the significant changes to warfighting capabilities since the 1940s, there is a need for a wargaming capability to become more accessible. Ideally, such a wargaming capability could reside within tactical and strategic systems. There is also a need for a wargaming framework that can easily be updated to reflect the most accurate information available to support wargame realism. There is nothing commercially available to do this.

In addition to modeling the probabilistic nature of warfighting capabilities (e.g., the probability that a torpedo will hit and damage an opponent [probability of kill (Pkill)]), the wargame should also reflect the proficiency of crews and the improvements associated with improved human capability. The wargame framework should keep track of deployed munitions and the status of individual combatants. The wargaming framework should allow future capabilities to be imported or created for both red and blue forces. The wargaming framework should also be extensible to political or media outcomes that may be associated with military encounters.

The wargaming framework should support self-guided proficiency development, multi-player wargames, single-player wargames versus artificial-intelligence opponents, and management for in-person wargaming (also referred to as computer-assisted wargames). Modes for the wargame should include open gaming where players can see the location of opposing forces, and closed gaming where players are only aware of what their sensors and intelligence sources tell them about opposing forces. The wargame should include a debriefing mode where full information about both blue and red forces can be seen across the course of the completed campaign.

The initial transition target for the gaming Theater Naval Wargame would focus on Undersea Warfare and be included in future builds of AN/UYQ-100 (Undersea Decision Support System) used for Theater Undersea Warfare (TUSW) and AN/SQQ-89 (Undersea Warfare / Anti-Submarine Warfare Combat System) used aboard over 100 ASW-capable combatants between the US and various allies.
Factors that affect undersea warfare campaigns include sailor proficiency, the characteristics of surface and submarine combatants (to include sensors, countermeasures, and weapons), satellite surveillance, land-based anti-ship and anti-submarine weapons, and environmental factors.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations. Reference: National Industrial Security Program Executive Agent and Operating Manual (NISP), 32 U.S.C. § 2004.20 et seq. (1993). https://www.ecfr.gov/current/title-32/subtitle-B/chapter-XX/part-2004

PHASE I: Develop a concept for a TUSW Wargame and demonstrate the feasibility of that concept using unclassified data obtained or created by the proposer. Demonstrate the concept meets the parameters in the Description. Feasibility will be through modeling, simulation, and analysis.
Demonstrate the flexibility, extensibility, and utility of the wargaming framework using unclassified data sets the proposer has created or obtained. (Note: Wikipedia and publications such as Jane’s Fighting Ships would be appropriate sources for Phase I.)

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

PHASE II: Based on Phase I results, develop and deliver the prototype TUSW Wargame and demonstrate the prototype meets the required range of desired performance attributes given in the Description. Deliver a minimum viable product (MVP) version of the gaming framework for evaluation as a stand-alone module mid-way through the Phase II effort.

(Note: During Phase II, the Navy would provide the company access to classified data associated with actual and future military capabilities relevant to Undersea Warfare.)

Demonstrate the technology in a Moodle environment - a cloud-based learning management system environment. Facilitate in-person computer-aided wargame events to increase campaign coverage by a factor of 10 compared to un-aided in-person wargames. Present an MVP variant of the wargame to gain approval for proposed expansion over the remainder of the Phase II effort. (Note: This presentation of an MVP variant is referred to as “Step 1” of the ASW Advanced Capability Build technology evaluation process. Upon successful completion of Step 1, nominally a year after award of Phase II, the government will invest in independent evaluation of the MVP, referred to as “Step 2.” The MVP Step 2 should complete around 24 months after award of the Phase II.)

If exercised, the Phase II Option will include development of a final prototype of the wargame that is appropriate for initial deployment to Navy customers.

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

PHASE III DUAL USE APPLICATIONS: The TUSW Wargame will be transitioned to Phase III via either subcontract to an existing Prime Contractor or a Phase III award to the company. Planning for this transition will be based on success of the Step 2 evaluation of the Minimum Viable Product of the technology planned to occur around the end of the Phase II Base. The company will be expected to support the Navy in transitioning the technology for Navy use in on-board trainers for both the AN/UYQ-100 Undersea Warfare Decision Support System and the AN/SQQ-89 Surface Ship Undersea Warfare Combat System. The technology will provide warfighters the ability to become conversant with what it takes to win at the theater level in the context of modern technologies available to both allied and enemy combatants.

In addition to validation, testing, qualification, and certification via the Advanced Capability Build process in the description, the performer will be expected to follow the Continuous Integration/ Continuous Delivery (CI/ CD) cycle as mandated by the Navy’s DevSecOps processes and the transition Program Office (IWS 5).

It is anticipated that the company will be able to leverage the innovative technologies associated with this topic to provide compelling strategic gaming products for the commercial market. Commercial opportunities would include entertainment as well as serious games to serve strategy refinement in the areas of military and security sectors and any other sectors in which high stakes are involved if naïve strategies would lead to systemic failure, such as the financial sector and sectors involved with disaster response.

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KEYWORDS: Theater Undersea Warfare (TUSW); Naval wargames; proficiency development; probabilistic nature of warfighting; probability of kill (Pkill); computer-assisted wargames

N242-088 TITLE: Low-cost Floats for Observing Interior Ocean Flows

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

OBJECTIVE: Develop and demonstrate a low-cost, expendable ocean float that can be deployed in large numbers along with a concept to track the floats to observe interior ocean velocities through the reconstruction of Lagrangian pathways.

DESCRIPTION: Velocities in the interior of the ocean are difficult to observe, with Acoustic Doppler Current Profilers (ADCPs) and current meters representing the primary sources of observation. These techniques largely provide ocean velocities in an Eulerian reference frame. From the perspective of constraining numerical ocean models via observations, trajectories of interior ocean flow in a Lagrangian reference frame provide a more stringent measure of the fluid streamfunction, and data assimilation techniques that use Lagrangian information have proven to be very effective in ocean prediction. However, most Lagrangian information in the ocean comes only at the surface from drifting buoys. Observing the interior trajectories of the ocean has traditionally been more difficult, though there is a history of success using acoustic tracking to follow floats in the water column (see SOFAR, RAFOS, or COOL floats as examples). Modern manufacturing techniques, acoustic modem technologies, and advancements in low-power electronics and sensing may enable significant advancements in Lagrangian float design, tracking, and sensing capability. These Lagrangian sensing techniques may be particularly useful in regions where surface operations are difficult, such as the Arctic Ocean where sea ice cover impedes the use of oceanographic vessels to collect subsurface ocean velocity using traditional ADCP techniques.

The proposed observing capability would enable the characterization of the interior ocean streamfunction by deploying a large number of neutrally-buoyant in situ floats that would follow the ocean currents in the upper water column (from the surface to perhaps 500 meters deep), along with a concept to track the floats for up to a month to reveal submesoscale ocean flow features in a regional area (up to 105 square kilometers). Disposable Floats should be designed to have a specific reconfigurable density, without a requirement for active buoyancy control due to the expected significant increase in cost and complexity this would require. Additional oceanographic sensors (e.g., temperature, salinity) could be integrated into the floats, depending on float complexity, the overall tracking concept proposed, and cost of integration. It is up to the proposer to determine which options to include, providing cost considerations.

The Phase II effort will require an at sea demonstration of at least five prototype floats along with the proposed tracking system.

PHASE I: Design and develop a concept for a distributed sensing network of modular low-cost drifting floats that can be used to reconstruct flow trajectories for the interior ocean, including prototype float development and analysis of the predicted sensing performance of a full deployment of 100 floats over a representative ocean region. Develop a Phase II Plan.

PHASE II: Produce initial prototypes of floats along with the proposed sensing system, and test them at sea in a sufficiently complex maritime environment to demonstrate the capability of the system to characterize interior ocean streamfunction. Include the assimilation of data collected by the proposed system into numerical ocean models as part of the demonstration, with improved ocean characterization and prediction by the models as a critical metric.

PHASE III DUAL USE APPLICATIONS: Finalize float design and incorporate additional sensor payloads, if achievable. Commercial applications include oceanographic research (physical, chemical, and biological), effluent management and water quality monitoring, and use in coastal and open-ocean observing systems.

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KEYWORDS: Oceanographic Sensing; Lagrangian Data Assimilation; Trajectory Analysis; Dynamical Systems Theory; Ocean Velocity; Interior Ocean Observing; Acoustic Tracking; Ocean Floats; Isopycnal

N242-089 TITLE: Alternative Fabrication Pathways for Complex Alloys

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

OBJECTIVE: Develop a solid state processing pathway to fabricate refractory high entropy alloys that avoids partitioning (in multi-phase Alloys) seen in melting/solidification processes.

DESCRIPTION: Refractory high-entropy alloys (RHEAs) are considered a new kind of high-temperature materials with great application prospects due to their excellent mechanical properties and have the potential to replace nickel-based superalloy as the next generation of high-temperature materials for gas turbine and hypersonic applications. Currently, the majority of methods for processing of Cantor (3d transition) HEAs and metallic RHEAs are melt derived. This process can be challenging due to the disparate and extremely high melting points of the constituent metals. Moreover, elemental segregation often occurs during the solidification process, resulting in compositional inhomogeneity. In multi-phase alloys, portioning of elements into different phases occurs. This elemental partitioning promotes diverse properties in the different phases of the alloys such differing passivity properties. This SBIR topic seeks to develop a method for Cantor and RHEA production based on the reduction of a mixture of metal oxides, or a mixture of oxides and metallic powders. Processes utilizing non-flammable gas mixtures would be advantageous. The process could be aimed at obtaining (1) RHEA metallic powders (for subsequent solid-state processing) or (2) RHEA bodies (via additive processing of ceramic powders and subsequent reduction heat-treatment). Examples of target RHEAs compositions include MoNbTaW and HfNbTaTiZr.

PHASE I: Explore the literature to determine the relationship of processing versus complex alloy properties. Among the properties, what processes avoid partitioning of elements in multi-phase alloys. In addition, the offeror needs to utilize computational methods to ascertain non-additive manufacturing (AM) processes that minimize the energies to process these complex alloys. Develop model/algorithms that link alloy properties to the fabricating process and resulting microstructure and subsequent mechanical properties. The processes selected need to avoid elemental partitioning among multi-phase alloys. Determine the temperature at which elemental partitioning initiates. Focus on Cantor (3d transition) high entropy alloys. Analysis of defects and inhomogeneities is suggested to be done by non-destructive characterization methods. ICME (integrated computational materials engineering) should link the fabrication process with materials chemistry to prove the extent of feasibility of the selected process to avoid partitioning.

PHASE II: Apply ICME tolls to optimize processing to predict materials chemistry and processing parameter limits for complex alloys. Focus on employing lessons learned on RHEAs during Phase I. (Example: How do the thermodynamics and kinetics for producing RHEAs compare to the processing of Cantor HEAs?) Develop and/or modify model/algorithms that link alloy properties to the fabricating process and resulting microstructure and subsequent mechanical properties. (Note: As in Phase I, the process needs to avoid elemental partitioning among multi-phase alloys and needs to determine the temperature at which diffusional activities initiates elemental partitioning.) Analysis of defects and inhomogeneities is also suggested to be done by non-destructive characterization methods. With computational and experimental research for both Cantor and RHEAs, comprehensive models and algorithms should link optimized processing parameters with alloy chemistries that avoid elemental segregation often occurs during the solidification process after alloy melting, resulting in compositional inhomogeneities.

PHASE III DUAL USE APPLICATIONS: Continue to use the comprehensive models and algorithms to link optimized processing parameters with alloy chemistries that avoid elemental segregation and compositional inhomogeneities.

The developed process offers the opportunity of more uniform properties among phases. For instance, avoiding elemental partitioning will simplify strategies to form passive films on complex alloys due to more consistent materials chemistries among phases. Proven process optimization leading to a minimization of process - and materials - derived defects and inhomogeneities would improve acceptance of this process for producing components for the Navy and for private industry. Processing of components that are qualified for Navy use could also be applied to commercial use. Processing of components that are qualified for Navy use could also be applied to commercial use more quickly and less costly with parts are needed.

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KEYWORDS: Processing; RHEAs; refractory high entropy alloys; RMPEAs; arc-melting; partitioning; microstructure; Segregation; multi-phase

N242-090 TITLE: Low-Cost, High-Power Microwave Switches for Radar and Electronic Warfare (EW) Applications

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

OBJECTIVE: Design, optimize, and fabricate prototypes for a low-cost, low-loss, high-power microwave switch with fast-switching speeds over large instantaneous bandwidths for radio frequency (RF) surveillance and Electronic Warfare (EW) applications.

DESCRIPTION: While phased array systems with analog or digital phase control at each element provide a highly flexible means of shaping transmit or receive antenna patterns, the per-element cost remains high for these systems, especially when tailored toward stringent Naval requirements. These requirements range from demanding radiated power levels, high system efficiency, coexistence with other emitters and receivers, operation over very wide bandwidths, and multi-function capabilities. On top of this, there is a growing need for adaptive array systems with low SWAP-C for surveillance, electronic warfare, and modern communication systems. To meet these objectives, some phased array approaches are looking toward tunable circuitry solutions that are applied after the high-power microwave source, rather than before.

Some of these solutions are implementing high-power handling output tuners that actively control the scan impedance of an array, improving overall system efficiency [Refs 1, 2], and investigating “reflectarrays” or “intelligent reconfigurable surfaces” [Ref 3]. Phased array systems employ a corporate feed for RF power distribution over small subarrays also have a need for high-power phase shifters. Ferrite phase shifters have historically had a role in this area, but the high losses have made these architectures undesirable.

Several types of RF switches, such as solid state switches (PIN diode, FETs), electromechanical switches (waveguide, coaxial, MEMS), semiconductor switches with new materials (GaN, SiC), photoconductive semiconductor switches (PCSS), and plasma switches (Gas Discharge Tube), have been investigated, each with various strengths and weaknesses with respect to insertion loss, isolation, linearity, switching speed, power handling, or wideband performance [Refs 4, 5, 6, 7]. Compromises between these metrics are limiting the uptake of high-power RF switches.

To that end, the Navy is seeking novel methods of designing and producing low-cost, high-power microwave switches with minimal compromises in other key performance parameters for radar and electronic warfare applications. The proposed approach shall provide significant performance improvement with respect to power handling, tuning speed, efficiency, and linearity, while reducing unit cost to enable low-cost phased array solutions for the Navy.

PHASE I: Develop a preliminary design of hardware for a novel, low-cost, high-power microwave switch that significantly exceeds the current state-of-the-art and improves the performance of current switches. Develop a design approach and produce simulated results of a high-power, fast microwave switch that meets or exceeds the following metrics:
• Operating frequency: Any one octave over 2-12 GHz (Threshold), entire 2-18 GHz band (Objective)
• Power handling (1-dB compression point) - Operative above a curve defined by the following frequency & power points:
Threshold Power: 250 W @ 3GHz // 50 W @ 10 GHz
Objective Power 750 W @ 3GHz // 150 W @ 10 GHz
• Targeted unit costs: $50/device (Threshold), $5/device (Objective)
• Insertion loss: < 1dB (Threshold), < 0.3 dB (Objective)
• Isolation: > 20 dB (Threshold), > 40 dB (Objective)

• Switching speed: 500us (Threshold), 50 ns (Objective)
• Cycles: > 3e9 (Threshold), > 30e9 (Objective)
• Linearity: Input third order intercept approximately 10dB above P1dB point.
• Duty cycle: Greater than 20% (Threshold), to CW (Objective)
Note – As with other research programs, proposed solutions may have sub-threshold performance in an area if it excels in other areas.

Prototypes and experimental testing that reduce technical or manufacturing risk are encouraged. However, the Government understands some fabrication processes are not feasible within Phase I funding, so modeling and simulation approaches are also acceptable. Lastly, provide a Phase II plan that includes the estimated performance of prototype switches to be fabricated in Phase II.

PHASE II: Produce a prototype or set of prototypes of the Phase I switch design. Laboratory based testing shall be completed under the Phase II effort to demonstrate that the technology meets performance metrics set at the end of Phase I. Efforts should characterize devices against metrics set forth in Phase I, identify and iterate on designs to improve performance, and provide a recommended path for higher-volume production.

PHASE III DUAL USE APPLICATIONS: Design, build, and deliver higher level subassemblies including the new switching technology, with assistance from the Navy. Possible subassemblies may include high-power phase shifters, low-loss antenna tuners, or switch-tuned filters. These efforts will target components and subassemblies that support both DoD applications (e.g., phased array radar or electronic warfare systems), and commercial applications (e.g., adaptive arrays for high power 5G/6G cellular base stations).

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KEYWORDS: Microwave switches, antennas, phased arrays, phase shifters

N242-091 TITLE: An Open-Source Academic Publication Platform Tailored Toward Future Open Science Communications

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

OBJECTIVE: Develop an open software infrastructure to support modernized scientific and technical communication. The end product will support a variety of publishing goals, including flexible options to edit, review, comment, and compare related written works and be able to curate publications, proposals, abstracts, presentations, data, algorithms, and other communications.

DESCRIPTION: The current peer-review model for scientific literature publication is outdated. The review process is opaque to a fault, and the floor for what constitutes publishable content grows higher by the day. Many people and topics get lost in this mire; including good research hindered by incompatible, overly demanding or biased reviewers. At the same, platforms like Slack and Teams provide teaming tools; yet they are over developed for information distribution and lack an organized peer review process. A middle ground needs attention for dynamic content below journals but above more stovepiped information systems. While the proliferation of new open-source journals provide a simulacra of legacy journals, there exists a vacuum in open best practices and software methods to improve science communications at large. For example, how does one distribute well-reasoned but ultimately doomed research that tells a compelling and cautionary tale? Not only is the future of open science expanding via government mandate (OSTP 2022), there exists a need to track, catalog, archive, and otherwise compare technical work that would otherwise fall victim to the publish-or-perish mentality and have their contributions lost to the sands of time. The academic publication process seems ripe for disruption.
This SBIR topic seeks commercial innovations that can take advantage of new technologies in open software development cycle, version controlling, living documentation, continuous integration/continuous delivery, and others that have the potential to vastly change the paradigm of science/technical publication and communication to allow creation, curation, and distribution of knowledge in innovative ways. This may be achievable via development of a new software platform with a document and data store that better accounts for the variety of new communication methods, archival standards, and machine learning of key words/content to better serve all scientific work of relevance to the academic and government community, not just the flashiest success papers. Ultimately, this topic, seeks the development of both an open publication, open review platform and series of editorial standards that could be applied to a new journal-like medium for accepting a broader array of scientific communication such as null results in the geosciences.

PHASE I: The majority of this effort should focus on a survey of current geoscience publication methods and configurations, an assessment of expected future US government open science standards and procedures, and a proof-of-concept system level architecture of software components and processes for a modernized engine to support new science communication publication methods.

In the survey of current geoscience publications, the performer is expected to examine a series of editorial standards and protocol following popular journals and organizations such as from Nature/Springer, Elsevier, Wiley, the American Geophysical Union (AGU) or American Meteorological Society (AMS). Standards include document formatting, citation style, determining what constitutes a publishable unit, and a process for assigning peer-reviewers to topics (e.g., author-suggested reviewers, a roster of volunteer reviewers, etc.) that encourages repeat participation and ensures proper assignment of Subject Matter Experts (SMEs).) Reviewing open science mandates by the White House Office of Science and Technology and planned implementation strategies such as from NASA Open Science and NOAA will be compared to the previous publishing paradigms and used to contrast new needed publication functionality.

Outline front- and backend infrastructures for an open access hosting and open peer-review system with modern UI/UX for both desktop and mobile experiences. Considerations should be made for long term retention of content and scalability. Emphasis on lightweight, open-source and cloud-oriented solutions are preferred. The peer review system should include options for single-, double- and triple-blind reviews as well as fully open. Provide an open review option using a GitHub or Jira-like interface. For frontend planning, accessibility, including colorblind considerations and compatibility with popular mobile and desktop screen reading software (e.g., JAWS, VOX, TalkBack, etc.) are a priority. The design should also incorporate functionality for continued review/dialog as a living document, citation management and interoperability, and machine learning methods to suggest related work via key word and journal content analysis.

An outcome of the six-month Base effort should be a final report of background, anticipated functionality, technical challenges for software development and implementation, and recommendations for prototype development.

PHASE II: Develop, iterate, and prototype the software outlined in Phase I with an option period expanding the functionality and/or interacting with Naval research, university, and science publication partners for demonstration. End-to-end tests need to be conducted of multiple submission, review, and communication processes to ensure seamless operation for users. Emphasis should be on 1) replication of current journal publication standards, 2) demonstration of functionality that conforms to open science standards (such as tracking of review comments, replies, data, algorithms, and discussion toward living document type updates), and 3) extensibility to broader technical and science communication use cases, such as proposal reviews, special collection and discussion boards, public comment solicitations, and curation of historical documents (abstracts, preprints, conference proceedings, oral/poster presentations, etc.). Of particular interest is leveraging the developed infrastructure and metadata creation for advanced machine learning methods to better find and serve specialized related articles. Demonstrate such a capability using a large publication sample to find multiple, specific select groups of related topics.

PHASE III DUAL USE APPLICATIONS: Participate in local demonstrations for Office of Naval Research proposal tracking and review, special publications of technical reporting at a controlled level, and partnership with a geoscience publication entity (profit or non-profit) to demonstrate functionality via a new journal solicitation. Provide technical and editorial support to submitting authors and reviewers; stress testing of the system with metadata and other associations; and ingesting archived/historical publications for database indexing and analysis. Beyond Naval research use, dual-use commercialization is expected to be similar with other governmental entities with varying needs for software capabilities and data archival/analysis. Given the goal of open source architecture, it is anticipated that the cost model will involve varying degrees of user support, new functionality development, and other SaaS sustainment to align with vendor monetization goals.

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KEYWORDS: Open science; open source, publishing; science writing; technical writing; curation; machine learning; archival; peer review

N242-092 TITLE: GigEVision-compliant Event-based Cameras

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

OBJECTIVE: Develop camera interface hardware and software, which allows commercial off the shelf (COTS) event based sensors to utilize standard machine vision interfaces such as Ethernet hardware connections and GigEVision or GenICam/GenTL software.

DESCRIPTION: Event based sensing is a novel modality for capturing transient data objects in a scene. Born of the desire to mimic the way biological sensing apparatus operate (i.e., the human eye), event based cameras (EBCs) are fundamentally different than standard frame cameras, and therefore the resulting data stream is unique. EBC data must be read out, processed, and interpreted differently than how standard imagery is done today. To date, there does not exist a standard interface, in either hardware or software, by which the data stream is extracted from the EBC. This causes great difficulty for government researchers in operating, testing, and utilizing EBC capabilities.

The objective of this SBIR topic is to develop a new EBC with the hardware and software needed to accept and connect the EBC and its data to other government imaging and data processing apparatus. The prototype EBC is required to use COTS sensor components. The electronics, boards, physical connections, and software will be developed within this effort. Having standard hardware and software interfaces that can be appended to available COTS event based sensor components will enable this unique technology to be tested, integrated, and used at government facilities, empowering government development and unlocking the capability for the warfighter. Other manufacturing applications to this technology is for manufacturing capabilities in the DoD industrial base such as Shipyards and other locations for material prep, inventory, etc.

General Requirements and Specifications:
1) The software interface must comply with Motion Imagery Standards Board requirements.
2) The software interface must operate with low latency (< 2ms per payload).
3) The software interface must comply with GigEVision or GenICam/GenTL software standards.
4) The new EBC must be configurable via the GenICam interface.
5) The hardware interface must utilize 10 Gigabit Ethernet (10GbE/10GigE) technology for transmitting data and configuring the EBC.
6) The new EBC core must leverage COTS event-based sensor components.
7) The new EBC should have a small form factor (~4”x4”x4”) and have integrated digital-to-analog converters (DACs)/references for the on-chip event based sensor component biases.
8) The new EBC should have an external general purpose input/output (GPIO) interface which can be used for synchronization and timing.
9) The new EBC should utilize a field-programmable gate array (FPGA) or similar as the intermediary between the event based sensor components and the 10GigE interface. This device should be comparable to the specification of an Advanced Micro Devices (AMD) Kintex-7 and leverage 2MB of external memory for potential frame buffer.

Special Q&A Webinar Recording: An open information webinar session on DoN SBIR Topic N242-092 "GigEVision-compliant Event-based Cameras" was held May 9, 2024. The webinar recording and supporting material can be found here: https://www.navysbir.com/n24_2/N242-092.htm#qae

PHASE I: Develop concepts and schematics for electrical and mechanical components of a new EBC and 10GigE physical interface which is based upon COTS event based sensor components and will allow data transfer via Ethernet cables. Develop concepts and a block diagram of a software package which can read in data streams from this new EBC, configures the EBC biasing/readout modes and complies with GigEVision or GenICam/GenTL software standards. Demonstrate the feasibility of the concepts in meeting Navy and Naval Enterprise needs and establish the concepts for development into a useful product. Establish feasibility through material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones and that addresses technical risk reduction.

PHASE II: Develop a prototype for evaluation. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the hardware and software interfaces. Support Navy requirements for any testing, such as submittal of Navy Cybersecurity Waiver Board interaction, submissions and approvals and development of a system security plan. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters. Use evaluation results to refine the prototype into an initial design that will meet the Naval Enterprise requirements. Prepare a Phase III development plan to transition the technology to Navy enterprise use.

PHASE III DUAL USE APPLICATIONS: Support the Navy with putting this product into useful service in government facilities. This product could be leveraged by commercial camera producers who develop, manufacture, and sell EBCs. Possible transition to Tech candidate or Future Naval Capabilities (FNC) or Innovative Naval Prototype (INP) for a Program of Record.

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KEYWORDS: Event based cameras; camera interface; software interface; Motion Imagery Standards Board; MISB standard; Ethernet; hardware interface; automation; machine learning

N242-093 TITLE: Distributed Acceleration Sensor for Integrated Flight and Structural Control

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

OBJECTIVE: Develop distributed sensors and associated electronics to measure real-time structural acceleration of an airborne platform's mode shapes. The low-cost, low-SWAP, embeddable measurement system will enable tightly integrated flight and aeroelastic control on future platforms with an otherwise unachievable combination of speed, endurance, and agility.

DESCRIPTION: The distributed sensor must directly measure acceleration of an airframe's mode shape in real-time. Currently, accelerations at distinct points can be measured using a collection of conventional accelerometers, and these sensors can all be sampled and processed to estimate a mode shape. The effectiveness of this approach is dependent on accelerometer location relative to the mode shape, and therefore, depends on a priori knowledge of the mode shapes. Alternatively, fiber optic sensors can provide distributed measurements of structural displacement. The fiber optic sensor's capability for distributed measurements is compelling, but the fact that these sensors generally measure displacement means that the signals lag acceleration by 180 degrees. In terms of control of an agile yet flexible aircraft, 180 degrees of phase lag poses significant stability challenges. Simply differentiating the displacement signal is not a solution because differentiation would amplify noise. Accelerometers can be installed at various locations, but the measurements must be individually sampled and collectively processed to estimate the acceleration of a mode shape. This SBIR topic seeks sensors and electronics that will have the utility of a single, distributed measurement device, such as a fiber optic displacement sensor, and produce real-time acceleration measurements of airframe structural modes. This approach practically eliminates the need for a priori knowledge of the mode shapes. Many state-of-the-art accelerometers use a small, calibrated mass attached to a piezo-electric or piezo-resistive crystal. As the calibrated mass accelerates along with the sensor, a corresponding force on the crystal produces a proportional voltage or resistance change depending on the mode of operation. These sensors have the advantage of being robust and compact, but they produce measurements at a point. On the other hand, fiber optic sensors leverage light scattering phenomena correlated to changes in temperature or displacement of the fiber itself. Measurements of light scattered from throughout the fiber can be correlated to displacement and/or temperature variations along the length of the fiber. Thus, fiber optic sensors have the advantage of measuring transverse displacement along the length of fiber. These sensors can be attached to large structures under observation, such as aircraft or bridges. However, fiber optic sensors do not intrinsically measure acceleration, which would be more suitable for integrated flight and structural control due to the phase advantages. The focus of this SBIR topic is to create a sensor that intrinsically measures structural acceleration for spans greater than 40 feet in length, e.g., the span of a large, tailless sensor platform. Sensor measurements will exploit material phenomena that correlate to structural accelerations. Double differentiation of a displacement signal, which would serve to amplify high frequency noise, is not an acceptable solution for measuring acceleration.

PHASE I: Produce a conceptual design for the objective sensor. First order modeling and simulation (M&S) of the underlying phenomena should support the merit of the design. Provide a baseline for the materials, electronics, and software needed to produce a prototype as well as an estimated cost to build and test the prototype. Model potential test conditions and sensor output for a prototype sensor as well as the predicted output for a sensor installed on an operational aircraft.

PHASE II: Fabricate and test the prototype sensor designed in Phase I. Test the sensor in a controlled laboratory environment. Refine the M&S tools from Phase I and use them to predict the sensor response under the test conditions. Test measurements should be compared with predictions. Conventional accelerometers should be used to spot check distributed measurements from the sensor. Conduct experiments to quantify the precision, accuracy, range, drift, noise, and bandwidth of the sensor. Work with government, industry, and/or academia to identify potential air platforms to test the sensor in an operational environment. Estimate the cost of operational test and validation.

PHASE III DUAL USE APPLICATIONS: Work with DoD air platform providers to assess the potential of using the sensor in a structural and flight dynamic closed-loop feedback system to enable future tailless air platforms capable of high-speed dash, long-endurance loiter, and agile maneuvering. Work with commercial civil and aerospace engineering firms to assess potential sensor use in structural monitoring and condition based maintenance.

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KEYWORDS: Distributed Accelerometer; Fiber Optic Sensor; Structural Control; Aeroelastic Control; Aeroservoelastic Control; Structural Modes; Structural Acceleration; Flight Control

N242-094 TITLE: Anti-Corrosion Coating for Gas Turbine Compressor Components Operating in Marine Environments

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

OBJECTIVE: Develop and demonstrate a chemically and mechanically robust coating system or other surface treatment for sustained protection of engine compressor components, such as mating compressor stages, cases, and vane tracks, from corrosion in naval aero engine operation.

DESCRIPTION: In naval aviation, aircraft operate in and around marine atmospheric environments often with high humidity and salt content, which accelerates corrosion degradation of aircraft components. High compressor operation temperatures relative to ambient conditions create a cyclic environment within the engine, in which water can evaporate and cool between flight and ground time cycles, leading to the accumulation of salts and other contaminants. This cyclic environment further accelerates corrosion mechanisms. As a consequence of this cyclic, marine atmospheric environment, multiple components throughout military aircraft propulsion systems require frequent repair and/or replacement due to severe corrosion and pitting, which leads to high maintenance costs, increased engine removals, and reduced aircraft readiness.

The Department of the Navy is seeking the development and/or demonstration of a coating system or other surface treatment for sustained protection of compressor components from corrosion in naval aero engine operation. Such a proposed solution must have the mechanical durability to provide corrosion protection along surfaces in contact and under some loading from other components. Specific components of concern are low-pressure and high-pressure compressor stages and cases and are typically composed of martensitic stainless steels (17-4PH and Jethete M152), titanium (Ti-6Al-4V), and Inconels (IN600, IN718, IN909) [Note: specific alloys will be identified upon project award]. Proposed solutions may constitute either the development of a new solution or a demonstration leveraging an existing solution in naval aviation application.

A brief description of the target application of this solution is provided below:
1. Low Pressure Compressor Stage or Case Flanges: Individual stages of the low pressure compressor casing are joined together in a flange configuration, where one stage is bolted to another along a mating rim or collar on each stage. This flange joint can link dissimilar materials of the stages, bolts, and other supporting structures within the engine. Typically, these flanges can involve material combinations of stainless steel and titanium mating surfaces bolted together with Inconel hardware. In most cases, corrosion and pitting occurs on the stainless steel flange surface. In addition to potential galvanic interactions, the flange joint may be susceptible to crevice corrosion. Vibration of the engine can also generate fretting between the bolted surfaces. Greases or lubricants are generally not used along the mating faces to maintain a high coefficient of friction. Temperatures in the low pressure compressor stage vary with specific engine platform but may reach as high as 180°C in operation.
2. High Pressure Compressor Stage or Case Flanges: Similar to the low pressure compressor, individual stages of the high pressure compressor casing are joined together in a flange configuration. This flange joint can link dissimilar materials of the stages, bolts, and other supporting structures within the engine. Typically, these flanges can involve material combinations of stainless steel, Inconel, and titanium mating surfaces bolted together with Inconel hardware. In most cases, corrosion and pitting occurs on the stainless steel or Inconel flange surface. Again, similar to the low pressure flanges, the high pressure compressor flanges may be susceptible to galvanic corrosion, crevice corrosion, and to vibration and fretting damage. Temperatures in the high pressure compressor stage vary with specific engine platform but may reach as high as 500°C in operation.
3. High Pressure Compressor Vane Tracks: Along sections of the high pressure compressor case, there are grooves or vane tracks into which stator vane sections slide into place. Shims are used to ensure a tight fit

between the vane sections and the vane tracks. Again, the conditions at this contact point may establish conditions for galvanic corrosion, crevice corrosion, and fretting-related degradation. Pitting and other corrosion products form within the vane tracks, at times degrading the contact with the vane section and other times locking the vane section in place.

4. Compressor Stage or Case Free Surfaces: In addition to the contact and connection points between compressor stages, both low and high pressure, there is pitting occurring on exposed free surfaces along the interior-facing (gas pathway) and exterior-facing surfaces. This pitting may be observed adjacent to areas of contact with dissimilar materials (flange or other bolted connections) and far from areas with other material contact. Corrosion and pitting are also observed around the full circumference of the compressor.

Common among these applications are exposure to elevated temperature, exposure to salt water (sea spray, atmospheric, water wash, etc.), exposure to cyclic engine conditions (cycle on, take-off, land, etc.), exposure to mechanical contact conditions (wear, fretting, vibration, etc.) with potentially dissimilar materials, among others. Thus, solutions are desired which address multiple key challenges associated with these conditions. Each challenge is discussed briefly below and is listed in order of descending priority:

1. Environmental Corrosion Protection within a Naval Aviation Engine Operation Environment: Compressor environmental conditions cycle between ambient conditions when the aircraft is at rest on the ground and the elevated temperature conditions of take-off and in-flight operations. Ambient conditions vary globally but primary areas of operation are sub-tropical, maritime, or coastal environments with moderate to high humidity, high salt content, and exposure to other marine atmospheric contaminants. Take-off or in-flight operation conditions can see temperatures rise as high as 180°C in the low-pressure compressor and 500°C in the high pressure compressor. The environment is further complicated by the design of the compressor, which creates distinct local environments for corrosion. First, water tends to drain from the upper section of the compressor and pool in the lower section. Second, corrosion occurs both on open, exposed surfaces and along mating or contacting surfaces (i.e., stage flanges and vane tracks), which may trap water, salts, or other contaminants. The differences in local environment across the compressor are reflected by the multiple corrosion mechanisms observed: uniform corrosion, oxidation/rust, pitting, crevice corrosion, and galvanic corrosion.

2. Galvanic Corrosion Protection: As mentioned, corrosion is being observed at mating or contacting surfaces, including across the bolted flange interface of connecting compressor stages. In addition to the environmental factors, the engine design may introduce galvanic coupling of dissimilar materials. The stainless steel and Inconel cases are bolted to each other and to other components, like titanium support structures, within the engine, often with Inconel hardware. Changing the material design may not be possible, so coating or surface treatments should be capable of addressing both galvanic and environmental corrosion. (Note: Specific layering combinations of materials and dimensions can be provided upon project award.)

3. Mechanical Durability and Resistance to Flaking and Delamination: Solutions may be applied to mating surfaces (i.e., flanges and vane tracks) where durability to fretting or mechanical contact loading may be required. Solutions applied to mating surfaces may also be required to maintain equivalent coefficient of friction with the underlying substrate material to maintain consistent wear and load transfer performance. Solutions may also be applied to exposed surfaces along the gas flow pathway where resistance to flaking and impact damage may be required.

4. Minimal Coating or Surface Treatment Thickness: Solutions may be applied to mating surfaces and, in such instances, solution thickness may be constrained by allowable tolerances in component and/or engine system design. Solutions of an applied material thickness of less than 300 microns may be required.

5. Environmental Health and Safety Conscious: Current and forthcoming aviation regulations may restrict the use of hexavalent chromium and other hazardous materials in material systems used either in engine manufacture or repair. Chromate-based coatings have long been the standard for corrosion coatings, but

the coating itself, or volatilization of the coating into its by-products, may contain hazardous materials like hexavalent chromium. Solutions may be required to comply with these health and safety regulations and be free of, or seek to minimize, hexavalent chromium and other hazardous materials.
6. Suitability for Different Compressor Applications: The proposed solution should seek to target application across the different identified compressor stages and vane tracks listed previously and across the multiple alloys used in those compressor stages and vane tracks. Severe pitting is currently being experienced across the low-pressure and high-pressure compressor cases and vane tracks made of various stainless steel and Inconel alloys. While it may be possible, even optimal, to tailor a specific solution to each individual application, solutions which address multiple applications and materials may receive greater priority. (Note: Component dimensions, flange configurations, material heat treatments, and other information can be provided upon project award.)
7. Coating Removal: Ease of coating removal by chemical stripping, grinding, or other common process will assist inspection, repair of engine components, and minimize maintenance costs.

PHASE I: Develop an initial design of a new solution or refine the design of an existing solution by identifying an approach to evaluate the technical design and feasibility to accomplish long-term resistance to corrosion damage of compressor stages, flanges, and vane tracks in a naval aero-engine propulsion system. Perform some preliminary evaluation of the proposed solution concept with the aim to demonstrate the potential benefits of the solution if granted Phase II and Phase III support. Conduct the following analyses:
1. Technical Challenges Assessment: Perform a thorough review of the technical challenges facing a proposed solution. Consider what technical data about the engine operation environment, the application components, the materials, etc. may be necessary to complete an evaluation of any solution. Consider what technical data may or may not be available and how limited availability of that data may affect the project success. (Note: It is the nature of some military platforms that certain technical information may not be disclosed, but available technical data (material, heat treatment, basic dimensions, etc.) may be shared upon project award.) Identify and assess the different challenges posed by the specific engine applications (compressor case, flange, vane tracks) and environment conditions, material contact conditions, and external environment (local climate, sea spray, etc.). Identify and assess the most promising solutions, coatings, or surface treatments to address these technical challenges. Consider if one or multiple solutions may be necessary to address these challenges, different applications, and different materials. Based on the assessment of technical challenges and coating/surface treatment options, propose one or more solutions for that specific application(s) to evaluate and characterize further.
2. Solution Feasibility Assessment: Identify a strategy or method to evaluate the proposed solution(s), which best accommodate the breadth of technical challenges, compressor applications, and materials previously discussed. (Note: The methodology may incorporate all experimentation or a coupled experimentation-computation approach, but some experimental characterization (coupon-level testing) of solution performance is requested. The methodology should suitably capture the complex environmental factors (cyclic exposure to salt and/or other contaminants, humidity, and temperature) and contact mechanics (flange joints, fretting, etc.) of the compressor applications and proposed solution(s). Identify a test and performance matrix, which will be used to score or evaluate the solution(s).) The solution(s) should be evaluated based on quantifiable metrics or a combination of quantifiable and qualitative metrics identified on the basis of the technical challenges posed by the environment and contact conditions, capture corrosion resistance, wear resistance, and friction properties. The feasibility assessment should identify work and tasking to be completed both in Phase I as part of a preliminary evaluation and in subsequent Phases of work, if awarded. (Note: OEM participation, while not required in Phase I, may benefit the development of the feasibility assessment and may help align the feasibility assessment with the Transition Plan developed if Phase III is awarded.)
3. Preliminary Feasibility Evaluation: Include a preliminary evaluation of the proposed solution(s) based on the feasibility assessment. (Note: While the scope of this evaluation may not be as broad as work identified for Phase II or Phase III, the objective of the preliminary evaluation should be to demonstrate

the potential of the proposed solution(s), to identify the further benefits and improvements that may be achieved with subsequent phases of work, and to identify the potential risks. This preliminary evaluation may incorporate experimental or computational methods and should serve both as an evaluation of the solution(s) and of the proposed methods for the solution feasibility assessment.)
4. Risk Assessment: Identify potential risks with the proposed solution(s) and the evaluation strategy or method based on both the preliminary evaluation and other proposed solution assessment methodologies. Account for programmatic and technical risks to the development and evaluation of the proposed solution(s) and identify and describe the operational risks to the implementation of the proposed solution(s) in naval aero-engines. Develop a risk mitigation plan that outlines specific strategies and measures that will be employed to address those risks throughout the course of this project.
5. Project Schedule: Develop a detailed project plan and schedule for the tasks and activities for subsequent phases of the project, including Phase II (Prototype Development and Testing) and Phase III (Full-Scale Validation and Transition). Outline specific tasks, milestones, and objectives to be completed in each phase, including any decision points or milestones that may inform how or when the previously identified risk mitigation plan should be consulted. Identify the resources and expertise required for successful completion of each phase. Develop an anticipated timeline of each phase tasks and activities.
6. Program Cost Analysis: Conduct a preliminary cost analysis for the development and evaluation of the proposed solution(s). Include estimates for any required research and development, prototyping, and testing costs. Estimate the costs associated with identified risk mitigation activities.
Upon completion of Phase I, the feasibility assessment and project schedule for the proposed solution(s) will serve as the foundation for subsequent phases of this project, providing a clear roadmap for development and evaluation of the proposed solution(s) in a naval aero-engine environment.

PHASE II: Develop a prototype of the proposed solution(s) and conduct a feasibility evaluation to assess performance with respect to the seven technical challenges listed in the Description and to other technical challenges identified in Phase I as well as adaptability to multiple compressor applications. Perform either an experimentation or coupled computation/experimentation approach to refine, test, and optimize the proposed solution(s) based on the feasibility assessment prepared under Phase I. A scrap component validation of the downselected or refined solution(s) shall be performed to confirm the corrosion and mechanical durability performance of the proposed solution(s). OEM participation is recommended to facilitate the evaluation and solution design optimization. This approach should include the following:
1. Detailed Solution Design: Develop a detailed design of the proposed solution(s) to address the corrosion, mechanical durability, and other technical challenges presented by the compressor applications. This design should describe the application process and finishing steps for the solution(s), e.g., if the solution is a coating, identify the surface preparation, application method, and number of layers required. Identify all details of the solution design necessary to fully describe its preparation, application, and form. This design is expected to be identified over the course of Phase II via multiple iterations and refinements.
2. Design Optimization: The solution feasibility assessment and approach should incorporate an experimentation or computation based strategy for solution design refinement and optimization. This strategy should specifically include design refinement based on solution performance addressing the technical challenges identified in Phase I and suitability to multiple compressor applications. Analyze the available data and/or performance of the design to iterative refine and improve the design. Periodically, evaluate the design progression against the project milestones and pursue risk mitigation activities as appropriate to address any identified issues or to maximize potential benefits.
3. Prototype Fabrication: Based on the design optimization, fabricate a prototype solution on material coupons. Coupons should be manufactured to replicate the compressor materials, including alloy and heat treatment (this information will be provided upon project award). Prepare the coupons in accordance with the detailed solution design as if preparing the actual compressor components. Sufficient quantities of coupons should be prepared at minimum to experimentally evaluate the prototype via coupon-level testing. Once the proposed solution is refined or downselected to its final iteration, scrap component

sections may be provided for prototype demonstration of the solution(s) in the same evaluation procedure as the test coupons.
4. Coupon and Scrap Component Testing and Characterization: The solution feasibility assessment is required to include at minimum, coupon-level experimental testing and characterization of the prototype design. Experimental testing may also be part of the design refinement and optimization; however, for experimental evaluation of the prototype design, coupon-level testing should carefully simulate exposure of the solution(s) to the complicated compressor environment, including, but not limited to, characterization of the impact of cyclic environmental (humidity, salt, water, temperature, etc.) exposure, galvanic pair with other compressor alloys, and mechanical loading and/or fretting from bolted flanges and vane tracks. OEM participation is encouraged to provide assistance with details of the engine operation environment and evaluation of the test results. Evaluate the coupon performance in accordance with the feasibility assessment prepared in Phase I. Once coupon-level testing has satisfied the conditions of the solution feasibility assessment, sectioned pieces of scrapped compressor components may be supplied for subsequent validation on actual component hardware. The components should be subjected to any surface preparation, including any surface grinding to remove pre-existing damage, prior to applying the solution. The performance of the solution(s) on the scrapped component should be evaluated according to the same solution feasibility assessment and with OEM engagement.
5. Updated Risk Assessment: Revisit and update the risk assessment and mitigation plan developed in Phase I based on the solution design and prototype development undertaken in Phase II. Identify any new risks and mitigation strategies that may have arisen.
6. Phase III Planning: Develop a detailed plan for Phase III (Full-Scale Validation and Transition), outlining specific tasks, milestones, and resources that will be required. Scrapped compressor components will be made available for full-scale testing and validation. Identify any testing requirements or validation of the solution necessary for operation on naval aero-engines not performed under this program, and develop a plan for transition to the Navy. OEM participation is highly encouraged to identify OEM-specific testing requirements.

PHASE III DUAL USE APPLICATIONS: Collaborate with engine OEMs to develop and implement a transition plan for the proposed solution(s) to the Navy and OEMs and to confirm the corrosion and mechanical durability performance of the proposed solution(s). This work should include:
1. Transition Plan: Develop a plan to transition the proposed solution(s) to the Navy, including documentation of how the material surface should be prepared prior to application, how the solution(s) are to be applied, and any post-application finishing steps. Collaborate with engine OEMs to identify all test and characterization requirements to validate and transition the proposed solution(s) to engine compressor components for in-flight operation, including any coupon level testing and/or field service evaluation. Identify any transition pathways to any non-aviation or non-military applications. The proposed corrosion solution(s) may be applicable across multiple industries, including commercial aviation and propulsion, automotive, and marine propulsion, OEM involvement in prior phases of work was specifically encouraged to capture broad commercial and military requirements in the solution feasibility assessment for coupon testing to smartly tailor the evaluation process to maximize benefits to multiple applications. The transition plan should build off this prior work and include any other test requirements as appropriate. Identify any solution-specific health and safety precautions. Identify a solution inspection plan, including how Navy fleet maintainers should inspect the solution for deposition defects, damage in use, corrosion, or other degradation.
2. Transition Test Matrix: Based on the transition plan, collaborate with the OEM to identify a test matrix for evaluation of the proposed solution(s). This test matrix may consist of an updated solution feasibility assessment developed and applied in Phases I and II based on OEM input, but it should reflect the updated test requirements identified in the transition plan. The objective of the test matrix is to specify the experimental methods and success criteria of the requirements laid out in the transition plan, e.g., if the transition plan should identify the requirement to perform an accelerated environmental engine test, the

test matrix should specify the target environmental conditions, mission operation cycle, and other test parameters as recommended by the OEM.
3. Solution Validation: Based on the transition plan and test matrix, some of the identified transition requirements may be satisfied by the coupon or scrapped component testing; however, some requirements may remain unsatisfied. Any unsatisfied transition requirements should be addressed according to the transition test matrix pending available funding, component supply, and other test hardware.

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KEYWORDS: Naval Aviation Propulsion; Compressor; Turbine; Marine Atmosphere Corrosion; Stainless Steels; Nickel Superalloys; Corrosion Protective Coatings; Cyclic Environment Conditions

N242-095 TITLE: Directional Wave Spectra Sensing Module for Autonomous Underwater Vehicle Gliders

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

OBJECTIVE: Develop and integrate a directional spectra sensor for ocean surface waves on low-power, long-duration autonomous underwater vehicle gliders.

DESCRIPTION: Autonomous underwater vehicle gliders are buoyancy-propelled, ocean-going robots that serve as platforms for a variety of environmental sensors. Gliders surface regularly to communicate with a base station via satellite communications. During this period, the glider floats at the ocean surface under the action of the surface waves. The goal of this SBIR topic is to develop a sensor to measure the directional wave spectra from low-powered, long-duration ocean gliders [Ref 1].

Measuring the strength, direction, and period of ocean surface waves is the primary component of sea state – an essential ocean variable. Measuring sea state is critically important for predicting ocean conditions that affect the safety of all maritime operations. Typically, directional wave spectra are measured from ocean buoys equipped with accelerometers. Recently, free-drifting floats [Ref 2] and autonomous surface vehicles [Ref 3] have been used to sense directional wave spectra using electromagnetic velocity sensors and Global Positioning System (GPS) velocity information. Measuring surface wave conditions has not been regularly achieved on ocean-going, autonomous gliders.

The Navy seeks development of a fully integrated, low-power, directional waves spectra sensor for ocean surface waves on ocean gliders. While all components – glider platforms, motion sensors (accelerometers, GPS, electromagnetic, etc.), and compression analysis software – are available in commercial, off-the-shelf components, integrated systems that allow for real-time sensing, onboard computation of directional spectra, and delivery of information via satellite communications are still in their infancy. Partnering with academic research groups utilizing autonomous gliders as sensor platforms will simplify integration efforts. The glider-based surface wave directional wave spectra should align with wave measurement standards outlined by the Coastal Data Information Program [Ref 4].

PHASE I: Identify hardware components that can meet the necessary motion sensing requirements. Develop a concept for onboard processing and data transfer of directional wave spectra [Ref 4]. 3.) Plan for integration of hardware and software components with glider platform, including transfer function for platform motion to wave action. Analyze the strengths and weaknesses of the proposed design. Prepare a Phase II plan that will include a design review.

PHASE II: Develop and test a prototype system. Perform an analysis of an integrated system, including in situ validation of directional wave spectra measurements. Report results. Perform multi-stage testing allowing for redesign between tests with initial tests in a surrogate ocean environment (e.g., lake or tank), interim tests in the ocean under controlled conditions (e.g., coastal bay), and final tests in the open ocean under environmental conditions. Both hardware and software systems should be developed and tested during Phase II. The final prototype should include a fully integrated sensing package capable of reporting directional wave spectra parameters via glider satellite communications. Analyze and report on the strengths and weaknesses of the final design based on results of the field tests.

PHASE III DUAL USE APPLICATIONS: The developed technology has use in the DoD’s operational glider fleet. The Naval Oceanographic Office (NAVOCEANO) utilizes numerous gliders within the Glider Lab and Glider Operations Center. Directional spectra of surface waves can be integrated into Navy models implemented by the Fleet Numerical Meteorology and Oceanography Center, improving forecast accuracy and improving safety of navigation and operations. Similarly, NOAA can utilize the wave monitoring capabilities to improve forecasts of wave conditions for commercial fishing operations and public safety.

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KEYWORDS: Surface waves; autonomous glider; directional spectra

N242-096 TITLE: Context Aware Data Stream Pre-processor for Time-Sensitive Applications

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

OBJECTIVE: Develop a general context aware, self-learning pre-processing solution to systematically resolve a high throughput Radio Frequency (RF) data stream across distributed systems with resource limitations for time-sensitive applications.

DESCRIPTION: Domain specific data sources generate increasing amounts of information that require ultrafast processing for time-sensitive applications. This is particularly true for ultra-wideband signal processing across the RF spectrum where bandwidths are considerably wide (e.g., several GHz). As data streams continue to expand in throughput, however, the volume of inputs for such applications can quickly overwhelm and exceed a system's storage and processing capacities. Technology advancements are required to distinguish the most significant inputs relative to an application from within high throughput RF data streams, and to efficiently allocate limited resources (e.g., storage, compute, power) for further analysis of the highest value data as part of a larger processing chain. More simply stated, systems supporting data-heavy, time-sensitive applications require a pre-processing capability to determine what data should be stored (both short term and long term), what data needs to be processed immediately, and how to efficiently allocate resources accordingly.

This SBIR topic seeks a general context aware, self-learning pre-processing solution to systematically resolve a high throughput RF data stream across distributed systems with resource limitations for time-sensitive applications. For any given application the pre-processor should be context aware in order to value input data as appropriate, presumably in part by extracting features and matching inputs against elements in a library of prioritized items and/or by detecting anomalous inputs within the data stream, while continually learning and improving its ability to prioritize inputs for processing. Distributed, networked heterogeneous systems supporting the same application should be able to benefit from diffused learning updates of individual nodes. Innovative approaches to determining high value data are also encouraged. Once the data of greatest importance to a time-sensitive application is identified, the pre-processing solution must determine how to allocate system resources and efficiently make the data available for processing subject to any limitations on storage, compute, power, and latency. The pre-processor resulting from this effort should be generalizable and scalable across distributed, heterogeneous systems to maximize the potential applications and broad utility of this solution in the RF domain.

PHASE I: Define and develop a concept framework for a context aware, self-learning pre-processor that distinguishes high value inputs from a voluminous RF data stream at the point of ingest. Conceive and mature a scheme for resource allocation to support ultrafast processing with consideration to constraints on storage, compute, power, and latency. Provide measures of effectiveness, as well as attainable performance characteristics. The framework will need to be generalizable and extensible across a distributed set of heterogeneous hardware systems, with a proposed design for the hardware and software architectures that supports tip and cue of heterogeneous systems to augment processing-related capacities of any individual system as necessary. The design should include a summary of any storage, computing, and power requirements for administering this pre-processor relative to latency requirements. The feasibility of the concept will be established through modeling and simulation. Include, in a Phase II plan, the initial design specifications and capabilities description to build a prototype in Phase II.

PHASE II: Fully develop, verify, and validate a prototype pre-processing solution that demonstrates context awareness, self-learning, and an ability to perform the desired functionality on high throughput RF data streams. Design the prototype to distinguish high value data and then allocate storage and compute resources as part of a larger RF processing chain. Demonstrate the design performance through modeling and physical testing over a range of voluminous RF data streams devised to test processing capacities with and without the pre-processor in place. Use evaluation criteria and results to refine the prototype for an initial, generalizable, scalable design that supports domain specific, time-sensitive applications. Develop a Phase III plan to transition the technology to a system that can be acquired by the Navy.

PHASE III DUAL USE APPLICATIONS: Support Navy system integration of the pre-processor, hardware, and software to include validation testing of a demonstration on RF data streams in a relevant environment, employing any lessons learned from the Phase II evaluation. Incorporate the pre-processor into multiple domain specific, time-sensitive applications for exhibition of generalizability (e.g., signal processing for wireless networks, indications of new spectrum activity, sensing on autonomous vehicles). The pre-processor from this SBIR effort would support data triage with high throughput streams for time-sensitive applications across the automotive industry, infrastructure, energy, health care, and other domains.

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KEYWORDS: Pre-processor; Context aware; Self-learning; Radio Frequency (RF); Data stream; Distributed signal processing; Resource allocation

N242-097 TITLE: Unmanned Aerial System for Tag Deployment in Marine Mammal Monitoring

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

OBJECTIVE: Technologies and techniques for marine mammal monitoring are growing rapidly but many barriers remain. This SBIR topic seeks to adapt a compact, National Defense Authorization Act (NDAA)-compliant, commercial-off-the-shelf (COTS), unmanned aerial system (UAS), and develop the payloads to facilitate accurate deployment of Type A anchored biologging tags from small boats to improve marine mammal monitoring, health measurements, behavioral sequencing, and understanding of the effects of Navy sources of sound on marine mammals.

DESCRIPTION: Advances in both biologging tag technology and UAS present unprecedented opportunities to improve our capacity to collect robust data with minimal disturbance to marine mammal species. In particular, percutaneous tags can collect data over extended periods and are integral to understanding cetacean ecology. Compared to other less invasive tag types, these percutaneous tags are capable of collecting datasets on the order of weeks to months, which are critical in providing information on marine mammal distribution, migration, and behavior. Such data are necessary to support the Navy's environmental compliance requirements.

However, as these tags require both significant force and accurate placement to attach to the individual properly, current methods of tag deployments via a long pole from a small boat are challenging, as they require close boat approaches, thereby increasing the risk to both the cetacean and tagging personnel. Further, cetaceans often respond evasively to close boat approaches, which increases chances of harassment, reduces deployment opportunities, and extends the time it takes to deploy each tag.
As such, the use of UAS in tag deployment can help reduce these risks while also increasing tag deployment rates by enabling remote deployment of percutaneous tags. While UAS methods have led to the successful deployments of suction-cup attached tags on cetaceans, to date these available systems rely only on gravitational force and are therefore inadequate for Type A anchored tag deployments that require accurate tag placement.

This SBIR topic seeks to adapt a compact, NDAA-compliant, COTS UAS and develop payloads capable of carrying both the biologging tag and propulsive source to facilitate accurate deployment of Type A anchored tags. In particular, this prototype device should include the ability to launch and recover from small boats, have sufficient propulsive force to launch the tags at a sufficient speed for anchored attachment, accurately hit small targets when taking into account winds and motion of the UAS and animal, and minimize operator training and workload. Further, this COTS UAS device should utilize predictive systems to model the ballistic trajectory of the irregularly shaped tags and take into account onboard measured environmental factors such as true wind speed that affect the tag trajectory. Further development leveraging AI and computer vision could additionally enable assisted targeting where the UAS could automatically track specific features on an individual. In addition to this deployment capability, the UAS should additionally include the ability to collect high-resolution imagery of marine mammals with associated range and geo-spatial information.

Note: Phase I performers should review appropriate guidance required for animal research protocols at Animal Use Research Requirements | Office of Naval Research (navy.mil) so they have the information to use while preparing their Phase II Initial Proposal [Ref 6]. Institutional Review Board (IRB) determination as well as processing, submission, and review of all paperwork required for animal use can be a lengthy process and should be started in the Phase I Option period. Animal research will not 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: Develop concepts and determine feasibility of adapting COTS UAS technologies with payloads and technology suitable for percutaneous tag deployment in a compact, efficient, and cost-effective design, including the identification of components to increase propulsive force and accuracy. Develop key component technology milestones and conceptual designs for hardware. Prepare a Phase II plan.

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

PHASE II: Develop prototype payloads and technology hardware based on the Phase I effort. Establish hardware performance and develop a conceptual plan for integration into a COTS compact UAS system. A prototype should be delivered at the end of Phase II, ready for integration and testing by the Government.

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

PHASE III DUAL USE APPLICATIONS: Successful adaptation of a COTS compact UAS and development of payload suitable for percutaneous tag deployment will open tremendous opportunities for small businesses to provide marine mammal monitoring capabilities to a wide range of government agencies having equities in marine life issues. For example, NOAA National Marine Fisheries, National Ocean Service, Office of National Marine Sanctuaries, Bureau of Ocean Energy Management, U.S. Geological Survey, and the U.S. Fish and Wildlife Service, among others would benefit from this capability. A key goal of this phase will be making the technology available to the broader research and Navy communities.

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KEYWORDS: Unmanned aerial systems; drone; tag attachment; tag deployment; marine mammals; monitoring; percutaneous tag; anchored tag

N242-098 TITLE: Signal Cueing in Complex Environments

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software; 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: Design and develop a parallel system of adaptive machine learning (ML) cue generators that ensures multi-signal and multi-function electromagnetic spectrum monitoring (ESM) systems with the parallel system will properly respond to signal classes with different probabilities of occurrence and importance.

DESCRIPTION: In designing future ESM systems, it is recognized that adaptation to the current signals environment is critical to achieve high functionality. Patterns of life recognition systems are being developed that can keep track of the array of signal types observed and their characteristics including, but potentially not limited to, their pulse descriptor word entries and signal inter-relationships/clusters. An important question for ML systems is whether to allow adaptation to the actual electromagnetic (EM) environment by allowing automated retraining of the algorithms, and if yes, how and how often. It is unclear how long the ability to recognize rare but important signals would last if such retraining is allowed to occur.

Today most systems use a single cue generator to locate all the signals defined by some criterion present in the current EM environment. What appears to be needed in the future is a system of ¬¬N such cue generators, all fed by the same wideband data stream and delivering their conclusions to the same prioritizer/scheduler. That unit would then decide how the system’s finite local digital signal processing (DSP) resources will be used to best reduce the current data to actionable information. This SBIR topic is designed to begin prototyping such a system of cue generators operating in parallel, first in Phase I by developing the data movement system required, and then in Phase II demonstrating its functionality in a simple setting and begin the integration of a pattern of life system.

Phase I proposals need to include evidence that the proposer already has access to an ML implemented cue generator and an understanding of the complexities inherent in building a scaled up to N=4 or more system using only currently available commercial off-the-shelf (COTS) processor cards of CPU, FPGA, or GPU character and 1 server. Systems requiring use of a single class of COTS components or a proprietary ASIC are less desirable but can be considered if a strong case is made for their functional benefit. The proposals should describe a potential architecture for the system, including how to get the signal data in and out without losing accurate track of the time of arrival and dealing with the fact different cue generators may take different times to complete their analysis of the same Vita 49 packeted signal data stream. An experimental lab demonstration for the N=2 case during the Phase I Base is highly desirable as it would inform future Phases proposal.

PHASE I: Flesh out the architecture as described in the proposal. Execute a demonstration, at least by simulation, of an N=2 system using 2 copies of the identified ML cue generator trained to recognize different classes of signals. Proposals should describe this demonstration in detail. At most a minority of the proposed Phase I tasking should go toward improving the function of said cue generator. Generate a proposed Phase II plan, emphasizing issues to be addressed in realizing the ultimately large N system case; how the work would evolve; and what to do in the case of a severely limited SWaP system. The Phase I Option, if exercised, should select the hardware required to implement the proposed Phase II plan and begin to work integration issues.

PHASE II: Perform an experimental demonstration of an N=2 system fed by a government off-the-shelf (GOTS) or COTS digitizer and complex environment signal generator or a digitally delivered predefined set of digitized signal environments that include both the trained to signals and others that are used as background. Include verification that the cue generators performance does not decay as the number of background signals increases and that abrupt shifts in the signal content does not stall operation. Identify and implement delivery of what information the patterns of life units need to supply to this cue generator unit, e.g., for retraining purposes, as opposed to supplied to the cue prioritizer. Work to include feeding the results from a GOTS pattern of life generator into the prioritizer and integration of the prioritizer with the cueing system in the Phase II Option if it is exercised.

PHASE III DUAL USE APPLICATIONS: Expected government use is in systems that are at least reconfigurable for multiple functions. The most likely phase III is hence to do and demonstrate this integration of the parallelized cueing subsystem into an already multi-functional system. Economics is expected to increase the fraction of systems which are built that way in the future. A commercial application is most likely in the tele-com domain in systems to suppress pirate applications operating on commercial infrastructure by links with signals at amplitudes below the legitimate traffic or above the noise floor but with widely different waveforms. They must be detected first if the bad behavior is to be suppressed. Here the N=2, simplified prioritizer case might be sufficient where the first cue generator is for the expected traffic. The second is then for the pirate signals and the latter are routed to a specialized identifier and logging of incidents tracker.

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KEYWORDS: Signals of interest; machine learning; adaptive digital signal processing; resource management; software defined radios; situational awareness

N242-099 TITLE: Wireless Power Transfer

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE); Renewable Energy Generation and Storage; 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 Navy shipboard relevant wireless power transfer (WPT) methods for enabling new technologies such as Unmanned Vehicles (UxVs), providing new recoverability methods, providing shore power supply, and increasing energy resilience.

DESCRIPTION: Current industry standards, such as SAE J2954, address uni-directional WPT to stationary receivers on the order of tens of kilowatt (kW). SAE J2954/2 provides guidance on extending this standard to 500kW at approximately 10 inches.

United States Navy (USN) applications require distances greater than 10 inches for shore power supply and recharge of UxVs while at sea applications. The increased distance avoids risk of damage to ships or UxVs. In several applications the Navy requires power levels extending beyond 500kW. Increasing the power above the currently available solutions allows the technology to be applicable to larger platforms and higher recharge rates of UxVs. Additionally, placement of the WPT sending/receiving units is a challenge in a shipboard environment. The Navy requires WPT to pass through inclement weather, water layers, and ideally through various metals such as steel and aluminum. This SBIR topic aims at providing the USN benefit of WPT for application to damage recovery (casualty power connection), remote vehicle charging, shore power connection, and off-board power sharing. Metrics for WPT include distance, power magnitude, transmitting and receiver size, position alignment flexibility (static and dynamic), impact of different media in the WPT gap, safety, efficiency, and bi-directionality. These metrics will be compared against commercially available wireless power transfer solutions.

PHASE I: Identify challenges to utilization of WPT to USN applications. Model and simulate wireless power transfer capabilities across air, steel, aluminum, and salt water gaps. Analysis will demonstration how the WPT solution provides improvements over the J2954 standards and other WPT solutions in terms of the metrics provided in the Description.

PHASE II: Develop prototype WPT hardware solutions. Prototypes shall be capable of interfacing with at least one side of the WPT system operating at or electrically connected to a MIL-STD-1399-300-1 or -2 defined interface. Validate and verify the model outputs using prototype hardware in the loop (HIL) testing at a USN accredited test site at a relevant power level/scale.

PHASE III DUAL USE APPLICATIONS: Support transition to Navy use. Any development in this space can build upon currently available industry standards and therefore help enable a system supporting higher power wireless power transfer systems required for ubiquitous unmanned, electric vehicle societies.

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KEYWORDS: Wireless Power Transfer; WPT; Near Field Power Transfer; Autonomous Vehicles; Wireless Charging; Casualty Power; Recoverability

N242-100 TITLE: Photonics-Based Optical Frequency Shifter in the Near-Infrared (NIR)

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

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

OBJECTIVE: Develop a technology that shifts the frequency of near-infrared (NIR) light in a waveguide while suppressing undesirable sidebands.

DESCRIPTION: Atomic accelerometers and clocks are important elements of advanced inertial navigation and timing systems. In recent years, there has been significant effort to reduce the size, weight and power (SWaP) of various subsystems. For the laser subsystem in particular, this is typically anticipated to be accomplished by a transition from bulk optics to photonic integrated circuits (PICs). One of the challenging aspects of this transition is redesigning the laser architecture to be compatible with PICs. Some capabilities that are straightforward to achieve in a bulk system either do not have a direct analog in PICs or do not have a proven solution for the NIR wavelengths that are relevant for atomic sensors (e.g., rubidium at 780 nm and cesium at 852 nm).

Here we focus on acousto-optic modulation as a component that is often found in atomic system architectures. A bulk-crystal acousto-optic modulator can serve multiple functions:
1. A pure frequency shift, typically in the 10MHz-1GHz range
2. Optical pulse generation with sub-microsecond rise/fall time
3. Optical switching capability with low cross-talk between spatially-separated channels
4. Variable optical attenuation capability exceeding 20 dB

The goal of this SBIR topic is focused on the first function: the development a high-quality frequency shifter (i.e., one where spurious frequency contributions are highly suppressed) that is compatible with on-chip photonics integration. Current approaches include In-Phase/Quadrature (IQ) modulation [Ref 1] and acousto-optic modulation [Ref 2], among others [Ref 3]. All these components, however, are fabricated for primarily C-band laser systems. Although it is possible to frequency double a 1560 nm laser to produce 780 nm to satisfy a rubidium-based system, a natively NIR solution would be a valuable addition to PIC capability for multiple atomic species.

Technical requirements for the frequency shifter are below:
- Operating wavelength: 780 nm [threshold], devices compatible (not necessarily tunable) with 400-900 nm [objective]
- Optical power handling (at waveguide input): > 50 mW [threshold], > 300 mW [objective]
- Electrical power draw: < 1 W [threshold], < 100 mW [objective]
- Modulation 3dB bandwidth (without regard to modulation center frequency): > 1 MHz [threshold], > 5 GHz [objective]
- Spurious sideband suppression: < 20 dB [threshold], < 30 dB [objective]

Proposed technologies do not need to provide any of the additional capabilities 2-4 listed above. If the proposed approach happens to enable any of those functions, this fact should be described with enough detail to provide a sense for the scale of the changes required to achieve that functionality. The capability does not need to be proven experimentally.

PHASE I: Perform a design and materials study to assess the feasibility of the selected technology and its ability to meet the goals above. The final report will include:
• A discussion of how the technological approach will satisfy the requirements of the frequency shift function.
• An evaluation of the technology's SWaP for the component that would be built in Phase II.
• A discussion of the fabrication process including an assessment of risks and risk mitigation strategies.
• A discussion of the technology's compatibility with photonic integrated circuits.
• If applicable, a brief discussion of alternate capabilities enabled by the technological approach.
The Phase I Option, if exercised, will include the initial design specifications and description to build a prototype solution in Phase II.

PHASE II: Fabricate, test, and deliver three (3) prototypes of the design developed in Phase I. The completed prototypes shall be tested against the performance goals listed above. The final report shall include an assessment of potential near-term and long-term development efforts that would improve the technology's technical performance, SWaP, and ease of fabrication. It shall also include an evaluation of the cost of fabrication and how that might be reduced in the future. The prototypes shall be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continue development to assist the Government in integrating the technology with other PIC components.
In addition to advancing a quantum sensing capability for military/strategic applications, this technology will improve the SWaP and lower the cost of hyperspectral imagers and near infrared spectrometers useful for environmental monitoring, biomedical imaging, and film/coating characterization.

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KEYWORDS: Photonic integrated circuits; optical frequency control; inertial sensors; atomic clocks; atomic accelerometers

N242-101 TITLE: Reentry Plasma Onset and Emergence Sensor

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics; 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 a sensor that can determine the onset of, and emergence from, a plasma environment which precludes the send and receipt of telemetry signals during ballistic reentry.

DESCRIPTION: Plasma environments generated by ballistic reentry conditions prevent the transmission of signals between the test article and ground receiving sites. To mitigate this, pre-flight analysis is conducted using empirical data and previous flight test observations to predict onset and emergence times, and these delays are programmed into the test article with margin on each side of the blackout window. This process artificially restricts the amount of telemetry data that can be transmitted from the test article, and is difficult to adapt to new conditions that do not match previous test conditions or otherwise violate the empirical data assumptions.

Maximizing the time telemetry is transmitted before onset of the blackout period and after emergence will have a significant impact on the total value of the test event and ability to leverage the data collected to improve the next experiment. This sensor will not only need to characterize the environments in real time, but also be capable of communicating with the existing telemetry infrastructure and surviving both space and ballistic reentry environments. Market research has not discovered a package that currently meets all of these requirements, so development will be required to fulfill the technical requirements while meeting packaging, communication, and survivability constraints. A final, test-ready product at the conclusion of Phase III should be capable of withstanding the proton environment of the South Atlantic Anomaly, shock environments of 3000 G, acceleration environments of ±80 G, and pressure environments of 75 PSIA.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain at least a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Demonstrate capability to characterize a plasma environment in real time, and the ability to communicate with an external controller at defined set points representative of blackout conditions. The concept should show a path to meeting final size, weight, and power requirements necessary for integration into a Navy flight test vehicle. Feasibility should be communicated by a combination of research white papers, bills of materials, drawings, and simulations. 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: Build and evaluate a prototype sensor for compatibility with Navy reentry flight test architecture. Demonstration in a relevant plasma environment is preferred, but in the case that a test facility cannot be identified during the Phase II period of performance, surrogate testing which demonstrates the proof of concept while identifying the areas where results are not representative is acceptable. The prototype will be required to measure the environment, demonstrate communication with an external controller, and send a signal to stop and restart a signal at the proper times correlated with the ability to send and receive a signal. If representative testing cannot be accomplished by the end of the Phase II period of performance, two prototype sensors will be required at the conclusion of the effort for future test opportunities.

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

PHASE III DUAL USE APPLICATIONS: The final product should meet size, weight, and power requirements such that it is fully capable of integrating with a Navy ballistic flight test body. It will be capable of surviving launch, space, and reentry environmental requirements. In addition to fully performing the real-time plasma characterization mission, it should also fully integrate with the telemetry architecture to provide usable inputs for starting the delay process. This will be used on both developmental and surveillance Navy test reentry bodies undergoing end-to-end ballistic testing, and will greatly enhance the ability to transmit the data characterized by each test event for use in further development or in-service assessment. Once integrated into the final test capsule, the full flight test body will undergo environmental and functional testing to ensure all components are performing together as expected.

Plasma blackout conditions exist in any high temperature environment where communication between a vehicle and ground receiving sites is required. Examples of this include the reentry of crewed space missions as well as any future hypersonic aircraft exceeding Mach 10, where the rapid reacquisition of communication can play an important role.

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KEYWORDS: Plasma Blackout; Communications Blackout; Ballistic Reentry; Plasma Sheath; Atmospheric Reentry; Radio Blackouts; Ionization Blackouts

N242-102 TITLE: Radiation-Hardened Super High Frequency (SHF) Electronics

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

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

OBJECTIVE: Extend the bandwidth of radiation-hardened electronics into the SHF (3 to 30 GHz) regime. This will enable sensing modalities (e.g., low-Size, Weight, and Power (SWaP) atomic clocks for precision timing) that require higher bandwidth signals than have been achieved in prior rad-hard-designs.

DESCRIPTION: The capabilities of modern electronic systems are enabled in large part by their ability to operate at much higher speeds than their obsolete predecessors. Innovations such as high-speed clocking, input/output (I/O), and data storage and high-bandwidth communication have been made possible as feature sizes on integrated circuits have decreased and operating frequencies have pushed into the GHz radio frequency (RF) range. Reduction to state-of-the-art feature sizes is not possible due to the risk of radiation-induced damage. As a result, rad-hard electronics designs have lagged in their capabilities relative to commercial systems. This has limited the adoption of advanced sensing technologies in strategic applications. As a specific example, low-SWaP atomic clocks, which offer better long-term stability and inherent radiation insensitivity than free-running oscillators, require GHz-modulation of the current driving the clock's Vertical-cavity Surface-emitting Laser (VCSEL) source [Refs 1, 2]. Until the bandwidth of rad-hard designs is increased, important technologies such as this cannot be leveraged to meet the position, navigation, and timing requirements of the mission.

The purpose of this SBIR topic is to bridge at least a portion of the performance gap between state-of-the-art electronics and rad-hard electronics designs. As a demonstration testbed, performers will design and fabricate a system that includes custom electronics that drive a VCSEL. The system must be capable of modulating the current of a VCSEL at 5 GHz and demonstrate that the system is capable of fully suppressing the carrier frequency. Proposers must provide a detailed justification for why their approach is a viable rad-hard design. It is anticipated that proposed designs will leverage widely-adopted rad-hard application-specific integrated circuit (ASIC) design kits such as the Honeywell HX5000 Standard Cell ASIC Platform (a complementary metal oxide semiconductor (CMOS) silicon-on-insulator technology which is limited to 150 nm feature sizes [Ref 3]), but alternative approaches are welcome if their rad-hardness can be 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 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain at least a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Deliver a design concept of rad-hard electronics that can drive a VCSEL suitable for D1 spectroscopy of atomic cesium (single-frequency tunable to 894.6 nm) to produce single-mode output and fully suppress its carrier frequency via current modulation. The feasibility must be demonstrated via detailed analysis, modeling, and simulation. This must include the predicted operating parameters that fully suppress the VCSEL carrier with modulation frequencies from 1 to 10 GHz. In addition, a detailed justification must be provided of why the design is expected to demonstrate radiation tolerance up to 300 krad total ionizing dose, which is a specification achieved for advanced timing components (e.g., quartz oscillators) designed for space applications [Ref 4]. 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 one (1) prototype system to demonstrate the viability of the Phase 1 rad-hard electronics concept. The design must include the ability to tune the laser temperature, bias current, RF modulation frequency, and RF modulation power. Performers will build a prototype test bed that includes the fabricated electronics and a VCSEL suitable for D1 spectroscopy of atomic cesium (single-frequency, tunable to 894.6 nm). The prototype system must demonstrate full suppression of the VCSEL carrier from 1 to 10 GHz. If this proves unfeasible, a detailed explanation of the limitations and mitigations to ensure future success must be provided. The prototype test bed volume goal of no larger than 10 cm x 10 cm x 3 cm, tight integration of the prototype into a low-SWaP package is not required, but desired. If tight integration is not feasible a detailed path to Phase III integration must be provided. The prototype shall be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Integrate the Phase II test bed prototype into a compact unit that provides the ability for a future user to leverage the asset in an atomic clock configuration that is converted for fabrication. It must include the required controls (e.g., connectors, knobs, interfaces) that to allow the user the ability to electronically tune the laser temperature, bias current, RF modulation frequency, and RF modulation power. It must also provide the VCSEL light on an optical output. The integrated unit must retain the 10 cm x 10 cm x 3 cm volume. The integrated system must demonstrate full suppression of the VCSEL carrier from 1 to 10 GHz prior to delivery.
This unit provides an asset that is useful not only for strategic applications, but also for commercial space-based missions requiring radiation hardness.

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KEYWORDS: Radiation-hardened Electronics; Super High Frequency; Radio Frequency; RF; Chip-scale Atomic Clock; Precision Timing; RF Modulation

N242-103 TITLE: Radiation-Hardened Quartz Oscillators

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: Strategic Systems Programs (SSP) seeks to develop a radiation-hardened ultra-stable quartz oscillator.

DESCRIPTION: Ultra-stable, radiation-hardened (rad-hard) reference clocks have provided a stable and reliable clock signal for integrating system sensor data and calculating position with high accuracy. Quartz crystal oscillators have been shown to offer exceptional stability performance. Commercially-available, space-qualified quartz crystal oscillators demonstrate short-term fractional frequency drifts as low as 1E-12 at 1 second and sub-ppb drifts over short times. Additionally, they have been shown to be tolerant of radiation levels encountered in space applications, demonstrating sub-ppm fractional frequency shifts for 100 kRad total ionizing doses (TID).

The purpose of this SBIR topic is to develop quartz oscillators with radiation hardness sufficient for strategic applications. The strategic environment is harsher than the space environment, so designs must have decreased sensitivity to radiation effects. This will require higher purity quartz and new electronics designs specific to the target applications.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain at least a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Conduct an initial study to understand radiation environments, the impact of this environment on quartz crystal oscillators, and production methods that mitigate this impact [Refs 1,2]. Production considerations include, but are not limited to, high-purity crystal growth, crystal purification by sweeping, crystal cut, overtone selection, pre-aging irradiation, and plating. The Phase I Option, if exercised, will include the initial design specifications and description to build a prototype solution in Phase II.

PHASE II: Grow and/or acquire high-purity quartz. Process the quartz and the oscillator. Deliver five (5) prototypes based on the design developed in Phase I. Evaluate oscillator performance against specifications defined in Phase I. The testing will include, but is not limited to, frequency instability, drift, and aging. Radiation testing and evaluation will be performed by a third party arranged by SSP. The prototypes shall be delivered by the end of Phase II.

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

PHASE III DUAL USE APPLICATIONS: Many military, commercial, and scientific systems that operate in harsh environments depend critically on timing stability. Space radiation effects impact systems such as communication and navigation satellites. Systems operating in adverse environments in and around nuclear reactors and particle accelerators also require a degree of radiation hardness. Improving radiation hardness of crystal oscillators for strategic applications will also benefit these non-military applications through improved reliability and lifetime of timing components and may reduce size, weight, and power (SWaP) and system costs through relaxation of radiation shielding requirements. Package the rad-hard quartz crystal oscillator to meet additional requirements for environmental tolerance, including insensitivity to temperature changes and mechanical stresses.

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KEYWORDS: Quartz oscillator; crystal oscillator; radiation-hardening; red-hard; ultra-pure quartz; synthetic quartz; swept quartz

N242-104 TITLE: Fast 1-to-N Polarization Maintaining Fiber Optical Switches for the Near Infrared (NIR)

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

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

OBJECTIVE: Develop a technology that allows for near-infrared (NIR) light in a fiber waveguide to be rapidly and efficiently directed along one of many fiber waveguides in nanosecond scale time periods.

DESCRIPTION: Atomic accelerometers are important elements of advanced inertial navigation and timing systems. In recent years, there has been significant effort to reduce the size, weight, and power (SWaP) of various subsystems. One challenge of miniaturizing these sensors is precisely delivering the pulse sequence emanating from a single optical source to the multiple optical axes of a sensor.

Appropriate pulse shapes require nanosecond switching speeds, and avoiding unwanted atomic transitions requires high extinction ratios. These are currently achievable in bulk acousto-optic crystals. Currently, fiber switches can be found based on mechanical, Micro-Electromechanical Systems (MEMS), and solid-state approaches [Refs 1, 2]; however, none meet all requirements simultaneously.

The objective of this SBIR topic is to develop a compact NIR 1-N port fiber optic switch suitable for pulse shaping and switchyard roles in an atomic interferometer. This will replace the bulk acousto-optics or multiple laser sources currently used to achieve the same result, resulting in drastically reduced size and complexity. To meet the pulse shape role the switch must have rise and fall times on the order of nanoseconds and be capable of MHz repetition rates. To meet the switchyard role it must have high reliability, low insertion loss, ultra-low crosstalk, and at least four ports.

Technical requirements for 1-N port switch are:
• Operating wavelength: 780 nm [threshold], devices compatible (not necessarily tunable) with 400-900 nm [objective]
• Fiber type: Polarization maintaining
• Crosstalk / extinction ratio: > 20 dB [threshold], > 30 dB [objective]
• Rise and fall time: < 50 ns [threshold], < 20 ns [objective]
• Insertion loss: < 6 dB [threshold], < 3 dB [objective]
• Switching time: < 1 μs [threshold], < 0.1 μs [objective]
• Number of ports: 4 [threshold], 6 [objective]
• Optical power handling (at device input): > 100 mW [threshold], > 500 mW [objective]
• Electrical power draw: < 1 W [threshold], < 100 mW [objective]

PHASE I: Perform a design and materials study to assess the feasibility of the selected technology and its ability to meet the goals above. The final report will include
• A discussion of how the technological approach will satisfy the requirements of the ultra-fast NIR optical switch.

• An evaluation of the technology's SWaP for the component that would be built in Phase II.
• A discussion of the fabrication process including an assessment of risks and risk mitigation strategies.
• A discussion of whether the proposed technology is compatible with integration onto a photonic integrated circuit (this is not a requirement).
The Phase I Option, if exercised, will include the initial design specifications and description to build a prototype solution in Phase II.

PHASE II: Fabricate, test, and deliver three (3) prototypes of the design developed in Phase I. The completed prototypes shall be tested against the performance goals listed above. The final report shall include an assessment of potential near-term and long-term development efforts that would improve the technology's technical performance, SWaP, and ease of fabrication. It shall also include an evaluation of the cost of fabrication and how that might be reduced in the future. The prototypes shall be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continue development towards a production run of the 1-N port fiber switch.

In addition to advancing a quantum sensing capability for military/strategic applications, this technology has applications in the telecom industry, Light Detection and Ranging (LIDAR) systems, and future quantum network infrastructure.

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2. K. F. Lee and G. S. Kanter. "Low-Loss High-Speed C-Band Fiber-Optic Switch Suitable for Quantum Signals." IEEE Photonics Technology Letters, vol. 31, no. 9, 1 May 2019, pp. 705-708,. doi: 10.1109/LPT.2019.2905593. https://ieeexplore.ieee.org/abstract/document/8668492

KEYWORDS: fiber optic, switch; near infrared; NIR; inertial sensors; atomic clocks; atomic accelerometers