DEPARTMENT OF THE NAVY (DON)
2027 DoW Small Business Technology Transfer (STTR) BAA
Release 2
Proposal Submission Instructions

IMPORTANT

- **Effective October 1, 2026, the Department of the Navy transformed from a Systems Command-centric model to a centralized development pipeline, directly integrated with the Portfolio Acquisition Executive (PAE) framework to ensure alignment to naval priorities.**

- **The following instructions apply to STTR topics only:**
  - **DON27TZ02-NV001 through DON27TZ02-NV015**

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

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

- DoW has established proposal limitations on a per-topic basis. SBCs may submit only one (1) proposal in response to a single topic. Please review the DoW SBIR/STTR Program BAA for further information.

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

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

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

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

INTRODUCTION

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

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

TABLE 1: POINTS OF CONTACT FOR QUESTIONS REGARDING THIS BAA

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

TABLE 2: DON SBIR PARTICIPATING COMMANDS

Topic Numbers	Point of Contact	Participating Command	Email
DON27TZ02-NV001 to DON27TZ02-NV015	Mr. Steve Sullivan	Office of Naval Research (ONR)	ONR_SBIR_STTR@us.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

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

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

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

Proposal Volumes. The following seven volumes are required.

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

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

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

- **Cost Volume (Volume 3).**
  - Cost Volume (Volume 3) must meet the following requirements or the proposal will be REJECTED:
    - The Phase I Base amount must not exceed $200,000.
    - Phase I Option amount must not exceed $115,000.
    - Costs for the Base and Option must be separated and clearly identified in Volume 3.
    - For Phase I a minimum of 40% of the work is performed by the proposing SBC, and a minimum of 30% of the work is performed by the single research institution. The percentage of work requirement must be met in the Base costs as well as in the Option costs. The percentage of work is measured by both direct and indirect costs. To calculate the minimum

percentage of effort for the proposing SBC the sum of all direct and indirect costs attributable to the proposing SBC represent the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) is the denominator. The single research institution percentage is calculated by taking the sum of all costs attributable to the single research institution (identified as Total Subcontractor Costs (TSC) 1 in DSIP Cost Volume) as the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) as the denominator.

- Proposing SBC Costs (included in numerator for calculation of the SBC):
  - Total Direct Labor (TDL)
  - Total Direct Material Costs (TDM)
  - Total Direct Supplies Costs (TDS)
  - Total Direct Equipment Costs (TDE)
  - Total Direct Travel Costs (TDT)
  - Total Other Direct Costs (TODC)
  - General & Administrative Cost (G&A)

  NOTE: G&A, if proposed, will only be attributed to the proposing SBC.
- Research Institution (numerator for Research Institution calculation):
  - Total Subcontractor Costs (TSC) 1
- Total Cost (i.e., Total Cost before Profit Rate is applied, denominator for either calculation)

— **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. A value above or below $0.00 entered in the Cost Sharing field will not be considered in the Phase I contract award.**

- Additional information:
  - Provide sufficient detail for subcontractor, material, and travel costs. Subcontractor costs must be detailed to the same level as the prime contractor. Material costs must include a listing of items and cost per item. Travel costs must include the purpose of the trip, number of trips, location, length of trip, and number of personnel.
  - Inclusion of cost estimates for travel to the sponsoring participating Command'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 Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

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

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

  All proposing SBCs must review and submit the following items, as applicable:

  — **Allocation of Rights.** Required for all SBCs proposing to STTR. In accordance with the SBIR and STTR Policy Directive section 8(b) and DFARS 252.227-7040, the proposing SBC must submit this agreement as an upload as a separate PDF file in Volume 5, Supporting

Documents. The STTR Allocation of Rights template must be used and is available on https://navysbir.com/links_forms.htm. Please refer to the Proposal Preparation Instructions and Requirements section of the DoW STTR Program BAA for information on this requirement.

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

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

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)**. In accordance with 15 U.S.C. §638(vv) and the SBA SBIR/STTR Policy Directive, the DoW will review all proposals submitted in response to this BAA to assess security risks presented by SBCs seeking a Federally funded award. SBCs must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DoW SBIR/STTR Program BAA for details.

PHASE I EVALUATION AND SELECTION

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

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

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

- **Technical Volume (Volume 2).** The DON will evaluate and select Phase I proposals using the evaluation criteria specified in the Method of Selection and Evaluation Criteria section of the DoW SBIR/STTR Program BAA, with technical merit being most important, followed by qualifications of

key personnel and commercialization potential of equal importance. The information considered for this decision will come from Volume 2. This is not a FAR Part 15 evaluation and proposals will not be compared to one another. Cost is not an evaluation criterion and will not be considered during the evaluation process; the DON will only do a compliance review of Volume 3. Due to limited funding, the DON reserves the right to limit the number of awards under any topic.

The Technical Volume (Volume 2) will undergo a compliance review (prior to evaluation) to verify the proposing SBC has met the following requirements or the proposal will be REJECTED:

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

- **Cost Volume (Volume 3).** The Cost Volume (Volume 3) will not be considered in the selection process and will only undergo a compliance review to verify the proposing SBC has met the following requirements or the proposal will be REJECTED:
  - Must not exceed values for the Base ($200,000) and Option ($115,000).
  - Must meet minimum percentage of work; 40% of the work is performed by the proposing SBC, and a minimum of 30% of the work is performed by the single research institution. The percentage of work requirement must be met in the Base costs as well as in the Option costs.
  - **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. A value above or below $0.00 is entered in the Cost Sharing field will not be considered in the Phase I contract award.**

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

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

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

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

ADDITIONAL SUBMISSION CONSIDERATIONS

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

Foreign Risk Evaluation (FRE) Program to Assess Security Risks. 15 U.S.C. §638(vv) requires the Department of War, in coordination with the Small Business Administration, to establish and implement a due diligence program, known as Foreign Risk Evaluation (FRE) Program, to assess and, when possible, mitigate security risks presented by SBCs seeking a Federally funded award. Please review the Certifications and Registrations section of the DoW SBIR/STTR Program BAA for details on how DoW will assess security risks presented by SBCs. The FRE Program to Assess Security Risks will be implemented for all Phases.

Discretionary Technical and Business Assistance (TABA). The Small Business Innovation and Economic Security Act Section 7 mandates agencies offer TABA. 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; commercializing the SBIR/STTR product or process, including intellectual property protections and cybersecurity assistance; and screening for potential foreign involvement in technology development or commercialization activities. TABA services can be provided through vendor(s) selected by the SBC or the SBC may propose use of TABA funding to hire new staff, augment staff, or direct staff to conduct or participate in training activities consistent with the purpose of TABA as detailed above. The Phase I TABA amount, if proposed, cannot include any profit/fee by the proposing SBC and must be inclusive of all applicable indirect costs. TABA cannot be used in the calculation of general and administrative expenses (G&A) for the SBIR proposing SBC. An SBC receiving TABA will be required to submit a report detailing the results and benefits of the service received. This TABA report will be due at the time of submission of the final report.

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

If proposing a TABA Provider, the following MUST be included in the request or be subject to denial.
- Provider(s)
- Provider(s) point of contact, email address, and phone number
- An explanation of the provider's unique qualifications to provide the TABA service
- Tasks that will be performed by the provider (to include the purpose and objective of the assistance)
- Total provider(s) cost, number of hours, and labor rates (average/blended rate is acceptable)

If proposing TABA funding to hire new staff, augment staff, or direct staff to conduct or participate in training activities consistent with the purpose of TABA, the following MUST be included or be subject to denial.
- Name(s), position(s), business need to be filled, and/or training to be provided
- Number of employees to be hired, augmented, or directed to participate in training activities
- Qualifications of employees hired or augmented, or detailed need for training
- Tasks that will be performed (to include the purpose and objective of the assistance)
- Total staff/training cost, number of hours, and labor rates (average/blended rate is acceptable)

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

— Supporting Documents (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "TABA" in the section titled Additional Cost Information when using the DON Supporting Documents template.

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

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

Partnering Research Institutions. The Naval Academy, the Naval Postgraduate School, and other military academies are Government organizations but qualify as partnering research institutions. However, DON laboratories DO NOT qualify as research partners. DON laboratories may be proposed only IN ADDITION TO the partnering research institution.

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

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

Notice of NIST SP 800-171 Assessment Database Requirement. The purpose of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 is to protect Controlled Unclassified Information (CUI) in Nonfederal Systems and Organizations. As prescribed by DFARS

252.240-7997, in order to be considered for award, an SBC is required to implement NIST SP 800-171 and shall have a current assessment uploaded to the Supplier Performance Risk System (SPRS) which provides storage and retrieval capabilities for this assessment. The platform Procurement Integrated Enterprise Environment (PIEE) will be used for secure login and verification to access SPRS. For brief instructions on NIST SP 800-171 assessment, SPRS, and PIEE, please visit https://www.sprs.csd.disa.mil/nistsp.htm. For in-depth tutorials on these items please visit https://www.sprs.csd.disa.mil/webtrain.htm.

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

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

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

SELECTION, AWARD, AND POST-AWARD INFORMATION

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

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

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

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

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

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

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

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per SBC per topic. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) is $315,000. The Phase I Base amount must not exceed $200,000 and the Phase I Option amount must not exceed $115,000. 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 Commands 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 the BAA). The Phase I Final Report and Initial Phase II Proposal will be used to evaluate the SBC's potential to progress to a workable prototype in Phase II and transition the technology to Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding Command either in the Phase I contract or by subsequent notification.

Awards. The DON will consider the following for Phase II award: Cost Plus Fixed Fee (CPFF), Firm Fixed Price (FFP), Basic Ordering Agreement (BOA), or Prototype Other Transaction (OT). Phase II awards can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR/STTR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the SBCs (e.g., the Navy SBIR Transition Program, STP).

Navy SBIR Transition Program (STP). Phase II awardees have the opportunity to 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.

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 STTR DOW 2027 BAA
Topic Index
Release 2

DON27TZ02-NV001	Co-Packaged Optics (CPO) for Advanced Cryocooled Electro-Optical/Infrared (EO/IR) Sensors
DON27TZ02-NV002	Field-Friendly Super Intelligence and Machine Learning Systems
DON27TZ02-NV003	Growth and Production of As2S3 Waveguides
DON27TZ02-NV004	Validated Modular Autonomy for Undersea Multi-Vehicle Coordination
DON27TZ02-NV005	Self-Sustaining Wave Energy Capture for Persistent Autonomous Ocean-Going Systems
DON27TZ02-NV006	Compact Unmanned Aerial System for Marine Species Monitoring
DON27TZ02-NV007	Multi-Modal Luminescent Paint Systems for Underwater Surface Diagnostics
DON27TZ02-NV008	Membranes for Separation, Purification, Compression, and Storage of Carbon Resources from Alkaline Water
DON27TZ02-NV009	Domestic Manufacturing of Large Area Raman Laser Materials
DON27TZ02-NV010	Persistent, Geochemically-Driven Low-Temperature Power Systems for Subsea Intelligence, Surveillance, and Reconnaissance
DON27TZ02-NV011	Heterogenous Swarm Control through Super Intelligence-embodied Architecture
DON27TZ02-NV012	Mission-Specialized Large Language Models for Operational Training and Knowledge Integration
DON27TZ02-NV013	Computational Frameworks for the Development and Qualification of Additive Manufacturing-Tailored Wire Feedstock for Naval Directed Energy Deposition
DON27TZ02-NV014	Conformal Printed Antennas for Missile and Weapon Composite Airframes
DON27TZ02-NV015	Photonic-Crystal Surface Emitting Lasers (PCSELS) in the Near-Infrared (NIR)

DON27TZ02-NV001 TITLE: Co-Packaged Optics (CPO) for Advanced Cryocooled Electro-Optical/Infrared (EO/IR) Sensors

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

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate innovative Co-Packaged Optics (CPO) architectures and integration techniques for advanced cryocooled Electro-Optical/Infrared (EO/IR) sensor systems that significantly reduce the number of electrical wirebonds, increase bandwidth density, and withstand rugged maritime environments for deployment in advanced sensing and tactical edge computing platforms.

DESCRIPTION: Current Department of the Navy (DON) platforms are generating unprecedented volumes of data via advanced radar, SIGINT, and high-resolution imaging sensors. Processing of this data at the tactical edge requires extreme bandwidth but can consume excessive powers, creating significant thermal and signal integrity bottlenecks [Ref 1]. Specifically, for advanced EO/IR sensors that operate in cryocooled temperatures (e.g., 70-140K), the excessive power required to electrically read out the data, i.e., transmit from cold space and receive in warm space, presents a challenging limitation on the size, weight, and power (SWaP) of an integrated dewar cooler assembly. Fiber optics and photonic integrated circuits (PICs) are key optical readout technologies that can offer extreme bandwidth, low power consumption, and mature fabrication but require integrated packaging solutions for next generation DON systems [Ref 2].

CPO offers an integrated solution that considers both optical and electrical elements in EO/IR sensor design, optimizing performance, reliability, and manufacturability. CPO brings the optical transceiver components directly into the same package as the readout integrated circuit (ROIC). This minimizes the electrical channel length or completely eliminates it with photonic interconnects, fundamentally lowering power consumption (energy per bit) and enabling massive bandwidth scaling [Refs 1-4]. To date, commercial CPO solutions are primarily designed for room temperature, climate-controlled hyperscale SI data centers.

This STTR topic seeks to adapt and innovate current CPO technologies for the stringent Size, Weight, Power, and Cost (SWaP-C) and packaging (cryogenically cooled) constraints of advanced Navy EO/IR sensing platforms. The focus of the topic is on the design and development of a CPO architecture that integrates with the ROIC layer of a typical EO/IR sensor chip assembly, enables high-bandwidth cold to warm readout, and operates in cryocooled temperatures.

Proposals must address critical challenges, including:

1. ROIC compatibility: PIC interconnect architecture that is compatible with conventional analog and mixed-signal digital ROICs designed in <180 nm node foundries, optimal number of fiber outputs to meet total ROIC bandwidth.
2. Thermal Management: Dissipating heat effectively when dense photonics and ROICs are co-located in a cryocooled integrated dewar assembly. Minimize PIC power consumption to less than 20 mW.
3. Power Efficiency: Choice of electrical-optical conversion scheme and minimizing power consumption (e.g., half-wave voltage for EO modulators, Vpi), PIC waveguide propagation loss, PIC to fiber input/output coupling losses, and stray light scatter.

4. Integration & Packaging: Complementary metal–oxide–semiconductor (CMOS)-compatible substrate materials, 2.5D/3D integration techniques, and cost-effective scalable manufacturing processes.

PHASE I: Conduct a feasibility study for a conceptual design of a CPO architecture with full transceiver functionality that addresses the four critical challenges and is tailored for a SWaP-constrained Navy maritime EO/IR sensor system.

- Deliverables: Perform architectural modeling, signal integrity simulations, and thermal/mechanical modeling.
- Metrics: Define target performance metrics, such as energy efficiency (e.g., < 10 fJ/bit), bandwidth (e.g., > 1 Tbps), coupling loss (e.g., < 0.5 dB/fiber connection) and estimated mean time between failures (MTBF) under standard military environmental conditions (e.g., MIL-STD-810H). Prepare a
- Outcome: A comprehensive Phase II development plan that identifies the PIC foundry and packaging facility, including preliminary packaging designs and a proof-of-concept simulation report.

PHASE II: Develop, fabricate, and demonstrate a working CPO prototype based on the Phase I design. Ensure that the

- Deliverables: The prototype shows compatibility with a notional sensor ROIC (i.e., greater than or equal to 640 x 480 Video Graphics Array (VGA) format and less than or equal to 10 um pitch). (Note: The ROIC digital signals can be emulated using a pseudo-random number generator (PRNG).) Demonstrate that the prototype is capable of cryocooled operation with full transceiver functionality, i.e., efficient electrical-optical conversion and transmission from cold space, data transfer through optical fiber, and optical-electrical conversion in warm space.
- Testing: Conduct laboratory testing in a relevant cryogenic environment (70-140K) to validate bandwidth, power/energy efficiency, coupling loss, and bit-error-rate (BER) for the entire transceiver operation. Perform preliminary environmental testing (thermal cycling, vibration) to prove the viability of the optical attachment and packaging under stress.
- Outcome: Deliver the prototype device, test reports, and a Phase III transition plan for integrating the technology into a specific DON system or sensor suite.

PHASE III DUAL USE APPLICATIONS: Transition to Navy maritime sensing program of record and commercial sensing applications.

- DON/DoW Application: Transition the ruggedized CPO technology to military Prime Contractors for integration into maritime Infrared Search and Track (IRST) and airborne Intelligence, Surveillance, and Reconnaissance (ISR) platforms, and mobile command centers requiring high-performance computing (HPC) at the edge.
- Commercial Application: Transition the technology to commercial markets, specifically targeting telecom infrastructure, hyperscale data centers, and Super Intelligence/Machine Learning (SI/ML) compute clusters where thermal efficiency and bandwidth density are highly valued.

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KEYWORDS: Co-packaged optics; CPO; silicon photonics; interconnects; read out integrated circuit; ROIC; sensors; Electro-Optical/Infrared; EO/IR

DON27TZ02-NV002 TITLE: Field-Friendly Super Intelligence and Machine Learning Systems

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

COMPONENT TECHNOLOGY PRIORITY AREA(S): Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop an Super Intelligence/Machine Learning (SI/ML) method that achieves the high-performance accuracy of modern Deep Neural Networks (DNNs) while mitigating their limitations.

DESCRIPTION: Current DNN architectures suffer from inherent "Black Box" vulnerabilities, demanding massive computational scaling and offering no clear link between parameter count and performance. The proposed model must address these shortfalls:

- Optimized Resource Utilization: Unlike DNNs that heuristically overparameterize to boost accuracy, the proposed model must quantitatively map parameter count to expected performance and enable users to identify the minimum configuration required for mission success, significantly reducing computational overhead, complexity, and deployment costs.
- Transparency: The model must replace opaque, distributed neural layers with novel methods for interpretability and trust that go beyond the current post-hoc techniques. By making input-output logic similar to standard programming code, the model should ensure decisions are easily explainable, verifiable, and compliant with auditing standards.
- Reliability: The model must recognize whether it can provide a reliable output for a given problem instance, which will address another well-known criticism of DNNs wherein performance is typically measured as an average, e.g., average accuracy, over many instances of a problem and will help build user trust and acceptability of the model vs DNNs, particularly in sensitive areas like person identification in a crowd video and identifying the source of a cyber-security violation.

The model must deliver DNN-level performance with superior speed and a reduced memory footprint, optimized for lean, secure processing on low-cost CPU and embedded edge hardware. By eliminating cloud-dependence, the model will maximize data privacy and operational security while substantially reducing power consumption compared to GPU-reliant models. It must operate flexibly across mixed CPU-GPU environments, allowing operators to dynamically balance throughput against computational cost. Beyond standard convolutional neural networks (CNNs), the model’s architecture must be extensible to transformer-based and multimodal models handling text, image, and video.

The metrics below establish outer-edge targets specifically for CNN-based image classification. While satisfying every metric is not mandatory, the model will be evaluated on the number of targets achieved and the viability of the engineering trade-offs.

1. Comparison with Base Architecture of ResNet-18 and larger
2. Comparison of the Number of Classes 10 and 100 using 3 datasets: MNIST, CIFAR-10 and CIFAR-100, having different combinations of numbers of classes and total number of image pixels (number of channels*number of pixels per image)
3. Mean Average Accuracy of Classification: Same as DNNs or higher
4. Number of Parameters (Fraction of Base Architecture): 50% of DNNs or less
5. Training MFLOPs/Image (Fraction of Base Architecture): 50% of DNNs or less
6. Training Memory Size (Fraction of Base Architecture): 50% of DNNs or less
7. Inference MFLOPs/Image: 50% of DNNs or less
8. Rate of Growth of Metrics (5), (6), and (7): Sublinear

In Phase II, similar metrics and their extensibility and relevance to transformers and multimodality scenarios (images and videos as well as their combinations with text to form LLMs and VLMs) will need to be provided and their implementation explained.
This STTR topic requires combinations of research and development, and proposers must demonstrate a strong partnership between the small business and a research institution.

The proposed solution should eliminate the dependency on complex computing infrastructure (e.g., GPUs) by delivering comparable performance on standard off-the-shelf hardware (CPUs, edge devices). It should optimize the cost-to-performance ratio, balancing accuracy with reductions in time, storage, and computational cost. Furthermore, the architecture should ensure robust explainability—like conventional software programs—and provide reliable confidence metrics to establish user trust. At a minimum, the method should result in the development of an alternative to existing CNN-based architectures for image classification.

The many problems with the modern SI/ML architectures and models mentioned earlier are well recognized and reported. Many researchers and companies are currently attempting to address these shortcomings, including a number of startups. Most of the better-known ones are doing so by modifying hardware and software of the industry-leading NVidia systems. None seems to be rethinking the basic formulation of the problem which underlies the direction taken in the approach of the Model. If successful, the Model may turn out to have a major impact on the Naval systems and SI/ML industry which is already very large and growing fast. The deeper impact that could result from the lean design of Model could significantly add to the societal reach of SI/ML methods.

PHASE I: Develop a minimal complexity design to assess the value of the concept of the model. (Note: The design does not have to be optimal but should serve as a feasibility to assess the art-of-the-possible, by conducting an adequate, convincing subset of experiments of those specified in the Description.) Conduct a feasibility study that should investigate all known options that meet or exceed the minimum performance parameters suggested in the Description and should also address the trade-offs and risks, in accordance with the level of innovation. Prioritize demonstrating feasibility on the core image classification challenge even though the long-term vision for the model is extensibility. Prepare a final Phase I report on the design and experimental results and a Phase II plan.

PHASE II: Develop a minimal complexity model prototype and test it with at least all the experiments listed in the Description, ensuring that the results should clearly assess the absolute and relative (to DNN) performances of the scaled operational optimal prototype, and its scalability with increasing data complexity via the specified metrics, to demonstrate the model's capabilities from the Phase I study determined to be most feasible. Provide the optimal model prototype; a report containing designs and testing results and how they demonstrate the power and future potential of the prototype; and a Phase III plan for prototype evaluation and other potential efforts as necessary. Provide metrics and their extensibility and relevance to transformers and multimodality scenarios (images and videos as well as their combinations with text to form LLMs and VLMs) and their implementation explained. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Generalize the CNN-targeted prototype model so it also applies to Transformers. Convert the prototype to an industry-friendly replicable form, implementable in one or multiple more progressive versions, as advised by industrial experts. Evaluate it on industry-grade large datasets of large images from very large numbers of classes. Deliver the final model prototype and a report containing designs and testing data. (Note: Detailed mission descriptions and effectiveness requirements will be addressed at a higher level of classification.)

Light-weight visual classification systems have many applications, particularly for autonomous robots.

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KEYWORDS: Deep Learning Neural Networks; Black Box; Power consumption; Explainability; Trust; Edge Computability

DON27TZ02-NV003 TITLE: Growth and Production of As2S3 Waveguides

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

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Determine and demonstrate how thin film deposits of As2S3 can be grown on an appropriate cladding material and etched to form a low loss waveguide for photonic applications of the Stimulated Brillouin Scattering (SBS) non-linearity in Radio Frequency (RF) applications.

DESCRIPTION: Multiple academic papers have indicated that the reverse mode of the SBS interaction between acoustic phonons and coherent 1.55 μm photons can cause Stoke's peak gain on RF sidebands. It is desirable to harvest that effect for application in the burgeoning field of RF photonics. However, for that to happen, it is desirable that methods be developed to optimize the growth and etching of quasi-epitaxial As2S3, the material with the largest known SBS coefficient. In order to achieve low optical loss, achieving extremely low surface roughness of as-deposited films (< 10 nm rms roughness) is required plus ways to preserve that in producing waveguides of around 100 nm thickness and with high confinement bottom and top cladding. While atomic layer deposition (ALD) growth has produced other chalcogenides with very flat, conformal surfaces, it has not been used for As2S3; moreover, that other material was amorphous as deposited and drastically changed optical properties when crystalized. It may be that highly directional growth onto pre-etched substrate mesas produce better performance waveguides in which to produce amplification. Lastly, it is essential to demonstrate a way to achieve extremely low loss signal transfer on and off the die if RF photonics is to outperform conventional electronics in the future.

Phase I proposals for this STTR topic shall name the deposition and etching techniques that will be developed under the base award and estimate the surface smoothness of both the as-deposited material and the finished waveguides. The work plan must allow the validation of these estimates during the Base award so that the preliminary Phase II plan can define with good certainty the properties achievable in Phase II if awarded.

Measurement of the optical properties of completed waveguides during the Base award is highly desirable. First demonstrations of a method of coupling to the waveguide with losses under 2 dB in the Phase I Option is also desirable. A work division where the non-profit develops the fabrication technology and the company develops the many GHz wide band amplifier and coupling technologies is one possible division of the work. A clear discussion of the dependencies and determinants of the ultimate performance as a photonic amplifier should be included in the initial proposal.

It is highly desirable that, by the effort's end, how feasible it is that by varying the optical carrier power in and the waveguide length, RF signal gains from 5 to 20 dB can be achieved with total noise figures including all coupling losses of <6 (threshold, 3 objective) dB. Paths to wafer scale fabrication yield above 90% should also be defined.

PHASE I: Determine the technical feasibility of using the proposed deposition and lithography techniques to produce an in-line photonic amplifier based on the SBS effect in As2S3. Demonstrate the potential compatibility of this material with use of SiN structures including surface grating couplers (desirable).

Establish high reliability estimates of the ultimate performance feasible from this combination of materials, fabrication processes, and simple photonic circuit and technology roadblocks.

PHASE II: Develop prototype amplifier circuits via multiple design/fab/ test cycles in the Phase II Base period. Define paths to wafer scale fabrication yield above 90%. The Phase II Option period, if exercised, would then be spent improving the fabrication technology in order to deliver a specific many GHz wideband amplifier to the photonic circuit selected in collaboration with the governmental cost share source. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: This STTR topic is designed to create an enabling technology, that is a generic way of producing analog amplification of RF sidebands on photonic carriers so as to advance RF photonics. If the SiN out-couplers mentioned can also be perfected, these component devices could replace other inhomogeneous material technologies that are capable of producing localized, small amplification. In particular, the large size and difficult to control bursts of energy produced by EDFA amplifiers when used in not-CW applications can be avoided in full PIC circuits. Co-design of the SiN layer and a grating coupler to it will enable use in data center processor interconnects applications. In Phase III, the materials technology of this topic would be refined and combine with device maturation efforts. Commercial applications most likely in the telecommunications and SI world. Military applications will be within electromagnetic warfare systems.

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KEYWORDS: Stimulated Brillouin Scattering; Chalcogenides; photonic amplifiers; Stoke’s peaks; As2S3; surface roughness; epitaxial vs amorphous optical properties

DON27TZ02-NV004 TITLE: Validated Modular Autonomy for Undersea Multi-Vehicle Coordination

COMPONENT TECHNOLOGY PRIORITY AREA(S): Integrated Network Systems-of-Systems;Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop software modules for existing autonomous undersea vehicles that support and extend existing system autonomy with multi-vehicle coordination behaviors.

DESCRIPTION: Autonomous undersea vehicles performing expeditionary missions require state-of-the-art cooperative sensing and engagement capabilities. The Navy seeks to enhance those capabilities with modular software designed for reliability and operational effectiveness. The advancement sought is development of a modular coordination layer extending existing single vehicle with decentralized multi-vehicle behaviors to enable autonomous decision making under degraded communications, sensing, and PNT conditions.

The software prototype needs to take in mission requirements provided by existing Navy command and control (C2) systems and sensor data provided by multiple platforms and use those inputs to coordinate mission performance with other vehicles. It should be compatible with modular unmanned autonomy architectures already in use by the Navy, such as the Open Autonomous Underwater Vehicle (OpenAUV) architecture and the Robot Operating System 2 (ROS 2). Within those architectures, the prototype must interface with existing autonomy designed for single-vehicle operations with minimal changes to already established systems. When the prototype is disabled or unnecessary, vehicle performance and behavior must conform to what would be expected of an unmodified single vehicle.

The multi-mission management functions of the software prototype need to use a decentralized C2 scheme that is robust in low-information environments and that degrades gracefully if communications or sensing are limited. The C2 scheme must demonstrate sufficient scalability to effectively manage many vehicles: tens to hundreds. Real-time C2 is a must.

The prototype should assume the primary sensing mode of each vehicle is acoustic. Realistic sensors include forward-look and side-scan sonar, possibly with a synthetic aperture. Cameras may be available, but if so, their field of view should not be assumed to allow for keeping other vehicles in sight. Realistic communications include acoustic modems with transmission rates of 5000 bps or less, possibly much less. Communications methods with higher transmission rates are unlikely to be available and may only be possible at extremely close range.

The prototype should assume that access to radar and satellite systems is extremely limited or non-existent. In particular, the prototype should not depend on regular access to global positioning system (GPS) data, and it should take into account the possibility that each vehicle is subject to position, navigation, and timing errors that increase in magnitude as each mission progresses.
The software prototype must include as an essential component a method of continuous validation that establishes and quantifies risk and trust for all autonomous decision-making, with an emphasis on repeatability. Deliverables must include the documentation and software necessary to implement this continuous validation method, as well as a report quantifying the efficacy of the method.
The ideal prototype will be mission agnostic, instead focusing on a generalized set of multi-vehicle behaviors and objectives.

The software prototype should minimize potential negative impacts on mission effectiveness, vehicle endurance, vehicle survivability, and operator workload. The prototype can include enabling hardware,

provided that such hardware can be installed on existing autonomous undersea vehicles. The complexity of any vehicle modifications should be minimized. The prototype software and any accompanying hardware should also minimize their overall power consumption. Deliverable reports should include analysis identifying and quantifying any such impacts.

PHASE I: Develop a concept for an architecture for a prototype multi-vehicle mission module. Ensure that this architecture should provide an approach for decomposing missions into generalized multi-vehicle behaviors and objectives. Identify and design a method of continuous validation that establishes and quantifies risk and trust for autonomous decision-making. Provide required deliverables that include prototype module architecture designs; documentation for the method of continuous validation; and analysis of how those approaches attain the topic's goals, including both academic research and validated modeling and simulation.

PHASE II: Develop a method of continuous validation and determine the extent to which that method can quantify risk for autonomous decision-making, including repeatability analysis. Validate the method itself against a series of reference vehicles running a set of standard missions.
Using the proposed method of continuous validation, develop the prototype software module. Analyze its performance on one or more reference vehicles running standard autonomy. Base the analysis on modeling and simulation, component-level testing, laboratory tank tests, and at least one in-water test outside of a laboratory environment.

Demonstrate reliability and operational effectiveness in subsea environments with low-bandwidth communications.
Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Assess the performance of the prototype method of continuous validation as it would be used by Fleet stakeholders for their autonomous vehicles. Modify the method as necessary in response to Fleet feedback and any discrepancies between expected and actual performance. Complete the prototype software module, any associated hardware, and the documentation necessary for integration into modular unmanned autonomy architectures already in use by the Navy.

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KEYWORDS: Autonomous; Autonomy; Continuous Validation; OpenAUV; Robot Operating System; ROS; ROS2; Validation

DON27TZ02-NV005 TITLE: Self-Sustaining Wave Energy Capture for Persistent Autonomous Ocean-Going Systems

COMPONENT TECHNOLOGY PRIORITY AREA(S): Renewable Energy Generation and Storage;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a human-portable wave energy capture device able to deploy autonomously and generate sufficient power to effectively recharge autonomous vehicles.

DESCRIPTION: Unmanned surface and undersea vehicles need regular recharging, and since they often operate far from human contact, their charging systems require a reliable, self-sustaining power source. The Office of Naval Research (ONR) believes the ideal power source will be a wave energy capture device (WECD). WECDs capture kinetic and potential energy generated by the movement of ocean waves on or near the surface of open water.

The desired WECD must be portable, specifically, designed as a set of components that can each be carried by one or two people who must be able to quickly assemble and disassemble those components. Components designed for one-person carry should weigh no more than 14 kg with largest dimension no greater than 1.9 m, while components designed for two-person carry should weigh no more than 45.4 kg with largest dimension no greater than 2.3 m. The WECD must be able to be relocated to areas of very different depths, including full ocean depth so the WECD's design cannot require placement or anchoring on the sea floor. And since the WECD may need to deploy near the shore, its design must allow it to function in waters as shallow as 100 meters.

Ocean weather conditions can be challenging. The WECD should function reliably at Sea State 6 or less (very rough seas, with wave heights of 4 to 6 meters), and it should be able to survive conditions up to Sea State 8 (very high seas, with wave heights of 9 to 14 meters).

ONR assumes the WECD will be tethered to some device at or near the surface of the water. That tethered system may be an autonomous vehicle in loiter mode, and since loitering involves continuous vehicle movement, the WECD should operate reliably while in motion, and its design should leverage such motion to increase energy capture.

The WECD should produce a minimum of 20 kilowatt-hours (kWh) per day, but more is highly desirable. ONR believes 100+ kWh per day is achievable. Even in calm seas, the ideal WECD should produce sufficient electricity to charge a 2-kWh battery in 6 hours or less. Vehicle movement may be considered when ensuring this minimum level of power generation.

The desired WECD may be needed in areas where human assembly is impractical. Thus, the deliverables must include a prototype device capable of deploying the assembled WECD from the deck of a medium or large autonomous surface vessel. Like the WECD itself, the deployment device (DD) should function reliably in challenging weather conditions: Sea State 4 or less (moderate seas with wave heights of 1.25 to 2.5 meters).

Once deployed, very little of the WECD itself should be visible at the surface of the water. The WECD should minimize any increase in the visibility of the vehicle it is tethered to. This includes surface and airborne observation, both optically and by radar. Acoustic noise generated by the WECD should either be minimized or disguised to seem environmental or biological.

Cost for the WECD and associated DD should be minimized. ONR expects that under certain environmental conditions or mission requirements, WECDs may not be recoverable. At full-rate production, the ideal price will allow for multiple units per million dollars.
Under normal operating conditions, including Sea States of 6 or less, the expected operational duration of the deployed WECD should be at least one month, with three months or more expected if Sea State 4 or less is maintained.

PHASE I: Develop a concept for a WECD and DD capable of satisfying the listed requirements. Evaluate feasibility of the conceptual design by performing modeling and simulation, supplemented by component-level laboratory tests and water tank tests as appropriate. Provide required Phase I deliverables to include design plans and schematics for the WECD and DD, along with test and evaluation reports that are sufficiently detailed to enable ONR to assess the feasibility of the contractor's proposed approach; and a Phase II plan.

PHASE II: Complete design and perform fabrication, verification, and testing of a prototype WECD and prototype DD based on the designs completed in Phase I. Perform testing that can include modeling and simulation (M&S); any such M&S must be validated and supplemented by in-water tests and must include at least one end-to-end sea test. Evaluate the performance of the WECD and DD during tests against the objectives expressed in the Description. Provide deliverables that include the prototype WECD and DD, along with an evaluation report that is sufficiently detailed to enable ONR to assess the performance of the contractor's prototypes with respect to all objectives. Develop a plan for production of WECD and DD devices, making whatever improvements are appropriate based on the results of testing and evaluation in Phase II.

PHASE III DUAL USE APPLICATIONS: Validate the production plan with low-rate initial production (LRIP) of WECD and DD devices, and tests of those devices using a combination of M&S and in-water tests, including sea tests. Deliver at least one set of WECD and DD from LRIP to Navy operators for extended testing. (Note: All test data generated by the Navy will be shared with the contractor.) Evaluate the LRIP units for consistent performance and reliability based on the objectives expressed in the Description. Deliver LRIP WECD and DD units and evaluation reports that are sufficiently detailed to enable ONR to assess the units' performance with respect to all objectives.

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KEYWORDS: Energy Density; Hydrodynamics; Ocean Energy; Oscillating Water Column; Sea State; Self-Sustaining; Survivability; Wave Energy; Wave Energy Capture; Wave Power; WECD

DON27TZ02-NV006 TITLE: Compact Unmanned Aerial System for Marine Species Monitoring

COMPONENT TECHNOLOGY PRIORITY AREA(S): Biotechnology

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop an inexpensive, compact, and National Defense Authorization Act (NDAA)-compliant Unmanned Aerial System (UAS) – optimized for marine mammal monitoring.

DESCRIPTION: A major remaining hurdle with marine species management is to know if, and when, measurable short-term behavioral and/or physiological responses of marine species to sound exposure results in biologically significant or meaningful effects on individuals and/or their populations. Advances in UAS methods and technology present unprecedented opportunities to improve the capacity to collect this robust data with minimal disturbance to marine species. However, while UAS methods have led to significant advances in our understanding of marine species' behavior, health, and body condition, thus far many obstacles remain including cost, flight duration, size, and image resolution.

This STTR topic seeks to develop a compact, inexpensive, and NDAA-compliant UAS and payloads designed to collect high-resolution photogrammetry imagery to improve marine mammal monitoring, health measurements, and behavioral sequencing. In particular, the prototype device should contain the following technical parameters: high resolution flat zoom lens camera integrated with a gimbal system; highly maneuverable and flexible payload system; lightweight batteries less than 100 Watt hours; an accurate Light Detection and Ranging (LiDAR) altimeter and range finder integrated with the camera and capable of measuring distances up to 50m or more; and a monitor that is operational in direct sunlight and with polarized sunglasses;. It should be designed for flight times as much as or greater than 40 minutes; be compact and portable in both size and weight such that the UAS and case can fit airline luggage restrictions; have the ability to be quickly calibrated, launched, and caught by hand during small boat-based operations and to tolerate temperature range of -20 degrees to +40 degrees Celsius; and have a minimum weather resistant rating of IP45 to allow for operations in wet conditions; be capable of dynamic home point positioning; and produces minimal noise.

While there are several existing NDAA-compliant drones available in the marketplace, the desired components and capabilities only exist in piecemeal and further, these UAS are prohibitively expensive for the field. The DON seeks to develop a prototype device to be designed and optimized for marine species monitoring, encompassing all the above technical parameters. Critically, this device must be affordable for the marine research community with the target market price between $10,000 - $15,000.

PHASE I: Develop concepts for and determine the feasibility of UAS technologies suitable for marine species-focused photogrammetry in a compact, efficient, and cost-effective design, including the identification of components to increase imagery resolution, increase flight time, and decrease size and weight of the prototype device. Develop key component technology milestones and conceptual designs for hardware. Prepare a Phase II plan.

PHASE II: Develop prototype hardware based on the Phase I effort. Establish hardware performance and develop a conceptual plan for integration into a compact system. Deliver the prototype ready for integration and testing by the Government at the end of Phase II. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Continue refinement and iterative field testing of the prototype. Provide documentation and support to the Navy and Government user community to ensure

best practice use. Clearly identify and describe the expected transition of the product/process/service within the government under a Phase III effort.

Successful development of an improved UAS suitable for marine species research will open tremendous opportunities for small businesses to provide monitoring capabilities to a wide range of government agencies having equities in marine life issues. For example, National Oceanic and Atmospheric Administration (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. Additionally, any commercial entity with a need or support mission to monitor and assess a small area from an aerial perspective with high-resolution imagery would benefit from this technology.
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; system; vehicles; drone; NDAA-compliant; photogrammetry

DON27TZ02-NV007 TITLE: Multi-Modal Luminescent Paint Systems for Underwater Surface Diagnostics

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop an integrated, multi-modal luminescent paint system optimized for simultaneous, non-intrusive, large-scale, high-resolution global measurement of wall pressure, shear stress, and temperature fluctuations on complex, curved geometries in underwater environments.

DESCRIPTION: Quantifying coupled boundary layer interactions along hydrodynamic surfaces require non-intrusive, full-field imaging of surface pressure, temperature, and skin friction (shear stress). While optical diagnostics have revolutionized aerodynamic testing, adapting luminescent paints to hydrodynamic testing in water introduces fundamental physical and application constraints that current state-of-the-art systems cannot overcome:

- Pressure-Sensitive Paint (PSP): Conventional PSP relies on oxygen-quenching physics. When submerged, oxygen diffusion into the polymer binder is severely inhibited by the liquid boundary layer and low oxygen solubility, rendering standard PSPs insensitive or plagued by extremely slow response times. Furthermore, severe temperature cross-sensitivity corrupts the pressure signal.
- Temperature-Sensitive Paint (TSP): Accurate dynamic temperature measurements are crippled by the standard utilization of Taylor's frozen-flow hypothesis, which inaccurately assumes turbulent structures remain unchanged as they advect. In water, non-equilibrium flow, high thermal mass and rapid localized diffusion cause this hypothesis to break down, failing to capture true high-frequency temperature fluctuations.
- Mechano-Luminescent Paint (MLP): MLPs offer a direct optical pathway to map shear stress via mechanical deformation. However, current MLP formulations are in their technological infancy, suffering from poor dynamic range, low luminous efficiency, and signal degradation from material fatigue and hydrostatic pressure cross-talk.

In addition to the above challenges, current formulations are difficult to apply uniformly over large areas. Existing techniques fail to maintain a consistent, repeatable coating thickness on complex, curved, or non-flat surfaces. This inconsistency skews calibration and compromises measurement reliability across large-field hydrodynamic models. Innovative material architectures, such as utilizing distinct, multi-color mechano-luminescent particles or multi-core/shell dye structures, may enable simultaneous, uncoupled optical separation of pressure, shear, and temperature in all flow environments, i.e. gas, liquid, and multiphase flows.

This STTR topic seeks an integrated material, application, and optical processing suite. The system must decouple cross-sensitivities and deliver simultaneous, high dynamic range, full-field quantitative maps of the wall pressure, shear, and temperature fluctuations.

PHASE I: Develop a concept for advanced formulations for water-compatible PSP, TSP, and MLP systems capable of measuring pressure fluctuations from 10 Pa to 100 kPa, shear stress from 0.1 to 100 Pa, and temperature variations from 0.05 to 20°C, as well as providing uniform spatial sampling capable of resolving unsteadiness up to 50 kHz without relying on Taylor's hypothesis. Evaluate the conceptual system's ability to decouple cross-sensitivities in simultaneous mapping of wall pressure, shear stress, and temperature through analytic modeling and laboratory testing. Identify potential application methodologies (e.g., specialized spray or deposition techniques) that ensure uniform, repeatable adhesion

to curved, non-flat structures. Perform an initial cost estimate and identify technical risks to be addressed in Phase II.

PHASE II: Demonstrate a fully functional, multi-modal prototype paint system on a large-scale (greater than a square meter), curved hydrodynamic model in a test facility. Evaluate the dynamic range, resolution, and frequency response of the system. Validate analytic models of the cross-sensitivities developed in Phase I. Demonstrate a highly repeatable application process achieving less than 5% thickness variation across complex curves, ensuring consistent calibration. Evaluate paint degradation, peeling, or leaching under flow velocities up to 15 m/s over continuous 8-hour test windows. Conduct a detailed cost and manufacturing analysis. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Develop an improved formulation and manufacturing plans using the knowledge gained during Phases I and II in order to support transition of the technology for Navy use and use in hydrodynamics, aerospace, automotive, energy system, and electronics packaging applications.

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KEYWORDS: Naval Hydrodynamics; Hydro-Acoustics; Advanced Diagnostics; Pressure Sensitive Paint

DON27TZ02-NV008 TITLE: Membranes for Separation, Purification, Compression, and Storage of Carbon Resources from Alkaline Water

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

COMPONENT TECHNOLOGY PRIORITY AREA(S): Biotechnology;Renewable Energy Generation and Storage;Sustainment

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a low-cost, robust, energy-efficient, and scalable membrane process to continuously separate, purify, compress, and store carbon dioxide from electrochemically processed alkaline water sources to support the local synthesis of fuels, nutrients, materials, and pharmaceuticals in austere, forward-deployed environments.

DESCRIPTION: This STTR topic seeks to develop a low-cost, low-energy, low-temperature (not to exceed 50°C), high-throughput nonmetallic membrane process to purify and store carbon dioxide (CO_2) (from acidic seawater solutions). Carbon resources harvested from seawater represent a critical renewable feedstock for the localized synthesis of tactical fuels, materials, nutrients, and pharmaceuticals. Developing the capability to generate these resources in-theater or at the tactical edge enhances multi-domain operational sustainment. Current technologies used to recover the dissolved CO_2 produced from electrochemically processed seawater often result in dilution of the CO_2 with air and water vapor that can lead to detrimental sintering and oxidation of catalysts used in thermochemical and biological synthetic approaches. In addition, there are volumetric and compression penalties associated with the dilution of the targeted gas. The proposed membrane process will reduce the complexity, size, and costs associated with supplying pure carbon dioxide resources from alkaline water sources.

The integrated membrane, purification, and compression process will provide equipment, process, design criteria, energy and material balance; and establish operational performance parameters.

PHASE I: Define a concept for a specific membrane process for the separation and purification of CO_2 from acidified seawater solutions. Define, develop, and perform initial laboratory assessment of the proposed membrane process to validate the technical feasibility of the approach for the capture, purification, and storage of CO_2 from seawater over a pH range of 2 to 5. Perform analysis of the CO_2 to determine yield and purity. Perform analysis on the membrane to determine the membranes' ability to maintain performance, structural and chemical integrity.

PHASE II: Develop a prototype process based on the work achieved in Phase I. Design the prototype as a continuous process to capture, purify, and store 90 to 100% of CO_2 from a 25,000 gal/day acidified seawater source; and to purify the captured CO_2 to 98% with the resulting purified CO_2 stream free of oxygen (O_2) and water (H_2O), compressed to at least 300psi, and stored for utilization in various synthetic processes. Establish performance parameters and proof of concept for development of full-scale process. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Using data on the resulting integrated membrane, purification, and compression process, provide the design criteria for transitioning the technology to larger capacities. Develop and test a 250,000 gal/day process. Provide a cost-benefit analysis to show process outperforms current cryogenic distillation and pressure swing adoption processes.

Dual use applications include: (1) breweries and distilleries to recover and reuse CO_2, (2) desalination plants for post treatment of CO_2 capture and mineral scaling prevention, (3) offshore oil, gas, and

maritime industries for commercial fuel synthesis, (4) commercial aquaculture, (5) fire suppression, and (6) dry ice for preservation.

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KEYWORDS: Synthesis, carbon, membrane, separation, purification, seawater, alkaline water

DON27TZ02-NV009 TITLE: Domestic Manufacturing of Large Area Raman Laser Materials

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

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop scalable domestic manufacturing technologies and processes for large Raman active optical crystals that will enable wavelength agile laser systems for Navy applications.

DESCRIPTION: The Navy employs laser systems on air- and sea-borne vessels that serve a wide range of applications including laser range finding, target designation, shipboard and airborne LiDAR, and directed energy platforms. Future naval systems require improvements in spectral agility, optical efficiency, and power, with reductions to size and weight while maintaining operation in harsh maritime environments.

Current laser architectures rely upon a limited set of mature gain and nonlinear optical materials including Nd- and Yb-doped yttrium aluminum garnet (YAG), potassium titanyl phosphate (KTP), lithium triborate (LBO), and barium borate (BBO). While these technologies provide reliable performance, wavelength conversion often requires multiple optical stages that increases system complexity, introduces alignment sensitivity, and can limit scalability to higher optical powers and larger apertures.

Raman active optical materials offer a pathway toward compact and wavelength agile laser architectures capable of generating multiple output wavelengths from a single pump source. Such materials may enable simplified optical systems with reduced alignment complexity, improved robustness to vibration and shock, enhanced spectral diversity, and compact eye-safe laser sources. Many Raman laser crystals have been demonstrated to be grown to large sizes at high quality, but broader adoption of Raman active optical materials in these systems hinges on improving domestic production. Many candidate Raman laser materials are produced in small quantities at limited sizes and lack established domestic manufacturing capability and therefore development of domestic manufacturing technologies compatible with large crystal sizes is of importance for future naval laser systems.

Candidate materials shall be compatible with bulk crystal growth processes capable of producing large aperture, high optical quality single crystals and offer a pathway toward crystal sizes of 50 mm and greater.

This STTR topic seeks to develop a prototype manufacturing technology and process which can produce one or more Raman active materials at large crystal sizes with the potential to scale to high throughput. The prototype should minimize reliance on expensive precious metal crucibles. The prototype shall produce Raman active crystals that are large (> 5mm x 5mm x 25mm), achieve laser damage thresholds exceeding 10 J/cm², support self-Raman operation through rare earth doping, and meet the following optical quality criteria:

Objective Threshold Notes
Refractive Index Homogeneity: Threshold = <10 ppm; Objective = <5 ppm
Transmitted Wavefront Distortion (at 50mm aperture): Threshold = Lamda/6; Objective = <Lambda/8
Surface Quality (Scratch-Dig): Threshold = 20-10; Objective = 10-5 (NOTE: The first number relates to the maximum allowable width of a scratch in micrometers, while the second number relates to the maximum allowable diameter of a dig or pit in hundredths of a millimeter.)

Dislocation Density: Threshold = <10 cm^(-2); Objective = < 1 cm^(-2)
Inclusion/Bulk Defect Density: Threshold = <5 inclusions greater than 1µm per cm^3; Objective = No detectable inclusions greater than 0.5µm per cm^3
Materials of interest include:
Undoped and doped (Nd, Yb, Er, Tm) potassium gadolinium tungstate (KGW) and Potassium yttrium tungstate (KYW) [Refs 1,2,3]
Undoped and doped (Nd, Yb, Er, Tm) Barium molybdate and Barium nitrate [Refs 4,5]
Other Raman active tungstate, molybdate, nitrate, vanadate or related compelling Raman crystal systems
Alternative material systems are encouraged provided performers demonstrate a credible pathway toward large aperture crystal production and significant Raman gain performance.

PHASE I: Develop a technical approach and concepts for manufacturing large and high-quality Raman active crystals. Develop and model a growth process and identify methods for optical characterization of grown crystals. Determine the technical feasibility of scaling the process to high throughput and provide a cost analysis. Produce a document containing the technical approach, concepts for manufacturing, growth model details and results, proposed optical characterization process, and approach to scale up the proposed manufacturing concept. Provide a Phase II development plan with performance goals and key technical milestones and that addresses technical risk reduction.

PHASE II: Based on the developed concepts in Phase I, develop and demonstrate the manufacturing prototype for growing large high-quality Raman active crystals. Fabricate one or more crystals and validate the prototype through characterization sufficient to establish technical feasibility and manufacturing viability. Characterize optical performance and laser damage thresholds. 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 and commercial use.

PHASE III DUAL USE APPLICATIONS: Upon successful execution of Phase II and demonstration of a prototype manufacturing process that can produce large and high-quality Raman active crystals, support the ONR Navy ManTech program in transitioning the technology into program of record (PoR) manufacturing lines. Participate in the transition of manufacturing technologies and Raman active crystal materials into Navy laser systems supporting LIDAR, laser range finding, optical communications, and directed energy applications.
Commercial applications include industrial laser systems, environmental sensing, autonomous vehicle LiDAR, medical imaging, telecommunications, spectroscopy, and advanced manufacturing.

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KEYWORDS: Raman Laser; Nonlinear Optical Materials; Crystal Growth; Czochralski; Bridgman; Top-Seeded Solution Growth; Light Detection and Ranging; LiDAR; Directed Energy

DON27TZ02-NV010 TITLE: Persistent, Geochemically-Driven Low-Temperature Power Systems for Subsea Intelligence, Surveillance, and Reconnaissance

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop a modular, self-sustaining, non-toxic subsea energy-harvesting capability that exploits naturally occurring sediment-seawater geochemical gradients to provide persistent, logistics-free power for distributed Intelligence, Surveillance, and Reconnaissance (ISR) sensor nodes in Arctic marine environments, with reliable operation at -2°C, and providing at least 250mW average net harvested power and storing sufficient energy in an onboard storage subsystem to operate up to a 5W (objective) sensor payload for 10 minutes every 4 hours over a projected 24+ month deployment.

DESCRIPTION: The Department of the Navy's expanding operational requirements in the Arctic domain demand persistent subsea situational awareness. Current seabed ISR nodes and Unmanned Underwater Vehicle (UUV) docking stations rely on conventional lithium-chemistry batteries. These legacy power sources present severe logistical and operational limitations: they suffer from rapid capacity degradation in extreme cold, possess highly toxic/hazardous chemistries, and require frequent, resource-intensive physical replacement (battery swapping) in highly contested or ice-covered environments.

To achieve persistent, logistics-free ISR, the Navy has a critical need for an environmentally benign, deploy-and-forget power architecture. This STTR topic seeks the development of Seafloor Electrochemical Power Harvesters to generate continuous electrical current by exploiting the natural oxidation-reduction (redox) potential difference between the anoxic marine sediment (mud) and the oxygenated overlying seawater. The proposed approach must demonstrate a credible path to 5W power and 24-month endurance in sub-zero Arctic conditions through a ruggedized seabed electrochemical power-harvesting architecture that maximizes long-term energy extraction while using only indigenous sediment microbial communities and naturally occurring geochemical gradients. Proposed solutions may use abiotic or biologically mediated mechanisms via electrode design, power management, and optimum emplacement.

Biocatalytic Prioritization & Environmental Strictures:
While purely abiotic electrochemical approaches will be considered, approaches that leverage biologically-mediated processes (e.g., utilizing natural biocatalysis to enhance electron transfer at the anode) will be prioritized due to their potential for higher power density and self-renewing longevity. However, to prevent any risk of ecological disruption to fragile Arctic ecosystems, solutions must strictly rely on harnessing the naturally occurring, indigenous populations already present in the local sediment. The introduction, deployment, or seeding of any exogenous, synthetic, lab-grown, or non-native biological agents (microbes/bacteria) is strictly prohibited.
By utilizing advanced electrode materials that naturally synergize with the local subsea environment, the system must reduce or avoid reliance on deployable primary batteries for the supported payload while ensuring operational viability in extreme cold and high-pressure conditions.

PHASE I: Formulate the theoretical electrochemical model for sub-zero geochemical harvesting. Identify and test advanced catalytic electrode materials that maximize electron transfer efficiency at -2°C, prioritizing architectures that optimize interaction with indigenous sediment microbial communities and/or indigenous electroactive microorganisms.

Conduct a benchtop prototype demonstrating the targeted voltage and current density in a simulated cold-water/sediment environment utilizing only native sediment samples, accompanied by a scalable power management design.

PHASE II: Scale the Phase I material architecture into a prototype ruggedized, modular power generation unit. Integrate the system with advanced, low-loss DC-DC boost converters to condition the output for standard ISR payloads. Conduct extensive tank testing in simulated Arctic conditions to validate the 24-month longevity and an objective of 5W output. Position the Phase II prototype to be tested against PMS 485-D2 surrogate sensor payloads to prove integration and power conditioning.
Deliver a TRL 5/6 deployable prototype system and comprehensive testing data proving capability integration with a surrogate acoustic or environmental sensor. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Transition the technology into a deployable form factor for Navy undersea infrastructure. Integrate the power module with operational subsea sensor networks, UUV charging nodes, or acoustic listening arrays. Deliver a qualified plug-and-play auxiliary power module that can be integrated into the next-generation Distributed Maritime Operations (DMO) surveillance architectures managed by PMS 485.
Transition the technology to commercial sectors for powering offshore oil and gas monitoring equipment, oceanographic research sensors, and early-warning tsunami detection networks.

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KEYWORDS: Subsea Power; Arctic ISR; Arctic Intelligence, Surveillance, and Reconnaissance; Geochemical Energy Harvesting; Undersea Logistics; Advanced Catalytic Materials; Contested Environments; Seafloor Electrochemical Systems

DON27TZ02-NV011 TITLE: Heterogenous Swarm Control through Super Intelligence-embodied Architecture

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

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop Agentic Super Intelligence (SI) architecture and associated applications for control of low-cost Commercial off-the-shelf (COTS) uncrewed systems (Group 1 unmanned aerial vehicle [UAV] or small unmanned ground vehicle [UGV]) for use in adaptable heterogenous swarming applications.

DESCRIPTION: Current methods of heterogeneous swarming control often involve individual entities with incompatible messaging protocols, ridged data interpretation, and lack of broader situational awareness, generating a protocol/perception problem that results in fragmented decision-making. Model Context Protocol (MCP), Large Language Models (LLMs), and related Agentic SI architectures, can enable a Universal Serial Bus Type C (USB-C) solution to this fragmentation problem by allowing individual entities to communicate with human operators or other entities through natural language. The Department of the Navy is seeking development of Agentic SI-enabled COTS small UAVs or small UGVs USB-C capabilities for demonstration of applicability in Naval and Marine Corps tasks. The goal is to deliver a small heterogenous swarm of low-cost uncrewed systems capable of receiving tasks through a natural language interface and performing complex tasks such as inspection of a facility for damage, evaluating road conditions, conducting security operations, and/or intercepting of other platforms. Performers should focus on software development to run on low cost and edge compute devices attached to highly expendable COTS platforms. Submissions will leverage preexisting DoW compliant hardware deployments using either compute resources organic to the UAV/UGV platform or flight-ready modules (e.g., Single Board Computer NVIDIA JETSON NDAA) with favorable Size, Weight, and Power (SWAP). Submissions should identify the unique nature of their Agentic-SI capability in accomplishing the objective.

PHASE I: Document and demonstrate an approach for Agentic SI control of small UAV or UGV. Required deliverables for Phase I include a demonstration and design approach for validation. GNSS may be used at this stage, but overall architecture must be GNSS optional. Hardware used in Phase I needs to be either NDAA complaint or have NDAA compliant analogs listed for Phase II. Individual unmanned systems must be tasked by human or other agent through natural language and respond similarly. Demonstrate at least one Group 1 UAV or small UGV (such as an RC Car) performing 3 of the following 5 tasks. No priority is given to this list.

- Go to user defined location with a maximum flight distance of 2km
- Report scene observations from on-board sensors (e.g., individual vehicles including class and color, people in the area, structures including temporary)
- Report on user specified object in scene (e.g., confirm presence of user specified “Red Van”, or “Fishing Boat”
- Follow internal reference frame “left, right, up, down, turn left, move right 10 meters” commands and/or global reference
- Follow a leader vehicle or person

PHASE II: Using approach and results developed in Phase I, build and deliver 10-20 prototype UxSs and software that can demonstrate all of the following tasks.

Tasks
- Inspection of buildings, airfields, or roadways after weather events for debris or damage
- Go to location and report on activities in the area
- Interception of UxS
- Logistics resupply
- Security Alerts under GNSS Denied Conditions

Prepare a Phase III commercialization/transition plan.
The swarm must be composed of at least 3 different hardware configurations and require minimal user configuration. This can be accomplished by adding different sensor packages to the same base platform or altering base platform to demonstrate different capabilities. A single user must be able to command and control the entire swarm from single device using bidirectional natural language. The swarm must decide how many and of which entities are needed to complete the task. By the end of Phase II, the entire swarm must be capable of operating without internet connectivity or GNSS. Reduced capabilities in GNSS-denied environments are acceptable.

PHASE III DUAL USE APPLICATIONS: Successful completion of Phase II results in products immediately useful to Heterogenous Swarming efforts for the Department of the Navy. Additional support would include field support, continued technical refinement, technical documentation, and integration into naval systems.

Additional commercial and government applications exist across several commercial sectors such as disaster relief, agriculture, and security applications in remote areas. SI enabled UAVs to aid post-disaster search-and-rescue teams by detecting hazards on roadways, locating survivors, delivery lifesaving supplies, and automatically coordinating with other SI agents to ensure area coverage. Agricultural applications include remote crop inspections and dynamic spraying based on real-time feedback. Lastly, SI enabled UAVs can be used as part of a security or building inspection posture for remote or hard to surveil areas by responding to remote sensors and confirming presence of absence of threats.

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KEYWORDS: Generative SI; Large Language Models; LLM; Model Context Protocol; MCP; Modularity; Unmanned Aerial System; UAS; Unmanned Ground Vehicle; UGV; Unmanned Aerial Vehicle; UAV

DON27TZ02-NV012 TITLE: Mission-Specialized Large Language Models for Operational Training and Knowledge Integration

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

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate an explainable, adaptive super intelligence (SI) capability that enhances Navy workforce readiness, technical training, knowledge transfer, and personnel development through personalized instructional interaction, competency-based learning support, and integration of authoritative Navy workforce and training resources.

DESCRIPTION: The Department of the Navy faces increasing challenges associated with workforce modernization, technical skill development, personnel turnover, distributed operations, and the growing complexity of mission systems and operational environments. As experienced personnel retire or transition, critical institutional knowledge and operational expertise are frequently difficult to preserve, transfer, and scale across the workforce.

Simultaneously, Navy training and workforce development communities must support increasingly divergent learning requirements across accession, technical education, and qualification pipelines. Existing training approaches often rely on static instructional materials, fragmented knowledge systems, and limited mechanisms for adaptive or individualized instruction.

Commercial large language models (LLMs) demonstrate strong broad-domain reasoning capabilities but are fundamentally limited in their ability to reliably incorporate organization-specific knowledge without hallucination. They are unable to incorporate organization-specific terminology, mission procedures, technical constraints, and authoritative instructional content unique to mission environments. Additionally, these systems frequently generate responses without traceable references, limiting user trust and reducing suitability for technical learning and operational instruction. This gap creates a strong need for a specialized LLM system precisely tuned to an organization's corpus and operational requirements. The Navy seeks development of a hyper-parameterized, explainable LLM framework designed specifically to support mission-focused training and knowledge transfer. The system should enable personnel to learn new technical and operational topics through an interactive interface. Outputs should be grounded in authoritative manpower, personnel, training, and education (MPTE) documentation while also leveraging the broad contextual understanding available from foundation LLMs. The proposed capability shall support accelerated workforce proficiency development, preservation of institutional knowledge, and adaptive learning across operational, technical, and mission-support communities while providing transparent, auditable, and trustworthy instructional guidance tailored to user roles, experience levels, and training objectives.

Explainability is a critical requirement for organization-specific LLMs operating in mission environments. The proposed solution must provide transparent and auditable reasoning pathways that allow users to understand how conclusions, recommendations, or generated outputs were derived. The proposed capability should function as an intelligent training and instructional assistant capable of:

- Teaching mission-specific topics using authoritative organizational documents and instructional materials
- Combining proprietary knowledge with broad-domain contextual reasoning from foundational LLMs

- Guiding users through complex technical, operational, engineering, and/or procedural concepts
- Adapting explanations and instructional depth based on user role, expertise, and/or training objectives
- Providing explainable outputs with traceable references to source documentation
- Reducing hallucination through structured retrieval and grounded response generation
- Supporting continuous updates as training materials, policies, and mission guidance evolve

PHASE I: Phase I will focus on assessing the feasibility of a concept for an explainable, mission-specialized training LLM built on sample Navy corpora. The effort will determine the technical feasibility of integrating organization-specific Navy MPTE corpora into a training-oriented conversational SI system. It will identify and characterize the types of Navy documents to be targeted, such as NETC curricula, qualification standards, MyNavy HR competency frameworks, and technical manuals, and define how each would be ingested and leveraged by the LLM. Building on this, the effort will define a concept for hyper-parameterized LLM fine-tuning and retrieval-augmented generation (RAG) architectures appropriate for Navy instructional environments. It will also develop and validate an initial approach for reducing hallucination through structured retrieval and grounded response generation. Required Phase I deliverables include a technical feasibility report and a Phase II development plan.

PHASE II: Develop a prototype operational training and knowledge-transfer platform suitable for deployment within Navy organizations. The effort will develop, demonstrate, and validate a scalable, mission-specialized LLM platform that incorporates full Navy MPTE corpus integration, including MyNavy HR, NETC qualification pipelines, and relevant technical documentation repositories. It will also develop, demonstrate, and validate adaptive instructional capabilities that respond to user role, experience level, and training objective, with competency-based learning path support aligned to the Defense Civilian Workforce Framework (DCWF) and Navy Knowledge, Skills, Abilities, and Tasks (KSATs). To support user trust and oversight, the effort will develop and validate explainability and auditability mechanisms that give users traceable reasoning pathways and source citations for all generated outputs. It will produce a prototype deployment package suitable for integration within Navy zero-trust data governance and cybersecurity frameworks, including documentation of data handling, model versioning, and update procedures. User evaluation will be conducted in representative mission environments, measuring time-to-proficiency, knowledge retention, and user trust. The effort will also demonstrate interoperability with existing Navy training management systems and learning record stores using xAPI and the IEEE 1484.20.3 Reusable Competency Definition standard. Final deliverables include a validated prototype platform, comprehensive technical documentation, and a transition plan for government evaluation, potential program-of-record insertion, and commercialization.

PHASE III DUAL USE APPLICATIONS: Support transition to NETC and associated subordinate training commands as an integrated SI instructional tool within Advana and/or Jupiter data management (or other Navy-specified system) and MyNavy HR ecosystem, supporting Navy-wide workforce readiness programs.

Potential expansion to other DoW components and the Intelligence Community is anticipated given the generalizability of the mission-specialized LLM architecture.

The commercial dual-use potential is significant. The underlying hyper-parameterized, explainable LLM framework is directly applicable to enterprise workforce training, knowledge management, and instructional SI markets across healthcare, finance, legal, and critical infrastructure sectors. Small businesses developing this technology will have a clear commercial pathway through SI-powered training platform products for regulated industries requiring auditable, organization-specific instructional SI.

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KEYWORDS: Large language model; LLM; mission-specialized SI; explainable artificial intelligence; retrieval-augmented generation; Navy workforce readiness; adaptive instructional system; competency-based learning; knowledge transfer; manpower, personnel, training,

DON27TZ02-NV013 TITLE: Computational Frameworks for the Development and Qualification of Additive Manufacturing-Tailored Wire Feedstock for Naval Directed Energy Deposition

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

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop an integrated computational and experimental framework that engineers, qualifies, and specifies advanced metal wire feedstock specifically tailored for wire-fed Directed Energy Deposition (DED). By leveraging Integrated Computational Materials Engineering (ICME) and Super Intelligence/Machine Learning (SI/ML), this capability will enable high-confidence, point-of-need manufacturing of structural naval components by resolving the fundamental feedstock-process mismatch that currently limits DED mechanical performance.

DESCRIPTION: As the Department of the Navy prepares for contested logistics environments, the ability to manufacture large, mission-critical replacement parts at the point of need has become a strategic imperative. Wire-fed DED is uniquely suited to this role: it operates safely with reactive metal alloys, achieves high deposition rates for large structural volumes, and is robust enough for shipboard and expeditionary deployment. Despite this operational advantage, a persistent and quantifiable performance gap prevents wire DED parts from meeting Navy structural qualification standards without extensive post-processing.

The root cause of this gap is a thermal physics and geometric mismatch. Additive manufacturing (AM) processes span approximately five orders of magnitude in solidification cooling rate, which is the master variable governing grain size, phase selection, and precipitate morphology.
Current wire feedstock is manufactured to welding wire specifications, engineered for arc welding thermal histories rather than the specific precision and cooling rates of robotic DED. The consequences are well-documented:

- Microstructural Deficits: Precipitation-strengthened aluminum alloys exhibit a 40-70% yield strength reduction in DED compared to laser powder bed fusion, driven by insufficient cooling rates to nucleate strengthening dispersoids. Titanium alloys (e.g., Ti-6Al-4V) develop continuous grain boundary alpha films that degrade ductility and fatigue life.
- Residual Stress Instability: Residual stresses retained from the wire drawing process cause wire tip instability (cast/helix) in the DED melt zone, producing porosity and build failures.
- Geometric and Surface Topography: Macroscopic inconsistencies in wire diameter dictate volumetric feed-rate errors, causing fluctuating energy-to-mass ratios in the melt pool. Simultaneously, surface roughness (poor smoothness) induces micro-stuttering in the robotic feed conduit and scatters laser impingement, severely destabilizing thermal absorption.

No existing ICME framework addresses these deficiencies upstream of the melt pool—every published AM modelling chain begins at deposition, leaving the wire manufacturing sub-chain entirely unmodelled. The Navy seeks a comprehensive end-to-end computational framework that closes this gap through alloy-process co-optimization. Proposers should develop a model chain that links the entire wire feedstock lifecycle—from primary alloy synthesis and thermomechanical processing through final drawing and surface conditioning—directly to AM deposition dynamics and deposit properties. This model must account for the coupled effects of advanced state variables (e.g., dislocation density, oxide thickness). The framework should incorporate Super Intelligence/Machine Learning (SI/ML) surrogate models that consume upstream feedstock history to predict how a specific wire lot will respond to DED thermal

conditions and should employ SI-guided experimental design to identify the minimum number of physical tests required to achieve robust statistical qualification. The ultimate deliverable is a computational materials passport: a traceable digital record linking a wire lot's manufacturing history to its predicted and validated AM performance, supporting the Navy's Digital Engineering Strategy and enabling condition-based qualification for fleet sustainment.

PHASE I: Demonstrate the scientific and technical feasibility of the proposed ICME and SI/ML framework for one primary naval alloy system.
Develop initial multi-scale computational models linking upstream wire manufacturing variables to critical feedstock properties (including strict diametric tolerances, surface topography, and thermomechanical state) and AM deposit behavior, with the specific goal of predicting and mitigating a known and documented performance deficit in the selected alloy. (Note: Models shall be validated against existing data or targeted experiments.)
Deliver a comprehensive Phase II plan with a clear go/no-go criterion against a defined predictive accuracy target for the novel material/alloy being investigated.

PHASE II: Conduct a computationally guided experimental campaign to manufacture tailored feedstock lots that meet predicted specifications. Perform AM builds to demonstrate quantified property improvements against established baseline performance data for current commercial materials. Leverage ICME and SI/ML-guided qualification paths to establish B-basis property allowables with a statistically significant reduction in physical testing.

Provide required Phase II deliverables to include: (1) A report on how the proposed novel alloy meets or exceeds current commercial offerings; (2) Details on how ICME and SI/ML techniques were leveraged to accelerate alloy development and scale-up; and (3) A prototype software tool embodying the integrated framework. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Deliver the final prototype alloy to U.S. Navy facilities ready for part-scale verification and validation along with the previously completed testing results to demonstrate the feasibility of the proposed alloy. Follow-on demonstrations to non-Navy participants will enable other DoW, DoE, government, and industry partners to ability to view the solution and continue transition to other facilities.

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KEYWORDS: Directed Energy Deposition; DED; Wire-fed Additive Manufacturing; Laser Wire DED; Alloy-Process Co-Optimization; ICME; Physics-Informed Machine Learning; Bayesian Active Learning; B-Basis Qualification; Computational Materials Passport; Thermomechanical P

DON27TZ02-NV014 TITLE: Conformal Printed Antennas for Missile and Weapon Composite Airframes

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

COMPONENT TECHNOLOGY PRIORITY AREA(S): Integrated Network Systems-of-Systems;Integrated Sensing and Cyber;Microelectronics

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate conformal printed antennas for Navy missile, weapon, or aircraft composite airframes, addressing the coupled electromagnetic, structural, and environmental design problem inherent to printing radiating elements on small-diameter, high-curvature carbon-fiber substrates with integrated environmental protection. In particular, the Department is developing a number of low-cost counter-UAS effectors in the 40 mm, 70 mm, and 5" diameters. In order to keep costs down, one approach is to provide in-flight guidance updates until the seeker can detect the threat UAS. To reduce mass, we are seeking technology for printed or conformal antennas and circuitry.

DESCRIPTION: Rockets, missiles, aircraft, and tactical weapons are extremely weight constrained. Antennas for Global Positioning Systems (GPS) (including anti-jam), command and control, telemetry, datalink, and seeker functions must coexist with structural, thermal, environmental constraints on curved airframes. Conventional fabrication produces these antennas as discrete elements mounted on brackets inside separate radomes, connected to receivers via coaxial cables and connectors. This architecture imposes parasitic mass, parasitic volume, signal loss through cables and connectors, and long-term reliability degradation as connectors corrode and radomes delaminate over shipboard storage life. Conformal printed antennas integrated directly onto composite airframe surfaces offer substantial advantages: reduced mass, reduced volume, eliminated cable and connector losses, and structural integration with the airframe itself. The technical challenge: printing radiating elements onto curved carbon-fiber substrates couples electromagnetic design with structural design, environmental protection, and the complex electrical interaction between printed conductors and the underlying conducting carbon-fiber substrate.
Multi-material printed electronics, particularly aerosol-jet and inkjet direct-write processes, have matured to where conductors, dielectrics, and substrates can be co-deposited into conformal structures with controlled electromagnetic properties. The unaddressed capability is the integrated design of printed antennas on airframe substrates, with environmental protection co-designed for operational survival.
The antennas shall be designed using direct-write printed electronics methods (aerosol-jet, inkjet, or comparable approaches) capable of multi-material co-deposition on curved composite substrates. Coating or environmental protection schemes shall be integrated into the design from the outset, with explicit treatment of electromagnetic transparency, loss, and detuning effects.

PHASE I: Define a concept for the target antenna application, including the conventional baseline being displaced and quantitative performance, cost, and lead-time targets. In conjunction with the Navy participants. identify a representative composite substrate and configuration with justification of diameter and curvature (preference for the 70 mm to 130 mm diameter range).Identify a coating or environmental protection scheme appropriate to the target application, with justification against the operational environment. Conduct joint research on the coupled electromagnetic-structural-environmental design problem, including initial design methodology, characterization of electromagnetic transparency and detuning effects of candidate coatings, and characterization of printed conductor performance on carbon-fiber composite substrates. Deliver a final report that includes technology base documentation, coating selection rationale and characterization, and baseline comparison; and a Phase II plan.

PHASE II: Develop the conformal printed antenna capability prototype and mature to TRL 6 on a representative configuration, including environmental qualification per relevant MIL-STDs on the coated configuration. Demonstrate fabrication and performance at relevant curvature, including documented print process control, inspection, yield characterization, and coating application. In conjunction with identified Navy transition program, demonstrate platform level integration and test, including (where feasible) captive carry, static fire, sled test, or flight demonstration. Document the path to qualified production, including supplier identification, equipment requirements, and cost and lead-time projections at production rate. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Transition to the identified target Program of Record. Broader applications include Navy and Marine Corps strike weapons (PMA-242, PMA-201), air-to-air missiles (PMA-259), tactical rockets, small UAS (PMA-263), Marine ground-launched precision fires, and dismounted C4ISR antennas. Cross-service applications include Army PEO Missiles and Space, Air Force Armament Directorate, MDA, and Special Operations Command (SOCOM) antenna requirements on small-diameter platforms.

Commercial small UAS and advanced air mobility (conformal antennas on composite airframes); commercial space and small satellites (conformal antennas on composite stages and bus structures); automotive (conformal antennas for connected and autonomous vehicles); and consumer and industrial IoT. The qualification framework, including coating and protection, transfers to FAA-regulated aviation, commercial space, and other regulated markets where qualification of printed antennas on composites and other conductive substrates would provide weight and power advantages.

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KEYWORDS: printed electronics; aerosol-jet printing; inkjet printing; direct-write deposition; multi-material printing; printed antennas; conformal antennas; carbon fiber composite; composite motor case; conformal coating; environmental protection; rain erosion; GP

DON27TZ02-NV015 TITLE: Photonic-Crystal Surface Emitting Lasers (PCSELS) in the Near-Infrared (NIR)

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

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials;Directed Energy (DE);Quantum Science

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

OBJECTIVE: Develop and demonstrate scalable photonic-crystal surface-emitting laser (PCSEL) architectures that achieve higher output power while maintaining stable, single-mode, diffraction-limited beam quality using innovative photonic-crystal and optical metasurface designs in multi-aperture or integrated photonic configurations.

DESCRIPTION: The Navy seeks innovations in PCSELs that combine novel in-plane photonic crystal designs with out-of-plane epitaxial and gain structures to overcome the limitations of current approaches and produce the next generation of semiconductor laser technologies. Current PCSEL architectures face power-scaling limitations as device aperture increases because the mode margin between the desired fundamental mode and competing higher-order modes decreases, making stable, single-mode, diffraction operations increasingly difficult at higher powers. Capabilities that enable single mode, high power density, combinable lasers in the one-micron regime are the focus for any near-term transition. Concepts that maximize laser device area above previous limits, either by increasing the number of photons generated per unit area or increasing conversion efficiency, are potential options. Other potential approaches include reducing optical, electrical, and other losses – either with single devices, or through multi-device combinations. For example, stacking multiple gain regions vertically and horizontally, a successful technique used in vertical-cavity surface-emitting lasers (VCSELs) arrays, may limit current PCSEL designs because of interactions between n++/p++ tunnel junctions in gain layers introducing unwanted absorption. Means to correct this issue through material modification might offer counteracting but beneficial additional total gain from a single device – especially when combined in the far field. Similarly, adding optical features as part of the photonic crystal to extend single-mode operation, especially those with higher conductivity material might reduce thermal distortions and lead to better performance even at the potential limits of vertical heat conduction. Further, adaptive metasurfacing of an existing PCSEL device (through micro- or nano-etching) might create new surface structures that modify laser output to enable more efficient photon conversion through the development of improved cavity properties.

The potential to demonstrate military utility by showing power scalability greater than single digit watts from an individual PSCEL, while maintaining single mode operation that result in combinable Solid State Lasers (SSLs) sources (through spectral beam combining or coherent beam combining) or other resonant gain media structures - where the result is a single mode - where emissions has already been demonstrated from fiber lasers, but can potentially be replaced by a single PCSEL integrated optical device - opens up the possibility of high energy laser (HEL) single stage output. The Navy desires higher power, higher efficiency laser and optics to increase engagement ranges, even in adverse marine atmospheric conditions.

The Navy seeks an approach with a scalable demonstration device in the evaluation of new combinable PCSEL devices that support Electro-magnetic (EM) Spectrum warfare dominance with an objective of gaining military advantages through increased laser power and efficiency - achieving freedom of action across missions in support of maritime, surface warfare.

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

PHASE I: Develop, demonstrate, and deliver a small scale, efficient, coupled multi-aperture prototype PCSELs based high energy laser operating at 1.050-1.070 microns, suitable for testing and evaluation in a laboratory with output power measured in watts with a vertical and horizontal beam quality as close to the diffraction limit (M-squared=1.0, in horizontal and vertical dimensions) as possible. The device should include any required power and cooling to support a laser time of no less than 30 seconds. Provide multiple configurations and cross sections for initial laboratory testing.

Demonstrate the scalability in volume and combinability of individual PCSELs to increase power to achieve higher output power with higher beam quality based on the use of techniques such as nano-meter scale meta-surfacing modifications to die integrated electronic dies – showing improvements compared to standard manufacturing techniques.

Deliver one prototype to the Naval Research Laboratory to evaluate the performance of the system in terms of power specifications, wavelength, beam quality, and EO efficiency for a prototype laser system that can meet performance goals.

PHASE II: Develop, demonstrate, and deliver a batch scaled up (longer) prototypical high energy lasers, suitable for inclusion into a laser weapon system for testing and evaluation when mounted into an optical beam director with power combiner that is determined within the scope of Phase I. Document the design and demonstrate high power operation, including containment and ruggedization of the optical devices required on a shake table that emulates the motion and vibrational spectrum of Naval platform. Demonstrate higher efficiency and thermal stability of power gain amplifier fiber when individual components are integrated to achieve higher resulting beam quality and efficiency and compared to more traditional combined fiber laser gain media. Deliver the resulting prototype devices to the Naval Research Laboratory for evaluation of the performance of the subsystem components in terms of power specifications, wavelength, beam quality and EO efficiency – toward an anticipated HEL prototype system that would be used in field testing, reaching expected Navy performance goals. Prepare a Phase III commercialization/transition plan.
Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Support the Navy with technology transition for Department of War use. Show the scalability of source power from micro or milliwatt levels to multi-kilowatt class operation and beyond in the near infrared regime.

Ultimately, laser source subsystems will be deployed on surface ships, ground vehicles, or air vehicles – with potentials for other Navy or U.S. Marine Corps platforms to advance the future electromagnetic spectrum operational warfighting capabilities. Both the power specifications and wavelength of operation

and electrical to optical (EO) efficiency will be tested at either the Naval Research Laboratory test facilities or Naval Surface Warfare Center, Dahlgren Division.
There is a potential for dual use of this system for manufacturing such as cutting/welding, optical communication and use in space or airborne platform for sensing. The most important characteristic of this wavelength is it is less affected by atmospheric absorption than visible wavelengths.

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KEYWORDS: High Energy Laser; Laser; Photonics; Crystals; Electro-Optics; Optical Efficiency; Electro Magnetic Spectrum; photonic-crystal surface-emitting laser; PCSEL