DEPARTMENT OF THE NAVY (DoN)
24.B Small Business Technology Transfer (STTR)
Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to STTR topics only:**
  - **N24B-T025 through N24B-T030**

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

- The information provided in the DoN Proposal Submission Instructions document takes precedence over the DoD Instructions posted for this Broad Agency Announcement (BAA).

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

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

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

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

INTRODUCTION

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

The Program Manager of the DoN STTR Program is Mr. Steve Sullivan. For questions regarding this BAA, use the information in Table 1 to determine who to contact for what types of questions.

TABLE 1: POINTS OF CONTACT FOR QUESTIONS REGARDING THIS BAA

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

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

Topic Numbers	Point of Contact	SYSCOM	Email
N24B-T025 to N24B-T030	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

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

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

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

Proposal Volumes. The following six volumes are required.

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

- **Technical Proposal (Volume 2)**
  - Technical Proposal (Volume 2) must meet the following requirements or the proposal will be REJECTED:
    - Not to exceed 10 pages, regardless of page content
    - Single column format, single-spaced typed lines
    - Standard 8 ½" x 11" paper
    - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
    - No font size smaller than 10-point
    - Include, within the 10-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified. Phase I Options are exercised upon selection for Phase II.
    - Work proposed for the Phase I Base must be exactly six (6) months.
    - Work proposed for the Phase I Option must be exactly six (6) months.
  - Additional information:
    - It is highly recommended that proposing small business concerns use the Phase I proposal template, specific to DoN topics, at https://navysbir.com/links_forms.htm to meet Phase I Technical Volume (Volume 2) requirements.
    - A font size smaller than 10-point is allowable for headers, footers, imbedded tables, figures, images, or graphics that include text. However, proposing small business concerns are cautioned that if the text is too small to be legible it will not be evaluated.

- **Cost Volume (Volume 3).**
  - Cost Volume (Volume 3) must meet the following requirements or the proposal will be REJECTED:
    - The Phase I Base amount must not exceed $140,000.
    - Phase I Option amount must not exceed $100,000.
    - Costs for the Base and Option must be separated and clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3.
    - For Phase I a minimum of 40% of the work is performed by the proposing small business concern, 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 small business concern the sum of all direct and indirect costs attributable to the proposing small business concern represent the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) is the denominator. The 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 Small Business Concern Costs (included in numerator for calculation of the small business concern):
  - Total Direct Labor (TDL)
  - Total Direct Material Costs (TDM)
  - Total Direct Supplies Costs (TDS)
  - Total Direct Equipment Costs (TDE)
  - Total Direct Travel Costs (TDT)
  - Total Other Direct Costs (TODC)
  - General & Administrative Cost (G&A)

  NOTE: G&A, if proposed, will only be attributed to the proposing small business concern.
- 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.**

- Additional information:
  - Provide sufficient detail for subcontractor, material, and travel costs. Subcontractor costs must be detailed to the same level as the prime contractor. Material costs must include a listing of items and cost per item. Travel costs must include the purpose of the trip, number of trips, location, length of trip, and number of personnel.
  - Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.
  - The "Additional Cost Information" of Supporting Documents (Volume 5) may be used to provide supporting cost details for Volume 3. When a proposal is selected for award, be prepared to submit further documentation to the SYSCOM Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

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

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

  All proposing small business concerns must review and submit the following items, as applicable:
  - **Telecommunications Equipment Certification.** Required for all proposing small business concerns. The DoD must comply with Section 889(a)(1)(B) of the FY2019 National Defense Authorization Act (NDAA) and is working to reduce or eliminate contracts, or extending or renewing a contract with an entity that uses any equipment, system, or service that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As such, all proposing small business concerns must include as a part of their submission a written certification in response to the clauses (DFAR clauses 252.204-

7016, 252.204-7018, and subpart 204.21). The written certification can be found in Attachment 1 of the DoD SBIR/STTR Program BAA. This certification must be signed by the authorized company representative and is to be uploaded as a separate PDF file in Volume 5. Failure to submit the required certification as a part of the proposal submission process will be cause for rejection of the proposal submission without evaluation. Please refer to the instructions provided in the Phase I Proposal section of the DoD SBIR/STTR Program BAA.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries.** Each proposing small business concern is required to complete Attachment 2 of this BAA, "Disclosures of Foreign Affiliations or Relationships to Foreign Countries" and upload the form to Volume 5, Supporting Documents. Please refer to the following sections of the DoD SBIR/STTR Program BAA for details:
  - Program Description
  - Proposal Fundamentals
  - Phase I Proposal
  - Attachment 2

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

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

PHASE I EVALUATION AND SELECTION

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

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

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

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

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

- **Cost Volume (Volume 3).** The Cost Volume (Volume 3) will not be considered in the selection process and will only undergo a compliance review to verify the proposing small business concern has met the following requirements or the proposal will be REJECTED:
  - Must not exceed values for the Base ($140,000) and Option ($100,000).
  - Must meet minimum percentage of work; 40% of the work is performed by the proposing small business concern, 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.**

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

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

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

ADDITIONAL SUBMISSION CONSIDERATIONS

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

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

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

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

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

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

TABA must <u>NOT</u>:

- Be subject to any indirect costs, profit, or fee by the STTR proposing small business concern
- Propose a TABA provider that is the STTR proposing small business concern
- Propose a TABA provider that is an affiliate of the STTR proposing small business concern

- Propose a TABA provider that is an investor of the STTR proposing small business concern
- Propose a TABA provider that is a subcontractor or consultant of the requesting small business concern otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider)

TABA requests must be included in the proposal as follows:

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

Proposed values for TABA must NOT exceed:

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

If a proposing small business concern requests and is awarded TABA in a Phase II contract, the proposing small business concern will be eliminated from participating in the DoN SBIR/STTR Transition Program (STP), the DoN Forum for SBIR/STTR Transition (FST), and any other Phase II assistance the DoN provides directly to awardees.

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

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

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

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

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

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

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

SELECTION, AWARD, AND POST-AWARD INFORMATION

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

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

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

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

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

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

Contract Types. The DoN typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In addition to the negotiated contract award types listed in the section of the DoD SBIR/STTR Program BAA titled Proposal Fundamentals, for Phase II awards the DoN may (under appropriate circumstances) propose the use of an Other Transaction Agreement (OTA) as specified in 10 U.S.C. 2371/10 U.S.C. 2371b and related implementing policies and regulations. The DoN may choose to use a Basic Ordering Agreement (BOA) for Phase I and Phase II awards.

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

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

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

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

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

PHASE II GUIDELINES

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

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

Awards. The DoN typically awards a Cost Plus Fixed Fee contract for Phase II; but, may consider other types of agreement vehicles. Phase II awards can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR/STTR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the small business concerns (e.g., the Navy STP).

PHASE III GUIDELINES

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

Navy STTR 24.B Topic Index

N24B-T025 TITLE: Secured Cyber-Physical System for Distributed Additive Manufacturing of Metallic Aerospace Structural Parts

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

OBJECTIVE: Develop a cyber-secured, digital twin-based system for distributed Additive Manufacturing (AM) to ensure trusted/authenticated, intellectual property (IP)-protected, high-quality and reliable/repeatable metallic structural parts.

DESCRIPTION: AM is a melting and rapidly solidifying building process—layer by layer—from a Computer-Aided Design (CAD) 3 dimensional (3D) digital model. Besides its demonstrated values for low-rate production and making complex shapes, AM possesses great potential to be a transformational technology, generating parts just-in-time at the point of need with minimum logistic footprint. This organic capability could significantly improve readiness and aircraft availability for the Navy fleet. For mass production, AM also enables de-centralized/distributed manufacturing (vs. centralized), thereby minimizing backlogs, increasing output capacity/surge-on-demand, and thus making the supply chain more robust and agile. Despite all of the potential promises and benefits, AM still has not yet been widely accepted and implemented across industries due to three main obstacles that must be addressed and show more advancements: (a) data integrity, data rights/ownership and IP protection, (b) cybersecurity, and (c) (Local/Remote) Quality Control and Assurance.

As part of the Naval Product Lifecycle Management (N-PLM) system, Digital Thread (DTh) collects and integrates product-related data dynamically from multiple sources, and then bilaterally exchanges information across enterprises from concept development to disposal. Data associated with typical AM workflow includes CAD design models; detailed part specifications, materials and process specifications; Stereolithography/Additive Manufacturing File (STL/AMF) and G-Code files; machine-specific hardware and software/firmware; processing parameters such as part orientation and placement, energy power level, toolpath and scanning patterns; and so forth. Within the distributed/de-centralized manufacturing eco-system, the need for providing timely access, transmitting and sharing of valuable/proprietary information, and facilitating collaboration is essential among various groups both within the company, as well as outside, such as third-party suppliers. This activity requires proper protection, control, and management of shared trusted data transfer for accountability (tracking and traceability), and product quality assurance along with IP protection. Blockchain is a distributed ledger technology (DLT) that could provide seamless and efficient adaptation of a digital infrastructure such as secured keys for authentication to access the chain and trusted network for data exchange. It also provides immutability of records, which could safeguard sensitive manufacturing information against unauthorized manipulation and IP theft.

AM is considered to be a cyber-physical system (CPS) combining physical hardware with software systems, usually via online network. Researchers have demonstrated that AM process workflow to be susceptible and vulnerable to cyber-attacks on both cyber and physical systems ranging from altering the build file to side channel attack of the printing machine. Malicious attacks could not only degrade the part performance and reliability, but also could damage the machines and cause injury to the operators. The needs for an autonomous system to monitor, detect, and prevent cyber-physical attacks in (near) real-time is paramount for AM.

The AM process possesses a myriad of variabilities that could affect site-specific microstructures, material properties, surface roughness, dimension accuracy, and part performance due to feedstock, part geometries, build orientation, printing process parameters, heat treatments and post-print processing, and so forth. Digital Twin (DT) is a virtual dynamic clone of the AM process including in-situ monitoring, physics-based model, and closed-loop feedback control. Coupling DT with Artificial Intelligence/Machine Learning (AI/ML) and Big Data analytics, a DLT-enabled network could provide an effective and secured framework for (near) real-time quality control (QC) to assure process stability for repeatability and reliability of the printed parts. In addition to providing in-process visibility, a QC system could also be designed to detect the effects of cyber-attacks, such as part tampering.

The Navy seeks innovative technology solutions that are compatible/adaptable and integrated seamlessly (via Application Programming Interface (API)) with the existing N-PLM systems such as Siemens Teamcenter and PTC Windchill to protect AM system from cyber-physical attacks, prevent IP theft, and allow dynamic and low latency data access and transfer while assuring quality, repeatability/reliability, and manufacturing traceability of the printed parts.

PHASE I: Develop the system architecture and concept of operations for cyber-secured, DT-based distributive AM. Demonstrate the technical feasibility of the proposed concept/construct through working examples. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Expand the architectural design and complete application business model to incorporate business logic for all transactional data in the product life cycle. Demonstrate in cyber and physical environments the following:
1. AM version control and IP protection when distributing to external 3D print suppliers/customers, and implement seamless, secured management of Digital Thread (DTh) to ensure optimal AM part quality via:
    (a) preserving the digital thread for tracking and tracing part life cycle,
    (b) exercising printer controls to limit printing authorized amounts,
    (c) exchanging machine parameters during the cycle runs along with any alarm data from the suppliers to the designated activity for quality buyoff and invoice processing,
    (d) preventing mistakes associated with using wrong or outdated programs in forming a part,
    (e) ensuring authorized personnel to have access to the DLT protecting IP and version control, and
    (f) monitoring, detecting, and preventing cyber-attacks.
2. DT to provide a digital end-to-end simulated picture of AM steps (versus expected actual performance), including scan and design, build and monitor, test and validate, and deliver and manage steps.

PHASE III DUAL USE APPLICATIONS: Finalize the system development and application to plan and manage end-to-end AM management activity. Ensure usability for the end user. Perform final testing on a few representative aircraft parts to demonstrate the model's ability to support Navy Fleet Readiness Centers (FRCs).

Commercial industries have a similar need for their AM product lines and issues concerning product life cycle data and IP protection. Hence this digital system might find wide use across a broad variety of industry sectors.

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KEYWORDS: Additive Manufacturing; Digital Thread; Digital Twin; Cyber-Physical System; In-situ Monitoring; Blockchain

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N24B-T026 TITLE: High-Speed, Cross-Domain Data Transfer

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): FutureG;Integrated Network Systems-of-Systems; Trusted AI and Autonomy

OBJECTIVE: Identify, develop, and demonstrate technologies that enable high-speed, wireless data transfer across the air-sea interface via unmanned platform teaming.

DESCRIPTION: The problem: Advanced sensor payloads are being developed for unmanned underwater vehicles to detect and identify subsea threats. The challenge is to wirelessly transfer the sensor data from these payloads, in a timely manner, across the air-sea interface for analysis.

The current state-of-the-art: Generally, modern underwater communication links use acoustic methods whose biggest shortcoming is low-data bandwidth (< 1 Mbps) [Refs 1, 2]. Currently, high-speed wireless data transfer from underwater platforms requires the platform to surface and establish a radio link or be physically recovered by a crewed platform, interrupting the mission, and revealing the platform's location. Additionally, the time it takes to acquire and process the data may render the information obsolete, reducing its effectiveness for decision making.

Techniques to assist the passage of data through the sea surface, like buoys, are typically passively drifting or moored to a single location, reducing their effectiveness in supporting dynamic missions that cover large areas. With the advancement of autonomous systems, teaming between air, surface, and subsea unmanned platforms combined with new communication techniques, such as those that leverage multiple parts of the frequency spectrum [Refs 3–5] (i.e., acoustic, or optical frequencies underwater, and RF frequencies above water), have the potential to enable cross-domain command and control, and high-speed data transfer. High-speed, underwater, optical communication links have been demonstrated in the lab [Refs 6, 7], but their applicability to a relevant environment is not proven. This STTR topic aims to develop and demonstrate a methodology that leverages multi-spectrum technology (i.e., acoustic, radio, and optical)—paired with unmanned teaming—to enable high-speed communications across the air-sea interface in a wide range of water types. Data rates across the air-sea interface of greater or equal to 10 Mb/s are required, and the size, weight, and power (SWaP) of the components should be compatible with unmanned platforms.

PHASE I: Develop a methodology that incorporates unmanned platform teaming (i.e., air, surface, and underwater) with diverse communication technologies (i.e., acoustic, radio, and optical) to achieve high-data rates across the air-sea boundary. The methodology should include initial modeling of the communication links, and of relevant unmanned platform teaming behaviors to serve as a proof-of-concept for the proposed solution. Metrics such as communication range, throughput, persistence, and reliability should be investigated. Specific sensor technology and unmanned platforms should be identified, and the intended operating environment conditions specified. References to relevant work are encouraged and awardees may include an initial demonstration of communication technologies—and/or unmanned teaming—in simulated or relevant environments to further reinforce the legitimacy of the proposed solution. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Demonstrate the methodology developed in Phase I in a relevant environment. Sensors identified in Phase I should be produced or procured, and integrated into the unmanned platforms, also identified in Phase I. The methodology should be tested in a simulated environment before being deployed in a relevant environment. Unmanned teaming behavior should be developed to support the methodology identified in Phase I. Data from lab and field testing should be used to validate the models within the proposed solution.

PHASE III DUAL USE APPLICATIONS: Develop commercialization of the device, manufacturing methods, and finalize device form factor and capabilities. Evaluate market potential for military and civilian applications and assess required infrastructure for continued technology readiness level (TRL) and manufacturing readiness level (MRL) development.

Persistent situational awareness of the underwater domain is applicable for several private sector applications. Oil and gas can leverage this technology to survey challenging drill sites and inspect underwater infrastructure. Harbor operations, such as hull inspection, security, and infrastructure inspections would benefit as well. Unmanned teaming has the potential to reduce the need for, and risk to, crewed operations. Pairing this with advanced laser sensors will enable higher quality inspections for better decision making.

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KEYWORDS: communications; autonomy; unmanned; optics; sensors; maritime

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N24B-T027 TITLE: Real-Time In-Flight Aircraft State Estimation

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

OBJECTIVE: Develop a method that utilizes existing aircraft sensors to estimate an aircraft's weight, center of gravity location, airspeed, wind speed, and/or other flight critical aircraft state.

DESCRIPTION: Aircraft are often heavily dependent on key state information, which require redundant sensors to meet flight safety standards or mission requirements. In the case of a failure with a dual system, it is often difficult to determine which sensor is the faulty one. In addition, aircraft weight is often required to be entered by the aircrew, which limits its usability in the vehicle management system (VMS) due to potential inaccuracy.

The Navy requires the ability to utilize additional existing sensors to estimate aircraft states in real time while in-flight, which could lower the number of redundant sensors, lower the likelihood of mission abort, and/or increase pilot situational awareness. The proposer should validate the estimation methodology using simulation or flight test data; and determine the level of accuracy of the estimations. Some of the parameters that would be targeted to estimate are (but are not limited to) on-ground/in-air transitions, airspeed/ground speed, center of gravity location, aircraft gross weight, aircraft with or without an external load, and engine status/performance/approaching a failure.

PHASE I: Determine the technical feasibility of using sensor fusion to create a real-time, in-flight estimation of key aircraft states for an aircraft. Determine the methodology and which existing aircraft sensors are best suited for providing the estimations. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Validate the estimation methodology using simulation or flight test data. Determine the level of accuracy of the estimations.

Some of the parameters that would be targeted to estimate are (but are not limited to) on-ground/in-air transitions, airspeed/ground speed, center of gravity location, aircraft gross weight, aircraft with or without an external load, engine status/performance/approaching a failure.

PHASE III DUAL USE APPLICATIONS: Final testing would be incorporating the state estimation into a flight control algorithm as a sensor monitor and introducing sensor failures to test if the state estimation methodology is able to correctly identify the failed sensor and provide the proper aircraft state to the flight control algorithm. If successful, the estimation methodology would be implemented into new aircraft sensor voting algorithms and reduce the number of needed sources of data.

The ability to utilize existing sensors and reduce the number of additional required sensors to provide accurate, reliable aircraft state information would benefit commercial and military platforms as they share common redundancy requirements. The benefit would be a reduction in system complexity, cost, and weight.

With the projected rapid expansion of the electric vertical take-off and landing (eVTOL) and urban air mobility (UAM) market, the current levels of probability of loss of aircraft (PLOA), even for airliners, may not be sufficient when considering the predicted orders-of-magnitude increase in flight hours and the operation near highly populated, urban areas. We will need to find new technologies (like this) to increase safety without the burden of extra layers of redundancy. These small, weight-sensitive aircraft will not be able to handle the weight and space burden associated with operation in highly populated areas.

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KEYWORDS: Artificial Intelligence/Machine Learning; Sensor Fusion; Flight Critical; State Estimation; Redundancy; Vehicle Management Systems; Model-Based Systems Engineering

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N24B-T028 TITLE: Real-Time Detection of Operator Workload as Input to Scalable Autonomy During Dynamic Mission Operations

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

OBJECTIVE: Develop a method for real-time assessment of operator workload during dynamic flight operations to use as input for scalable autonomy in human-autonomy teams.

DESCRIPTION: Changes in the competitive capabilities of our adversaries has brought us to a new playing field in which we need to quickly develop and successfully leverage and integrate new technologies in support of our warfighters and the mission to maintain naval superiority. New developments in Machine Learning and Artificial Intelligence (ML/AI) provide opportunities for the integration and development of new autonomous and automated systems, ranging from advanced automated sensors, decision aids and mission systems to fully autonomous platforms that will work alongside the warfighter as a teammate rather than a tool. Successful integration of autonomy in warfighting systems will depend not only on their reliability and predictability, but their ability to work effectively with the human operator.

Effective human-autonomy teaming in naval operations will only be achieved if the human operator and autonomy system or agent are reactive to—and collaborative with—each other. A reduction in workload due to automation does not always result in superior operator and system performance; if task load is manageable, then offloading of tasks can result in underload and a loss of situational awareness [Ref 3]. Furthermore, automation does not always result in reduced workload. The paradox of automation is that monitoring the autonomous system, in addition to other mission responsibilities, can inadvertently increase workload. This increase in workload is thought to be due to the taxing nature of passive monitoring [Ref 4], which ultimately can result in complacency.

One proposed strategy to enhance human-autonomy teaming effectiveness is to build autonomous systems that adapt to the needs of the human operator in real time via dynamic workload thresholds based upon performance, psychophysiological activity, and/or other relevant metrics. The goal of such a strategy is to maintain situational awareness while moderating workload by increasing or decreasing levels of autonomy (i.e., number and types of tasks that are offloaded, type of decision aids provided, level of transparency, level and types of automated/autonomy functions, etc., [Ref 2]) based upon indicators of operator workload states [Refs 4 and 5]. Ideally, high operator workload would be addressed by increasing levels of automation or autonomous features, offloading/modifying tasks, and enhancing operator performance. Likewise, lower operator workload states would require minimal autonomy in order to ensure that the human remains in the loop to maintain engagement and situational awareness. The current state of autonomous functions of a system is either: (a) to be active at all times, (b) be manually turned on/off by the user, or (c) be manually selected by the user from various predetermined levels of autonomy. Thus, innovation is still needed to develop adaptive automation in real time, so that autonomy can be scaled to match the current operator need in order to ensure mission success. For this, we first need to:

Identify valid, consistent, and resilient metrics/tools to estimate various dimensions of operator workload (i.e., cognitive, temporal, physical, etc.) in real time, and develop a model to combine these into a single workload estimation measurement.

- Multiple metrics/methods/tools are expected to be combined for a more rounded and accurate estimation of workload and could include physiological and/or psychophysiological measures and metrics, as well as operator performance metrics, amongst others.
- The resulting tools and methods need to be unobtrusive to operator performance and comfort.

• The tools and methods need to be able to be resilient and function in naval aviation operational environments, to include in-aircraft use.
• Develop a model for operationally defining workload thresholds (i.e., overloaded or underloaded), which will require changes in system automation level or autonomous behaviors.
• Propose tasks and task allocation strategies between operator and autonomy/automation that would result in increased and/or decreased levels of autonomy/automation as needed, and would be based on the real-time workload indicators.

A solution that addresses the above-mentioned needs would provide a first step in supporting future human-autonomy teams that are inherent in the ever-growing manned-unmanned missions.
Note: NAVAIR will provide Phase I performers with the appropriate guidance required for human research protocols so that they have the information to use while preparing their Phase II Initial Proposal. Institutional Review Board (IRB) determination as well as processing, submission, and review of all paperwork required for human subject use can be a lengthy process. As such, no human research will be allowed until Phase II and work will not be authorized until approval has been obtained, typically as an option to be exercised during Phase II.

PHASE I: Identify the metrics, methods, and tools that will be used for the real-time assessment of operator workload. These should be validated in a simulation environment that dynamically induces varying levels of operator workload (e.g., overload or underload). The Phase I effort will include prototype plans to be developed under Phase II. Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II.

PHASE II: Develop, demonstrate, and validate an unobtrusive and affordable stand-alone kit for the dynamic assessment of operator workload, and its use and effectiveness as input for scalable automation/autonomy. An ideal kit would measure operator workload in an unobtrusive manner, so as not to interfere with operator task load, and would be viable for use in various naval aviation environments to include in-aircraft use. It will also include the development of an algorithm to operationally define overload and underload, as well as optimal workload. In addition, strategies should be proposed for manipulating the levels of automation in response to workload. Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II.

PHASE III DUAL USE APPLICATIONS: Final testing would involve validation of the technology in a naval aviation relevant use case that involves dynamic automation level modifications based on the workload assessment and demonstration that the intervention results in the intended changes in operator workload and enhanced system performance.

The real-time assessment of workload as input to scaling automation levels or autonomy behavior, could be used in any application that involves the interaction of a human operator with an automated system for extended periods and in dynamic environments. Some of these could be autonomous-car or transit vehicle operation, search and rescue mission systems, reconnaissance and surveillance mission systems, and monitoring systems and applications (e.g., scientific, medical, and nuclear).

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KEYWORDS: Human-autonomy teaming; adaptive automation; operator workload; real-time monitoring; neuroergonomics; psychophysiology

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N24B-T029 TITLE: ARCTIC FOX Sentinel

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

OBJECTIVE: Develop and demonstrate a new class of Arctic, implanted or embedded passive focused sensor package (air, ground, surface, sub-surface, or a combination thereof) for a variety of surveillance and reconnaissance applications that will be air-deployed, and have the capability for detection of manned and unmanned platforms across difficult terrain such as swamps, desert, tundra, and snow or water bodies to satisfy the most demanding mobility requirements of airborne and expeditionary forces. The end goal is a fully autonomous, air deployable, self-aligning sensor package solution where a multiunit employment team in a communication-degraded and/or GPS-denied environment can complete a mission with minimal human supervision under extreme environmental conditions.

DESCRIPTION: There is interest in utilizing emerging classes of highly sensitive, miniature, and energy-efficient sensors to perform a variety of surveillance and reconnaissance applications in support of the Department of the Navy A Strategic Blueprint for the Arctic. This STTR topic seeks to develop and demonstrate a new class of implanted or embedded passive focused sensor package (air, ground, surface, subsurface, or a combination thereof) in the Arctic environment. These systems will be air deployed and have the capability to detect manned and unmanned platforms across difficult terrain such as swamps, desert, tundra, and snow or water bodies to satisfy the most demanding mobility requirements of airborne and expeditionary forces. The end goal is a fully autonomous, air deployable, sensor package solution where a multiunit employment team in a communication-degraded and GPS-denied environment can complete a mission with minimal human supervision under extreme environmental conditions.

Technical Challenges and System Attributes:
(a) air or ship deployable, direct personnel positioned and recoverable,
(b) envisioned sensors (minimum):
- hydrophone(s) for water, in-ice and under-ice long-range detection,
- magnetometer(s)/Gravimeter for long-range submarine and anomaly detection,
- electric field sensor(s) for perimeter and intruder surveillance,
- seismometer,
- electro-optical/infrared (EO/IR) turret for airborne, perimeter and intruder surveillance,
- electronic warfare signals intelligence (EW SIGINT) (Receiver/Emitter),

(c) operate in temperatures ranging from: -49 °F (-45 °C) to 120 °F (49 °C),
(d) withstand 100 G impact on ice (air deployed),
(e) operate in a communication-degraded and/or GPS-denied environment,
(f) provide access for sensors below ice sheet: 1.5 m (Threshold)/15 m (Objective),
(g) deploy in difficult terrain such as swamps, desert, tundra, and snow or water bodies,
(h) endurance (switchable between modes):
- full operation: 168 hr (Threshold)/336 hr (Objective),
- sleep mode: 168 hr (Threshold)/336 hr (Objective,)

(i) real-time data output: longitude, latitude, altitude/height, velocity, sensor orientation (roll, pitch, yaw /heading), health status, calibrated raw data INS/GNSS (for post-processing),
(j) interfaces: RS422 (UART and HDLC/SDLC) Interfaces, CANaero/ARINC825/CAN, ARINC429, Ethernet (TCP/IP and UDP), SYNC-I/Os, and
(k) output and diagnostic measurement system included (full mission duration storage).
Phase I proposal should include envisioned conceptual overview, implementation/deployment vision, sensor selection, power distribution, data architecture, communication alerts, and notational software application.

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

PHASE I: Describe sensor configuration, power generation, deployment methodology and operational features. Define sensor requirements (magnetometer/gravimeter, hydrophone sensors, electric field sensors, EW Receiver/Emitter, seismometer) in terms of power, volume, weight, noise and motion limitations, water access methodology, and so forth. Identify specific sensors or sensor suites (1–6) to be included, and develop the strategy and design of integration and scale of the sensor platform and onboard processing/architecture. Describe communications, logistics, and maintenance strategy. Define the autonomous/data fusion signal processing requirements and communications to allow cooperative sensor array technology collaboration/formation. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the sensor platform scaled to accommodate 1–6 sensor suites, and validate the sensor integration in terms of physical implementation, electronics, and communications. Perform land/sea trials of individual and system level components in terms of performance, operational agility, and sensor integration. Develop the autonomous/data fusion signal processing requirements and communications defined in Phase I. Perform land/sea trial tests validating sensor data for detection of manned and unmanned platforms. Evaluate sensor performance using both single and multiunit deployment. Demonstrate ability to deploy on difficult terrain such as swamps, desert, tundra, and snow or water bodies.

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

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

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KEYWORDS: Arctic; Remote Sensing; Sensors; AI/ML; Data Fusion; Guard

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N24B-T030 TITLE: Wide Field-of-View, Compact Compound Meta-lenses for Visible-to-Near-Infrared Spectral Range and with 100X Size and Weight Reduction

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

OBJECTIVE: Develop a novel, extremely compact, and lightweight compound lens composed of multiple metasurfaces that permits an ultrawide field of view (FOV) for various imaging and surveillance applications in the visible and near-infrared spectral ranges.

DESCRIPTION: Wide-angle compound lenses, that can provide expanded FOV and keep scenes near and far in focus (large depth of focus), are important for military applications, such as surveillance and vision-based navigation. However, wide-angle lenses are notoriously difficult to create because they have relatively short focal lengths and relatively large lens components, compared to other types of compound lenses. To form images of scenes over a large solid angle while minimizing monochromatic aberrations, existing solutions typically utilize a large stack of aspherical refractive lenses. Even with sophisticated designs, wide-angle of view cameras with FOVs between 60°–110° often require mechanically moving components in order to provide a more comprehensive angular coverage.

It is the focus of this STTR topic to seek a much more promising disruptive technological solution to mitigate the legacy technology shortfalls of size, weight, and robustness issues of wide-angle of view cameras by exploring a wide-angle of coverage compound lens based on metasurface technology. Metasurfaces have recently emerged as a promising platform to realize advanced imaging functionalities [Ref 1]. A metasurface enables a designer to control light by exploiting strong interactions between light and 2D nanostructured thin films [Ref 2]. A metasurface is usually composed of a 2D array of densely-packed, nanoscale optical scattering elements (“meta-units”). The geometric degrees of freedom in the meta-units allow a designer to control a multitude of optical parameters, including the phase delay, amplitude, and polarization state. Therefore, a metasurface can engineer the optical wavefront in a predetermined fashion for the specific applications via the collective action of a 2D array of meta-units. Compared to a simple interface between two optical media, metasurfaces have superb capabilities to bend light beams by large angles with high efficiency [Ref 3], which makes them ideally suited for creating wide-angle of coverage and extremely compact imaging optics. In addition, dispersion engineering of meta-units allows metasurfaces to provide distinct phase profiles at different wavelengths [Ref 4], making it possible to create compound lenses that operate simultaneously at visible and near-infrared spectral bands for various daytime and nighttime operating conditions. The flat form factor of game changing metasurfaces can substantially decrease the weight of optical systems to as small as ~1 % of that of conventional systems based on traditional bulky refractive lenses. Metasurfaces can be fabricated with mature planar wafer-scale fabrication technologies pioneered by the semiconductor industry. That metasurface fabrications can leverage semiconductor manufacturing technology and its concomitant economy of scale represents a revolutionary improvement in low-cost scalable production, a marked departure from the very time consuming and costly legacy grinding and polishing processes currently used for lens manufacturing.

Despite their unique merits as an imaging platform, metasurfaces must overcome a couple of challenges to provide usable performance as wide-angle of coverage imaging optics. Metasurfaces rely on a spatial distribution of phase delay introduced by 2D arrays of subwavelength meta-units. The latter are typically designed without considering the near-field coupling between neighboring meta-units. In reality, a meta-unit is surrounded within subwavelength distances by distinct meta-units and the near-field interactions between them via optical evanescent waves can substantially perturb the local phase and amplitude responses of the meta-unit. This will lead to a deviation from the desired phase and amplitude profiles and could thus severely reduce the transmission efficiency of light through the metasurfaces and degrade the quality of the formed images. In addition, typical meta-unit designs assume light incidence at a normal angle to the metasurface plane; however, the angular optical response of meta-units can be far from that of a simple point source: the optical modes excited within a meta-unit vary as a function of incident angle, which will result in angularly dependent local phase and amplitude responses, with the ultimate consequence that a metasurface lens designed for normal incidence will fail to function properly at oblique incident angles. Thus, this STTR topic seeks an advanced design methodology where the near-field interactions and angular response of meta-units are taken into consideration while modeling optical response of metasurfaces [Ref 5] and an efficient algorithm is devised to determine the optimal arrangement of meta-units over the metasurface plane to minimize phase and amplitude errors due to near-field coupling over a wide range of incident angles.

Specifically, the meta-lens system should satisfy the following criteria: (a) for a collimated incident beam at a near-infrared wavelength (lambda = 940 nm) over an angular range of 50° (i.e., 100° FOV) in both the transverse directions, the focal spot produced by the meta-lens system should be diffraction limited (Strehl ratio > 0.8); (b) optical transmission through the meta-lens system should be higher than 75 %; (c) maximizing the focusing efficiency at the design wavelengths ranging from 450 nm to 750 nm in steps of 50 nm; (d) the first meta-lens layer of the system (i.e., optical aperture) should have a diameter of 1 mm, the focal distance (between the last meta-lens layer and the focal plane) should be 1 mm, and the entire meta-lens system should be less than 5 mm in thickness; and (e) the weight of the meta-lens system should be below 100 mg. The focusing efficiency, defined as the ratio of the integrated power over a circular aperture with diameter 18 µm (microns) in the focal plane to the total power over the lens aperture as a function wavelength.

Specifically, the camera system equipped with the meta-lens system should satisfy the following criteria: (a) for a collimated incident beam at three visible wavelengths (lambda=450, 550, and 650 nm) and one near-infrared wavelength (lambda=940 nm) over an angular range of 60° in both the transverse directions, the meta-lens should provide the same focal length and the focal spots should be diffraction limited (Strehl ratio > 0.8); (b) optical transmission through the meta-lens system should be higher than 85 % at the near-infrared wavelength and higher than 75 % at the visible wavelengths; (c) maximizing the focusing efficiency at the design wavelengths ranging from 450 nm to 750 nm in steps of 50 nm; (d) the first meta-lens layer of the system should have a diameter of 5 mm, the focal distance at both the visible and near-infrared wavelengths should be 2 mm, and the entire meta-lens system should be less than 7 mm in thickness; (e) the weight of the meta-lens alone should be below 500 mg; and (e) resolution of the camera should be at least 10 MP. The focusing efficiency, defined as the ratio of the integrated power over a circular aperture with diameter 18 µm (microns) in the focal plane to the total power over the lens aperture as a function wavelength.

In summary, this STTR topic seeks a solution to create wide-angle of coverage meta-lenses based on metasurfaces that offer the highest quality wide FOV lens for surveillance high-definition charged-coupled device (CCD) or Complementary metal–oxide–semiconductor (CMOS) cameras but with two orders of magnitude reduction in size and weight.

PHASE I: Demonstrate the efficacy of the new metasurface design methodology and the feasibility of a compound wide-FOV meta-lens system as described in the Description. Demonstrated quantitative agreement between the optical model and experiment, and completed a trade-space analysis that identified the optimal method for meta-lens system. Characterize component meta-atoms used in meta-lens system design. The Phase I effort should include prototype plans to be developed under Phase II.

PHASE II: Design, build prototypes, and demonstrate a high-definition CCD or CMOS camera system integrated with a compound wide-FOV meta-lens with dispersion engineered meta-units as described in the Description under natural sunlight and other broadband illumination conditions in Advanced Naval

Technology Exercise (ANTX) events. Produce a final report that includes a discussion of potential near-term and long-term development efforts that would improve technology performance and/or ease of fabrication; and also an evaluation of the cost of fabrication and how that might be reduced in the future. The prototypes should be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Design and demonstrate a producible metalens camera from Phase II and validate its resulting manufacturing readiness to be transitioned to a Program of Record. Support the Navy in transitioning the technology to Navy use.

The development of the optoelectronic image sensor has been a significant step towards the on-chip integration of cameras; however, the camera lenses are yet to be fully integrated with the image sensor. The freedom in controlling the metasurface phase profiles has enabled the implementation of spherical-aberration-free flat lenses that focus normally incident light to diffraction limited spots. Metasurface flat lenses are able to correct chromatic aberration over broad wavelength range, and to some degree reduce spherical aberration, coma, and other monochromatic aberrations, that would most likely revolutionize optical instrumentation. The prospect of largely shrinking the complexity and size of optical instruments (e.g., replacing the entire set of compound lenses in a camera lens with a few or even a single dispersion less and aberration-corrected flat lens) seems feasible in view of recent developments of metasurface lenses. Metasurface flat lenses will impact computational imaging, active wavefront manipulation, ultrafast spatiotemporal control of light, quantum communications, thermal emission management, novel display technologies, and sensing.

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KEYWORDS: metalenses; spectral; metasurfaces; imaging; surveillance; visible; near-infrared

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