DEPARTMENT OF DEFENSE
SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAM
STTR 22.A Program Broad Agency Announcement (BAA)

December 1, 2021: DoD BAA issued for pre-release
January 12, 2022: DoD begins accepting proposals
February 10, 2022: Deadline for receipt of proposals no later than **12:00 p.m. ET**

Participating DoD Components:

- Department of Navy (Navy)
- Department of Air Force (Air Force)
- Office of the Secretary of Defense – National Geospatial-Intelligence Agency (OSD – NGA)

IMPORTANT

Deadline for Receipt: Complete proposals must be certified and submitted in DSIP no later than **12:00 PM** ET, **February 10, 2022**. Proposals submitted after 12:00 PM ET will not be evaluated. The final proposal submission includes successful completion of all firm level forms, all required volumes, and electronic corporate official certification. Please plan to submit proposals as early as possible in order to avoid unexpected delays due to high volume of traffic during the final hours before the BAA close. DoD is not responsible for missed proposal submission due to system latency.

Classified proposals will not be accepted under the DoD STTR Program.

This BAA and the Defense SBIR/STTR Innovation Portal (DSIP) sites are designed to reduce the time and cost required to prepare a formal proposal. DSIP is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposers submitting through this site for the first time will be asked to register. Firms are required to register for a Login.gov account and link it to their DSIP account. See section 4.14 for more information regarding registration.

The Small Business Administration (SBA), through its SBIR/STTR Policy Directive, purposely departs from normal Government solicitation formats and requirements, thus authorizing agencies to simplify the SBIR/STTR award process and minimize the regulatory burden on small business. Therefore, consistent with the SBA SBIR/STTR Policy Directive, the Department of Defense is soliciting proposals as a Broad Agency Announcement.

SBIR/STTR Updates and Notices: To be notified of SBIR/STTR opportunities and to receive e-mail updates on the DoD SBIR and STTR Programs, you are invited to subscribe to our Listserv by visiting https://www.dodsbirsttr.mil/submissions/login and clicking "DSIP Listserv" located under Quick Links.

Questions: Visit the Learning & Support section of DSIP at https://www.dodsbirsttr.mil/submissions/learning-support/faqs for DoD SBIR or STTR program-related information. Email the DSIP Help Desk at DoDSBIRSupport@reisystems.com only for assistance with using DSIP. Questions regarding DSIP may be emailed to the DSIP Help Desk and will be addressed in the order received during normal operating hours (Monday through Friday, 9:00 a.m. to 5:00 p.m. ET). See section 4.13 for information on where to direct other BAA and topic-related questions.

TABLE OF CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

Navy, Air Force, and OSD-NGA, hereafter referred to as DoD Components, invite small business firms and research institutions to jointly submit proposals under this BAA for the Small Business Technology Transfer (STTR) Program. Firms with the capability to conduct research and development (R&D) in any of the defense-related topic areas described in this BAA and to commercialize the results of that R&D are encouraged to participate.

The STTR Program, although modeled substantially after the Small Business Innovation Research (SBIR) Program, is a separate program and is separately financed. Subject to availability of funds, DoD Components will support high quality cooperative research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector. Partnerships between small businesses and Historically Black Colleges and Universities (HBCUs) or Minority Institutions (MIs) are encouraged, although no special preference will be given to STTR proposals from such proposers.

This BAA is for Phase I proposals only. A separate BAA will not be issued requesting Phase II proposals, and unsolicited proposals will not be accepted. All firms that receive a Phase I award originating from this BAA will be eligible to participate in Phases II competitions and potential Phase III awards. DoD Components will notify Phase I awardees of the Phase II proposal submission requirements. Submission of Phase II proposals will be in accordance with instructions provided by individual Components. The details on the due date, content, and submission requirements of the Phase II proposal will be provided by the awarding DoD Component either in the Phase I award or by subsequent notification. If a firm submits their Phase II proposal prior to the dates provided by the individual Components, it may be rejected without evaluation.

DoD is not obligated to make any awards under Phase I, Phase II, or Phase III, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before the issuance of any award.

2.0 PROGRAM DESCRIPTION

2.1 Objectives

The objectives of the DoD STTR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

2.2 Technology and Program Protection to Maintain Technological Advantage

In accordance with DoD Instruction 5000.83, Technology and Program Protection to Maintain Technological Advantage, dated July 20, 2020, and as a means to counter the threat from strategic competitor nations, the DoD will employ risk-based measures to protect systems and technologies from adversarial exploitation and compromise of U.S. military vulnerabilities and weaknesses in: (1) systems, (2) components, (3) software, (4) hardware, and (5) supply chains. Any offeror submitting a proposal under this BAA will be required to disclose via self-report any foreign ownership or control. Offerors shall also require any proposed subcontractors included in their proposal under this BAA to disclose via self-report any foreign ownership or control. Reporting and disclosing such information will enable the DoD to identify national security risks posed by foreign participation, through investment, ownership, or influence, in the defense industrial base. This information will be used by DoD program offices to

determine risks posed by STTR contract awardees and their subcontractors to the DoD and the defense industrial base.

OUSD(R&E) Modernization Priorities

Focus Area	Description
5G	Technologies enabling the 5G spectrum to increase speed over current networks, to be more resilient and less susceptible to attacks, and to improve military communication and situational awareness.
Artificial Intelligence (AI)/ Machine Learning (ML)	Systems that perceive, learn, decide, and act on their own. Machine-learning systems with the ability to explain their rationale, characterize their strengths and weaknesses, and convey understanding of how they will behave in the future.
Autonomy	Technology that can deliver value by mitigating operational challenges such as: rapid decision making; high heterogeneity and/or volume of data; intermittent communications; high complexity of coordinated action; danger to mission; and high persistence and endurance.
Biotechnology	Biotechnology is any technological application that harnesses cellular and biomolecular processes. Most current biotech research focuses on agent detection, vaccines, and treatment. Future advances in biotechnology will improve the protection of both the general public and military personnel from biological agents, among numerous other potential applications.
Cybersecurity	Prevention of damage to, protection of, and restoration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communications, including information contained therein, to ensure its availability, integrity, authentication, confidentiality, and nonrepudiation.
Directed Energy (DE)	Technologies related to production of a beam of concentrated electromagnetic energy, atomic, or subatomic particles.
Hypersonics	Innovative concepts or technologies that enable, or directly support, weapons or aircraft that fly at or near hypersonic speeds and/or innovation that allows for enhancing defensive capability against such systems.
Microelectronics	Critical microcircuits used in covered systems, custom-designed, custom-manufactured, or tailored for specific military application, system, or environment.
Networked Command, Control, and Communications (C3)	Fully networked command control and communications including: command and control (C2) interfaces, architectures, and techniques (e.g., common software interfaces and functional architectures and improved C2 processing/decision making techniques); communications terminals (e.g., software-defined radio (SDRs)/apertures with multiple networks on the same band and multi-functional systems); and apertures and networking technologies (e.g., leveraging/managing a diverse set of links across multiple band and software defined networking/ network slicing).
Nuclear	Technologies supporting the nuclear triad-including nuclear command, control, and communications, and supporting infrastructure. Modernization of the nuclear force includes developing options to counter competitors' coercive strategies, predicated on the threatened use of nuclear or strategic non-nuclear attacks.
Quantum Science	Technologies related to matter and energy on the atomic and subatomic level. Areas of interest: clocks and sensors; networks; computing enabling technologies (e.g., low temperature amplifiers, cryogenics, superconducting circuits, photon detectors); communications (i.e., sending/receiving individual photons); and manufacturing improvements.
Space	Technologies supporting space, or applied to a space environment.
General Warfighting Requirements (GWR)	Warfighting requirements not meeting the descriptions above; may be categorized into Reliance 21 areas of interest.

The DoD SBIR/STTR Programs follow the policies and practices of the Small Business Administration (SBA) SBIR/STTR Policy Directive updated on October 1, 2020. The guidelines presented in this BAA incorporate and make use of the flexibility of the SBA SBIR/STTR Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to the DoD and the private sector. The SBIR/STTR Policy Directive is available at: https://www.sbir.gov/sites/default/files/SBA_SBIR_STTR_POLICY_DIRECTIVE_OCT_2020_0.pdf.

2.3 Three Phase Program

The STTR Program is a three-phase program. Phase I is to determine, to the extent possible, the scientific, technical, and commercial merit and feasibility of ideas submitted under the STTR Program. Phase I awards are made in accordance with the SBA Policy Directive guidelines, current version. The period of performance is generally between six to twelve months with twelve months being the maximum period allowable. Proposals should concentrate on research or research and development which will significantly contribute to proving the scientific and technical feasibility, and commercialization potential of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. Proposers are encouraged to consider whether the research or research and development being proposed to DoD Components also has private sector potential, either for the proposed application or as a base for other applications.

Phase II awards will be made to firms on the basis of results of their Phase I effort and/or the scientific merit, technical merit, and commercialization potential of the Phase II proposal. Phase II awards are made in accordance with the SBA Policy Directive guidelines, current version. The period of performance is generally 24 months. Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable prototype. A Phase II contractor may receive up to one additional, sequential Phase II award for continued work on the project.

Under Phase III, the Proposer is required to obtain funding from either the private sector, a non-STTR Government source, or both, to develop the prototype into a viable product or non-R&D service for sale in military or private sector markets. STTR Phase III refers to work that derives from, extends, or completes an effort made under prior STTR funding agreements, but is funded by sources other than the STTR Program. Phase III work is typically oriented towards commercialization of STTR research or technology.

3.0 DEFINITIONS

The following definitions from the SBA STTR Policy Directive and the Federal Acquisition Regulation (FAR) apply for the purposes of this BAA:

Commercialization

The process of developing products, processes, technologies, or services and the production and delivery (whether by the originating party or others) of the products, processes, technologies, or services for sale to or use by the Federal government or commercial markets.

Cooperative Research and Development

For the purposes of the STTR Program this means research and development conducted jointly by a small business concern and a research institution in which not less than 40% of the work is performed by the small business concern, and not less than 30% of the work is performed by the single research institution.

The percentage of work is usually measured by both direct and indirect costs; however, proposers should verify how it will be measured with their DoD contracting officer during contract negotiations.

Essentially Equivalent Work

Work that is substantially the same research, which is proposed for funding in more than one contract proposal or grant application submitted to the same Federal agency or submitted to two or more different Federal agencies for review and funding consideration; or work where a specific research objective and the research design for accomplishing the objective are the same or closely related to another proposal or award, regardless of the funding source.

Export Control

The International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, will apply to all projects with military or dual-use applications that develop beyond fundamental research, which is basic and applied research ordinarily published and shared broadly within the scientific community. More information is available at https://www.pmddtc.state.gov/ddtc_public.

NOTE: Export control compliance statements found in the individual Component-specific proposal instructions are not meant to be all inclusive. They do not remove any liability from the submitter to comply with applicable ITAR or EAR export control restrictions or from informing the Government of any potential export restriction as fundamental research and development efforts proceed.

Federal Laboratory

As defined in 15 U.S.C. §3703, means any laboratory, any federally funded research and development center (FFRDC), or any center established under 15 U.S.C. §§ 3705 & 3707 that is owned, leased, or otherwise used by a Federal agency and funded by the Federal Government, whether operated by the Government or by a contractor.

Foreign Entity

Foreign entity means any branch, partnership, group or sub-group, association, estate, trust, corporation or division of a corporation, non-profit, academic institution, research center, or organization established, directed, or controlled by foreign owners, foreign investors, foreign management, or a foreign government.

Foreign Government

Foreign government means any government or governmental body, organization, or instrumentality, including government owned-corporations, other than the United States Government or United States state, territorial, tribal, or jurisdictional governments or governmental bodies. The term includes, but is not limited to, non-United States national and subnational governments, including their respective departments, agencies, and instrumentalities.

Foreign Nationals

Foreign Nationals (also known as Foreign Persons) as defined by 22 CFR 120.16 means any natural person who is not a lawful permanent resident as defined by 8 U.S.C. § 1101(a)(20) or who is not a protected individual as defined by 8 U.S.C. § 1324b(a)(3). It also means any foreign corporation, business association, partnership, trust, society or any other entity or group that is not incorporated or

organized to do business in the United States, as well as international organizations, foreign governments and any agency or subdivision of foreign governments (e.g., diplomatic missions).

“Lawfully admitted for permanent residence” means the status of having been lawfully accorded the privilege of residing permanently in the United States as an immigrant in accordance with the immigration laws, such status not having changed.

"Protected individual’’ means an individual who (A) is a citizen or national of the United States, or (B) is an alien who is lawfully admitted for permanent residence, is granted the status of an alien lawfully admitted for temporary residence under 8 U.S.C. § 1160(a) or 8 U.S.C. § 1255a(a)(1), is admitted as a refugee under 8 U.S.C. § 1157, or is granted asylum under Section 8 U.S.C. § 1158; but does not include (i) an alien who fails to apply for naturalization within six months of the date the alien first becomes eligible (by virtue of period of lawful permanent residence) to apply for naturalization or, if later, within six months after November 6, 1986, and (ii) an alien who has applied on a timely basis, but has not been naturalized as a citizen within 2 years after the date of the application, unless the alien can establish that the alien is actively pursuing naturalization, except that time consumed in the Service's processing the application shall not be counted toward the 2-year period.

Fraud, Waste and Abuse

a. **Fraud** includes any false representation about a material fact or any intentional deception designed to deprive the United States unlawfully of something of value or to secure from the United States a benefit, privilege, allowance, or consideration to which an individual or business is not entitled.
b. **Waste** includes extravagant, careless or needless expenditure of Government funds, or the consumption of Government property, that results from deficient practices, systems, controls, or decisions.
c. **Abuse** includes any intentional or improper use of Government resources, such as misuse of rank, position, or authority or resources.
d. The STTR Program training related to Fraud, Waste and Abuse is available at: https://www.sbir.gov/tutorials/fraud-waste-abuse/tutorial-1. See Section 4.17 for reporting Fraud, Waste and Abuse.

Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal Agency and any small business concern for the performance of experimental, developmental, or research work, including products or services, funded in whole or in part by the Federal Government. Only the contract method will be used by DoD Components for all STTR awards.

Historically Black Colleges and Universities and Minority Institutions (HBCU/MI)

Listings for the Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are available through the Department of Education Web site, http://www.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

Certified HUBZone Small Business Concern

An SBC that has been certified by SBA under the Historically Underutilized Business Zones (HUBZone) Program (13 C.F.R. § 126) as a HUBZone firm listed in the Dynamic Small Business Search (DSBS).

Performance Benchmark Requirements for Phase I

Companies with multiple SBIR/STTR awards must meet minimum performance requirements to be eligible to apply for a new Phase I or Direct-to-Phase II award. The purpose of these requirements is to ensure that Phase I applicants that have won multiple prior SBIR/STTR awards are making progress towards commercializing the work done under those awards. The Phase I to Phase II Transition Rate addresses the extent to which an awardee progresses a project from Phase I to Phase II. The Commercialization Benchmark addresses the extent to which an awardee has moved past Phase II work towards commercialization. Additional information on performance benchmarking for Phase I applicants can be found at https://www.sbir.gov/performance-benchmarks.

Principal Investigator

The principal investigator/project manager is the one individual designated by the applicant to provide the scientific and technical direction to a project supported by the funding agreement.

For both Phase I and Phase II, the primary employment of the principal investigator must be with the small business firm or research institution at the time of award and during the conduct of the proposed project. Primary employment means that more than one-half of the principal investigator's time is spent in the employ of the small business firm or research institution. This precludes full-time employment with another organization. Occasionally, deviations from this requirement may occur, and must be approved in writing by the contracting officer after consultation with the agency SBIR/STTR Program Manager/Coordinator. Further, a small business firm or research institution may replace the principal investigator on an SBIR/STTR Phase I or Phase II award, subject to approval in writing by the contracting officer.

Proprietary Information

Proprietary information is information that you provide which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security.

Research Institution

Any organization located in the United States that is:

a. A university.
b. A nonprofit institution as defined in Section 4(5) of the Stevenson-Wydler Technology Innovation Act of 1980.
c. A contractor-operated federally funded research and development center, as identified by the National Science Foundation in accordance with the government-wide Federal Acquisition Regulation issued in accordance with Section 35(c)(1) of the Office of Federal Procurement Policy Act. A list of eligible FFRDCs is available at: https://www.nsf.gov/statistics/ffrdclist/.

Research or Research and Development

Any activity that is:

a. A systematic, intensive study directed toward greater knowledge or understanding of the subject studied.
b. A systematic study directed specifically toward applying new knowledge to meet a recognized need; or

c. A systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

Research Involving Animal Subjects

All activities involving animal subjects shall be conducted in accordance with DoDI 3216.01 "Use of Animals in DoD Programs," 9 C.F.R. parts 1-4 "Animal Welfare Regulations," National Academy of Sciences Publication "Guide for the Care & Use of Laboratory Animals," as amended, and the Department of Agriculture rules implementing the Animal Welfare Act (7 U.S.C. §§ 2131-2159), as well as other applicable federal and state law and regulation and DoD instructions.

"Animal use" protocols apply to all activities that meet any of the following criteria:

a. Any research, development, test, evaluation or training, (including experimentation) involving an animal or animals.
b. An animal is defined as any living or dead, vertebrate organism (non-human) that is being used or is intended for use in research, development, test, evaluation or training.
c. A vertebrate is a member of the subphylum Vertebrata (within the phylum Chordata), including birds and cold-blooded animals.

See DoDI 3216.01 for definitions of these terms and more information about the applicability of DoDI 3216.01 to work involving animals.

Research Involving Human Subjects

All research involving human subjects shall be conducted in accordance with 32 C.F.R. § 219 "The Common Rule," 10 U.S.C. § 980 "Limitation on Use of Humans as Experimental Subjects," and DoDI 3216.02 "Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research," as well as other applicable federal and state law and regulations, and DoD component guidance. Proposers must be cognizant of and abide by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as they regard vulnerable populations (DoDI 3216.02), recruitment of military research subjects (DoDI 3216.02), and informed consent and surrogate consent (10 U.S.C. § 980) and chemical and biological agent research (DoDI 3216.02). Food and Drug Administration regulation and policies may also apply.

"Human use" protocols apply to all research that meets any of the following criteria:

a. Any research involving an intervention or an interaction with a living person that would not be occurring or would be occurring in some other fashion but for this research.
b. Any research involving identifiable private information. This may include data/information/specimens collected originally from living individuals (broadcast video, web-use logs, tissue, blood, medical or personnel records, health data repositories, etc.) in which the identity of the subject is known, or the identity may be readily ascertained by the investigator or associated with the data/information/specimens.

See DoDI 3216.02 for definitions of these terms and more information about the applicability of DoDI 3216.02 to research involving human subjects.

Research Involving Recombinant DNA Molecules

Any recipient performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules shall comply with the National Institutes of Health Guidelines

for Research Involving Recombinant DNA Molecules, dated January 2011, as amended. The guidelines can be found at: https://osp.od.nih.gov/wp-content/uploads/2016/05/NIH_Guidelines.pdf. Recombinant DNA is defined as (i) molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in living cells or (ii) molecules that result from the replication of those described in (i) above.

Service-Disabled Veteran-Owned Small Business (SDVOSB)

A small business concern owned and controlled by a Service-Disabled Veteran or Service-Disabled Veterans, as defined in Small Business Act 15 USC § 632(q)(2) and SBA's implementing SDVOSB regulations (13 CFR 125).

Small Business Concern (SBC)

A concern that meets the requirements set forth in 13 C.F.R. § 121.702 (available here).

An SBC must satisfy the following conditions on the date of award:

a. Is organized for profit, with a place of business located in the United States, which operates primarily within the United States or which makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor;
b. Is in the legal form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust or cooperative, except that if the concern is a joint venture, each entity to the venture must meet the requirements set forth in paragraph (c) below;
c. Is more than 50% directly owned and controlled by one or more individuals (who are citizens or permanent resident aliens of the United States), other small business concerns (each of which is more than 50% directly owned and controlled by individuals who are citizens or permanent resident aliens of the United States), or any combination of these; and
d. Has, including its affiliates, not more than 500 employees. (For explanation of affiliate, see www.sba.gov/size.)

Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by an awardee of a funding agreement calling for supplies or services for the performance of the original funding agreement. This includes consultants.

Subcontractor

Subcontractor means any supplier, distributor, vendor, firm, academic institution, research center, or other person or entity that furnishes supplies or services pursuant to a subcontract, at any tier.

United States

"United States" means the fifty states, the territories and possessions of the Federal Government, the Commonwealth of Puerto Rico, the Republic of the Marshall Islands, the Federated States of Micronesia, the Republic of Palau, and the District of Columbia.

Women-Owned Small Business Concern

An SBC that is at least 51% owned by one or more women, or in the case of any publicly owned business, at least 51% of the stock is owned by women, and women control the management and daily business operations.

4.0 PROPOSAL FUNDAMENTALS

4.1 Introduction

The proposal must provide sufficient information to demonstrate to the evaluator(s) that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria. The proposed research or research and development must be responsive to the chosen topic, although it need not use the exact approach specified in the topic. Anyone contemplating a proposal for work on any specific topic should determine:

a. The technical approach has a reasonable chance of meeting the topic objective,
b. This approach is innovative, not routine, with potential for commercialization and
c. The proposing firm has the capability to implement the technical approach, i.e., has or can obtain people and equipment suitable to the task.

4.2 Proposer Eligibility and Performance Requirements

a. Each proposer must qualify as a small business concern as defined by 13 CFR §701-705 at time of award and certify to this on the Cover Sheet of the proposal. The eligibility requirements for the SBIR/STTR programs are unique and do not correspond to those of other small business programs (see Section 3 of this BAA). Proposers must meet eligibility requirements for Small Business Ownership and Control (see 13 CFR § 121.702 and Section 4.4 of this BAA).
b. A minimum of 40% of each STTR project must be conducted by the small business concern and a minimum of 30% of the effort performed by the single research institution, as defined in Section 3. The percentage of work is usually measured by both direct and indirect costs.
c. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm or the research institution at the time of award and during the conduct of the proposed effort. At the time of award of a Phase I or Phase II contract, the small business concern must have at least one employee in a management position whose primary employment is with the small business and who is not also employed by the research institution. Primary employment means that more than one half of the principal investigator's time is spent with the small business. Primary employment with a small business concern precludes full-time employment at another organization.
d. For both Phase I and Phase II, all research or research and development work must be performed by the small business concern and its subcontractors in the United States.
e. **Benchmarks**. Proposers with prior SBIR/STTR awards must meet two benchmark requirements for Progress towards Commercialization as determined by the Small Business Administration (SBA) on June 1 each year.

    (1) Phase I to Phase II Transition Rate: For all proposers with greater than 20 Phase I awards over the past five fiscal years excluding the most recent year, the ratio of Phase II awards to Phase I awards must be at least 0.25.

    (2) Commercialization Benchmark: For all proposers with greater than 15 Phase II awards over the last ten fiscal years excluding the last two years, the proposer must have received, to date, an average of at least $100,000 of sales and/or investments per Phase II award received or have received a number of patents resulting from the STTR work equal to or greater than 15% of the number of Phase II awards received during the period.

Consequence of failure to meet the benchmarks:

- SBA will identify and notify Agencies on June 1st of each year the list of companies which fail to meet minimum performance requirements. These companies will not be eligible to submit a proposal for a Phase I award for a period of one year from that date.
- Because this requirement only affects a company's eligibility for new Phase I awards, a company that fails to meet minimum performance requirements may continue working on its current ongoing SBIR/STTR awards and may apply for and receive new Phase II and Phase III awards.
- To provide companies with advance warning, SBA notifies companies on April 1st if they are failing the benchmarks. If a company believes that the information used was not complete or accurate, it may provide feedback through the SBA Company Registry at www.sbir.gov.
- In addition, SBA has posted a Guide to SBIR/STTR Program Eligibility to help small businesses understand program eligibility requirements, determine if they will be eligible at the time of award, and accurately complete necessary certifications.
- The benchmark information on the companies will not be available to the public.
- More detail is available at https://www.sbir.gov/performance-benchmarks.

f. A small business concern must negotiate a written agreement between the small business and the research institution allocating intellectual property rights and rights to carry out follow-on research, development, or commercialization (see Model Agreement for the Allocation of Rights).

4.3 Joint Ventures

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 13 U.S.C. § 121.701. Proposers must disclose joint ventures with existing (or planned) relationships/partnerships with any foreign entity or any foreign government-controlled companies.

4.4 Majority Ownership in Part by Multiple Venture Capital, Hedge Fund, and Private Equity Firms

Unless otherwise noted in the participating Component instructions, small businesses that are owned in majority part by multiple venture capital operating companies (VCOCs), hedge funds, or private equity funds are ineligible to submit applications or receive awards for opportunities in this BAA. Component instructions will specify if participation by a small business majority owned in part by VCOCs, hedge funds, or private equity funds is allowable **for a specific topic in the BAA**. If a Component authorizes such participation, any proposer that is owned, in whole in or in part, by any VCOC, hedge fund, and/or private equity fund must identify each foreign national, foreign entity, or foreign government holding or controlling greater than a 5% equity stake in the proposer, whether such equity stake is directly or indirectly held. The proposer must also identify any and all of its ultimate parent owner(s) and any other entities and/or individuals owning more than a 5% equity stake in its chain of ownership.

4.5 Conflicts of Interest

Contract awards to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees which may be a violation of federal law.

4.6 Organizational Conflicts of Interest

FAR 9.5 Requirements

In accordance with FAR 9.5, proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and any proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the BAA. The disclosure must include the proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations outlined in FAR 9.505-1 through FAR 9.505-4.

Agency Supplemental OCI Policy

In addition, DoD Components may have a supplemental OCI policy that prohibits contractors/performers from concurrently providing Scientific Engineering Technical Assistance (SETA), Advisory and Assistance Services (A&AS) or similar support services and being a technical performer. Therefore, as part of the FAR 9.5 disclosure requirement above, a proposer must affirm whether the proposer or any proposed team member (sub-awardee, consultant) is providing SETA, A&AS, or similar support to any DoD Component office(s) under: (a) a current award or sub-award; or (b) a past award or sub-award that ended within one calendar year prior to the proposal's submission date.

If SETA, A&AS, or similar support is being or was provided to any DoD Component office(s), the proposal must include:

- The name of the DoD Component office receiving the support;
- The prime contract number;
- Identification of proposed team member (sub-awardee, consultant) providing the support; and
- An OCI mitigation plan in accordance with FAR 9.5.

Government Procedures

In accordance with FAR 9.503, 9.504 and 9.506, the Government will evaluate OCI mitigation plans to avoid, neutralize or mitigate potential OCI issues before award and to determine whether it is in the Government's interest to grant a waiver. The Government will only evaluate OCI mitigation plans for proposals that are determined selectable under the BAA evaluation criteria and funding availability.

The Government may require proposers to provide additional information to assist the Government in evaluating the proposer's OCI mitigation plan.

> If the Government determines that a proposer failed to fully disclose an OCI; or failed to provide the affirmation of Government support as described above; or failed to reasonably provide additional information requested by the Government to assist in evaluating the proposer's OCI mitigation plan, the Government may reject the proposal and withdraw it from consideration for award.

4.7 Classified Proposals

Classified proposals will not be accepted under the DoD STTR Program. If topics will require classified work during Phase II, the proposing firm must have a facility clearance in order to perform the Phase II work. For more information on facility and personnel clearance procedures and requirements, please

visit the Defense Counterintelligence and Security Agency (DCSA) website at: https://www.dcsa.mil/mc/ctp/fc/.

4.8 Research Involving Human Subjects

All research involving human subjects, to include use of human biological specimens and human data, shall comply with the applicable federal and state laws and agency policy/guidelines for human subject protection (see Section 3).

Institutions to be awarded funding for research involving human subjects must provide documentation of a current Federal Assurance of Compliance with Federal regulations for human subject protection, for example a Department of Health and Human Services, Office for Human Research Protections Federalwide Assurance (http://www.hhs.gov/ohrp). Additional Federal Assurance documentation may also be requested by the awarding DoD Component. All institutions engaged in human subject research, to include subcontractors, must also have a valid Assurance. In addition, personnel involved in human subjects research must provide documentation of completing appropriate training for the protection of human subjects. Institutions proposing to conduct human subject research that meets one of the exemption criteria in 32 CFR 219.101 are not required to have a Federal Assurance of Compliance. Proposers should clearly segregate research activities involving human subjects from other research and development activities in their proposal.

If selected, institutions must also provide documentation of Institutional Review Board (IRB) approval or a determination from an appropriate official in the institution that the work meets one of the exemption criteria with 32 CFR 219. As part of the IRB review process, evidence of appropriate training for all investigators should accompany the protocol. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection and data analysis.

The amount of time required for the IRB to review and approve the protocol will vary depending on such things as the IRB's procedures, the complexity of the research, the level of risk to study participants and the responsiveness of the Investigator. The average IRB approval process can last between one and three months. Once the IRB has approved the research, the awarding DoD Component will review the protocol and the IRB's determination to ensure that the research will be conducted in compliance with DoD and DoD Component policies. The DoD review process can last between three to six months. Ample time should be allotted to complete both the IRB and DoD approval processes prior to recruiting subjects. **No funding can be used towards human subject research until ALL approvals are granted. Submitters proposing research involving human and/or animal use are encouraged to separate these tasks in the technical proposal and cost proposal in order to avoid potential delay of contract award.**

4.9 Research Involving Animal Subjects

All research, development, testing, experimentation, education or training involving the use of animals shall comply with the applicable federal and agency rules on animal acquisition, transport, care, handling, and use (see Section 3).

For submissions containing animal use, proposals should briefly describe plans for their Institutional Animal Care and Use Committee (IACUC) review and approval.

All Recipients must receive their IACUC's approval as well as secondary or headquarters-level approval by a DoD veterinarian who is trained or experienced in laboratory animal medicine and science. **No**

animal research may be conducted using DoD funding until all the appropriate DoD office(s) grant approval. Submitters proposing research involving human and/or animal use are encouraged to separate these tasks in the technical proposal and cost proposal in order to avoid potential delay of contract award.

4.10 Research Involving Recombinant DNA Molecules

All research involving recombinant DNA molecules shall comply with the applicable federal and state law, regulation and any additional agency guidance. Research shall be approved by an Institutional Biosafety Committee.

4.11 Debriefing/Technical Evaluation Narrative

After final award decisions have been announced, the technical evaluations of the submitter's proposal may be provided to the submitter. Please refer to the Component-specific instructions of your topics of interest for Component debriefing processes.

4.12 Pre-Award and Post Award BAA Protests

Interested parties have the right to protest as prescribed in FAR 33.106(b) and FAR 52.233-2. For purposes of pre-award protests related to the terms of this BAA, protests should be served to the Contracting Officer (listed below).

Ms. Chrissandra Smith
DoD SBIR/STTR BAA Contracting Officer
E-mail: chrissandra.smith.civ@mail.mil

NOTE: CONTACT FOR PROTESTS ONLY. All other inquires will not be answered or considered.

Washington Headquarters Services (WHS)
Acquisition Directorate
1155 Defense Pentagon
Washington, DC 20301-1155

For the purposes of a protest related to a selection or award decision, protests should be served to the point-of-contact (POC) listed in the instructions of the DoD Component that authored the topic.

For protests filed with the Government Accountability Office (GAO), a copy of the protest shall be submitted to the Contracting Officer listed above (pre-award ONLY) or DoD Component POC (selection/award decision ONLY) within one day of filing with the GAO. Protests of small business status of a selected firm may also be made to the Small Business Administration.

4.13 Phase I Award Information

All Phase I and Direct to Phase II proposals will be evaluated and judged on a competitive basis. Proposals will be initially screened to determine responsiveness. Proposals passing this initial screening will be technically evaluated by engineers or scientists to determine the most promising technical and scientific approaches. Each proposal will be judged on its own merit. DoD is under no obligation to fund any proposal or any specific number of proposals in a given topic. It also may elect to fund several or none of the proposed approaches to the same topic.

a. **Number of Phase I Awards**. The number of Phase I awards will be consistent with the Component's RDT&E budget. No Phase I contracts will be awarded until evaluation of all qualified proposals for a specific topic is completed.

b. **Type of Funding Agreement**. Each Phase I proposal selected for award will be funded under negotiated contracts or purchase orders and will include a reasonable fee or profit consistent with normal profit margins provided to profit-making firms for R/R&D work. Firm Fixed Price, Firm-Fixed-Price Level of Effort, Labor Hour, Time & Material, or Cost-Plus-Fixed-Fee type contracts can be negotiated and are at the discretion of the Component Contracting Officer.

c. **Dollar Value**. The Phase I contract value varies among the DoD Components; it is therefore important for proposing firms to review Component-specific instructions regarding award size.

d. **Timing.** Proposing firms will be notified of selection or non-selection status for a Phase I or DP2 award by the DoD Component that originated the topic within 90 days of the closing date for this BAA. Please refer to the Component-specific instructions for details.

The SBA SBIR/STTR Policy Directive, Section 7(c)(1)(ii), states that agencies should issue the Phase I award no more than 180 days after the closing date of the BAA. However, across DoD, the median time between the date that the STTR BAA closes and the award of a Phase I contract is approximately four months.

4.14 Questions about this BAA and BAA Topics

a. **General SBIR/STTR Questions/Information**.

(1) **DSIP Help Desk**:
Email the DSIP Help Desk at DoDSBIRSupport@reisystems.com for assistance with using DSIP. Questions regarding DSIP can be emailed to the DSIP Help Desk and will be addressed in the order received, during normal operating hours (Monday through Friday, 9:00 a.m. to 5:00 p.m. ET).

The DSIP Help Desk cannot provide updates to proposal status after submission, such as proposal selection/non-selection status or contract award status. Contact the DoD Component that originated the topic in accordance with the Component-specific instructions given at the beginning of that Component's topics.

(2) **Websites**:
The Defense SBIR/STTR Innovation Portal (DSIP) at https://www.dodsbirsttr.mil/submissions/login, which provides the following resources:

- SBIR and STTR Program Opportunities
- Topics Search Engine
- Topic Q&A
- All Electronic Proposal Submission for Phase I and Phase II Proposals. Firms submitting through this site for the first time will be asked to register on https://www.dodsbirsttr.mil/submissions.

DoD SBIR/STTR website at https://rt.cto.mil/rtl-small-business-resources/sbir-sttr/, which provides the following resources:

- SBIR and STTR Program Opportunities

- Dates for Current and Upcoming Opportunities
- Past SBIR and STTR Program Opportunities

(3) **SBIR/STTR Updates and Notices:**
To be notified of SBIR/STTR opportunities and to receive e-mail updates on the DoD SBIR and STTR Programs, subscribe to the Listserv by selecting "DSIP Listserv" under Quick Links on the DSIP login page.

b. **General Questions about a DoD Component**. General questions pertaining to a particular DoD Component and the Component-specific BAA instructions should be submitted in accordance with the instructions given at the beginning of that Component's topics, in Section 12.0 of this BAA.

c. **Direct Contact with Topic Authors.** From **December 1, 2021 to January 12, 2022,** this BAA is issued for pre-release with the names of the topic authors and their phone numbers and e-mail addresses. During the pre-release period, proposing firms have an opportunity to contact topic authors by telephone or e-mail to ask technical questions about specific BAA topics. Questions should be limited to specific information related to improving the understanding of a particular topic's requirements. Proposing firms may not ask for advice or guidance on solution approach and you may not submit additional material to the topic author. If information provided during an exchange with the topic author is deemed necessary for proposal preparation, that information will be made available to all parties through Topic Q&A. After this period questions must be asked through Topic Q&A as described below.

d. **Topic Q&A**. Once DoD begins accepting proposals on **January 12, 2022**, no further direct contact between proposers and topic authors is allowed, unless the Topic Author is responding to a question submitted during the pre-release period. However, proposers may submit written questions through Topic Q&A at https://www.dodsbirsttr.mil/submissions/login. In Topic Q&A, all questions and answers are posted electronically for general viewing. Identifying information for the questioner and respondent is not posted.

Questions submitted through the Topic Q&A are limited to technical information related to improving the understanding of a topic's requirements. Any other questions, such as those asking for advice or guidance on solution approach, or administrative questions, such as SBIR or STTR program eligibility, technical proposal/cost proposal structure and page count, budget and duration limitations, or proposal due date WILL NOT receive a response. Refer to the Component-specific instructions given at the beginning of that Component's topics for help with an administrative question.

Proposing firms may use the Topic Search feature on DSIP to locate a topic of interest. Then, using the form at the bottom of the topic description, enter and submit the question. Answers are generally posted within seven (7) business days of question submission (answers will also be e-mailed directly to the inquirer).

The Topic Q&A for this BAA opens on **December 1, 2021** and closes to new questions on **January 27, 2022 at 12:00 PM ET**. Once the BAA closes to proposal submission, no communication of any kind with the topic author or through Topic Q&A regarding your submitted proposal is allowed.

Proposing firms are advised to monitor Topic Q&A during the BAA period for questions and answers. Proposing firms should also frequently monitor DSIP for updates and amendments to the topics.

4.15 Registrations and Certifications

Proposing firms must be registered in the Defense SBIR/STTR Innovation Portal (DSIP) in order to prepare and submit proposals. All users will be required to register for a login.gov account and link it to their DSIP account. To register in Login.gov, click the Login/Register button in the top right corner on the DSIP Submissions homepage and follow the steps to register. If you already have a Login.gov account, you can link your existing Login.gov account with your DSIP account. Job Aids and Help Videos to walk you through the process are in the Learning & Support section of DSIP, here: https://www.dodsbirsttr.mil/submissions/learning-support/training-materials.

Please note that the email address you use for Login.gov should match the email address associated with your existing DSIP account. If you do not recall the email address associated with your DSIP account, or if you already have an existing Login.gov account using a different email address, you will need your Firm's DUNS number and your Firm PIN in order to link your Login.gov account with your DSIP account. If the email address associated with your existing DSIP account has been used for multiple DSIP accounts within your Firm, you will also need your Firm's DUNS number and your Firm PIN in order to link your Login.gov account with your DSIP account. The Firm PIN can be obtained from your Firm Admin. You can view the Firm Admin's contact information by entering your Firm's DUNS number when prompted. If you are the Firm Admin, please ensure that you contact all DSIP users in your Firm and provide them with the Firm PIN.

It is recommended that you complete your Login.gov setup as soon as possible to avoid any delays in your proposal submissions.

Before the DoD Components can award a contract, proposing firms must be registered in the System for Award Management (SAM). SAM allows firms interested in conducting business with the federal government to provide basic information on business structure and capabilities as well as financial and payment information. To register, visit www.sam.gov. It is in the firm's interest to visit SAM and ensure the firm's registration is active and representations and certifications are up-to-date to avoid delay in award.

SAM.gov merged into the modernized beta.SAM.gov environment on May 24, 2021. Legacy SAM.gov has been decommissioned and the new environment has retired the "beta" and is renamed SAM.gov. The system provides a modern portal for entities to register, update, renew, and check the status of their registration in the rebranded SAM.gov. Core functions of SAM and core data has not changed. Entities with an active registration do not need to take action and the process to register to do business with the government has not changed.

Follow instructions found during SAM registration on how to obtain a Commercial and Government Entry (CAGE) code and Data Universal Numbering System (DUNS) number. Once a CAGE code and DUNS number are obtained, update the firm's profile on the Defense SBIR/STTR Innovation Portal (DSIP) at https://www.dodsbirsttr.mil/submissions/.

In addition to the standard federal and DoD procurement certifications, the SBA STTR Policy Directive requires the collection of certain information from firms at time of award and during the award life cycle. Each firm must provide this additional information at the time of the Phase I and Phase II award, prior to final payment on the Phase I award, prior to receiving 50% of the total award amount for a Phase II award, and prior to final payment on the Phase II award.

4.16 Promotional Materials

Promotional and non-project related discussion is discouraged, and additional information provided via Universal Resource Locator (URL) links or on computer disks, CDs, DVDs, video tapes or any other medium will not be accepted or considered in the proposal evaluation.

4.17 Prior, Current, or Pending Support of Similar Proposals or Awards

IMPORTANT -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work (see Section 3) for consideration under numerous federal program BAAs or solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning prior, current, or pending support of similar proposals or awards, it must be disclosed to the soliciting agency or agencies as early as possible. See Section 5.4.c(11).

4.18 Fraud and Fraud Reporting

Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to $10,000, up to five years in prison, or both.

The Department of Defense, Office of Inspector General Hotline ("Defense Hotline") is an important avenue for reporting fraud, waste, abuse, and mismanagement within the Department of Defense. The Office of Inspector General operates this hotline to receive and investigate complaints or information from contractor employees, DoD civilians, military service members and public citizens. Individuals who wish to report fraud, waste or abuse may contact the Defense Hotline at (800) 424-9098 between 8:00 a.m. and 5:00 p.m. Eastern Time or visit http://www.dodig.mil/Components/Administrative-Investigations/DoD-Hotline/Hotline-Complaint/ to submit a complaint. Mailed correspondence should be addressed to the Defense Hotline, The Pentagon, Washington, DC 20301-1900, or e-mail addressed to hotline@dodig.mil.

4.19 State and Other Assistance Available

Many states have established programs to provide services to those small business firms and individuals wishing to participate in the Federal STTR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to STTR recipients;
- Assistance in obtaining Phase III funding.

Contact your State SBIR/STTR Support office at https://www.sbir.gov/state_services?state=105813# for further information. Small Businesses may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States.

4.20 Discretionary Technical and Business Assistance (TABA)

DoD has mandated the use of TABA pending further SBA guidance and establishment of a limit on the amount of technical and business assistance services that may be received or purchased by a small business concern that has received multiple Phase II SBIR or STTR awards for a fiscal year. However,

proposers should carefully review individual component instructions to determine if TABA is being offered and follow specific proposal requirements for requesting TABA funding.

5.0 PHASE I PROPOSAL

5.1 Introduction

This BAA and the Defense SBIR/STTR Innovation Portal (DSIP) sites are designed to reduce the time and cost required to prepare a formal proposal. DSIP is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposers submitting through this site for the first time will be asked to register. It is recommended that firms register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process.

Guidance on allowable proposal content may vary by Component. Accordingly, it is the proposing firm's responsibility to consult the Component-specific instructions for detailed guidance, including required proposal documentation, cost and duration limitations, budget structure, TABA allowance and proposal page limits.

DSIP provides a structure for providing the following proposal volumes:

Volume 1: Proposal Cover Sheet
Volume 2: Technical Volume
Volume 3: Cost Volume
Volume 4: Company Commercialization Report (upload of CCR from SBIR.gov to DSIP is required for proposers with prior Federal SBIR or STTR awards)
Volume 5: Supporting Documents

a. Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1)
b. Foreign Ownership or Control Disclosure (Proposers must review Attachment 2: Foreign Ownership or Control Disclosure to determine applicability.)
c. Other supporting documentation (Refer to Component-specific instructions for additional Volume 5 requirements)

Volume 6: Fraud, Waste and Abuse Training

All proposers must complete the following:

- Volume 4: Company Commercialization Report (upload of CCR from SBIR.gov to DSIP is required for proposers with prior Federal SBIR or STTR awards)
- Volume 5(a): Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1)
- Volume 5(b): Foreign Ownership or Control Disclosure (Proposers must review Attachment 2: Foreign Ownership or Control Disclosure to determine applicability)
- Volume 6: Fraud, Waste and Abuse training.

Refer to Section 5.3 below for full details on these proposal requirements.

A Phase I Proposal Template is available to provide helpful guidelines for completing each section of your Phase I technical proposal. This can be found at https://www.dodsbirsttr.mil/submissions/learning-support/firm-templates.

Detailed guidance on registering in DSIP and using DSIP to submit a proposal can be found at https://www.dodsbirsttr.mil/submissions/learning-support/training-materials. If the proposal status is "In Progress" or "Ready to Certify" it will NOT be considered submitted, even if all volumes are added prior to the BAA close date. The proposer may modify all proposal volumes prior to the BAA close date.

Although signatures are not required on the electronic forms at the time of submission the proposal must be certified electronically by the corporate official for it to be considered submitted. If the proposal is selected for award, the DoD Component program will contact the proposer for signatures at the time of award.

5.2 Marking Proprietary Proposal Information

Proposers that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall:

(1) Mark the first page of each Volume of the proposal submission with the following legend:

"This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed-in whole or in part-for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this proposer as a result of – or in connection with – the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained in pages [insert numbers or other identification of sheets]"; and

(2) Mark each sheet of data it wishes to restrict with the following legend:

"Use or disclosure of data contained on this page is subject to the restriction on the first page of this volume."

The DoD assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

Restrictive notices notwithstanding, proposals and final reports submitted through the Defense SBIR/STTR Innovation Portal (DSIP) may be handled, for administrative purposes only, by support contractors. All support contractors are bound by appropriate non-disclosure agreements.

5.3 Phase I Proposal Instructions

a. **Proposal Cover Sheet (Volume 1)**

On the Defense SBIR/STTR Innovation Portal (DSIP) at https://www.dodsbirsttr.mil/submissions/, prepare the Proposal Cover Sheet.

The Cover Sheet must include a brief technical abstract that describes the proposed R&D project and a discussion of anticipated benefits and potential commercial applications. Each section should be no more than 200 words. **Do not include proprietary or classified information in the Proposal Cover Sheet**. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released on the Internet. Once

the Cover Sheet is saved, the system will assign a proposal number. You may modify the cover sheet as often as necessary until the BAA closes.

b. **Format of Technical Volume (Volume 2)**

(1) **Type of file**: The Technical Volume must be a single Portable Document Format (PDF) file, including graphics. Perform a virus check before uploading the Technical Volume file. If a virus is detected, it may cause rejection of the proposal. **Do <u>not</u> lock or encrypt the uploaded file. Do not include or embed active graphics such as videos, moving pictures, or other similar media in the document.**

(2) **Length**: It is the proposing firm's responsibility to verify that the Technical Volume does not exceed the page limit after upload to DSIP. Please refer to Component-specific instructions for how a technical volume is handled if the stated page count is exceeded. Some Components will reject the entire technical proposal if the proposal exceeds the stated page count.

(3) **Layout**: Number all pages of your proposal consecutively. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal (no type smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins). The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by the Defense SBIR/STTR Innovation Portal (DSIP) when the Cover Sheet was created. The header may be included in the one-inch margin.

c. **Content of the Technical Volume (Volume 2)**

The Technical Volume should cover the following items <u>in the order given below</u>:

(1) **Identification and Significance of the Problem or Opportunity.** Define the specific technical problem or opportunity addressed and its importance.

(2) **Phase I Technical Objectives.** Enumerate the specific objectives of the Phase I work, including the questions the research and development effort will try to answer to determine the feasibility of the proposed approach.

(3) **Phase I Statement of Work (including Subcontractors' Efforts)**

a. Provide an explicit, detailed description of the Phase I approach. If a Phase I option is required or allowed by the Component, describe appropriate research activities which would commence at the end of Phase I base period should the Component elect to exercise the option. The Statement of Work should indicate what tasks are planned, how and where the work will be conducted, a schedule of major events, and the final product(s) to be delivered. The Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the Technical Volume section.

b. This BAA may contain topics that have been identified by the Program Manager as research or activities involving Human/Animal Subjects and/or Recombinant DNA. In the event that Phase I performance includes performance of these kinds of research or

activities, please identify the applicable protocols and how those protocols will be followed during Phase I. Please note that funds cannot be released or used on any portion of the project involving human/animal subjects or recombinant DNA research or activities until all of the proper approvals have been obtained (see Sections 4.7 - 4.9). **Submitters proposing research involving human and/or animal use are encouraged to separate these tasks in the technical proposal and cost proposal in order to avoid potential delay of contract award.**

(4) **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The technical volume must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following:
   a. Short description,
   b. Client for which work was performed (including individual to be contacted and phone number), and
   c. Date of completion.

(5) **Relationship with Future Research or Research and Development**
   a. State the anticipated results of the proposed approach if the project is successful.
   b. Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.
   c. Identify the applicable clearances, certifications and approvals required to conduct Phase II testing and outline the plan for ensuring timely completion of said authorizations in support of Phase II research or research and development effort.

(6) **Commercialization Strategy.** Describe in approximately one page your company's strategy for commercializing this technology in DoD, other Federal Agencies, and/or private sector markets. Provide specific information on the market need the technology will address and the size of the market. Also include a schedule showing the quantitative commercialization results from this STTR project that your company expects to achieve.

(7) **Key Personnel.** Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise technical resume of the principal investigator, including a list of relevant publications (if any), must be included (Please do not include Privacy Act Information). All resumes will count toward the page limitations for Volume 2.

(8) **Foreign Citizens.** Identify any foreign citizens or individuals holding dual citizenship expected to be involved on this project as a direct employee, subcontractor, or consultant. For these individuals, please specify their country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Proposers frequently assume that individuals with dual citizenship or a work permit will be permitted to work on an STTR project and do not report them. This is not necessarily the case and a proposal will be rejected if the requested information is not provided. Therefore, firms should report any and all individuals expected to be involved on this project that are considered a foreign national as defined in Section 3

of the BAA. You may be asked to provide additional information during negotiations in order to verify the foreign citizen's eligibility to participate on a STTR contract. Supplemental information provided in response to this paragraph will be protected in accordance with the Privacy Act (5 U.S.C. 552a), if applicable, and the Freedom of Information Act (5 U.S.C. 552(b)(6)).

(9) **Facilities/Equipment.** Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Justify equipment purchases in this section and include detailed pricing information in the Cost Volume. State whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name), and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

(10) **Subcontractors/Consultants.** Involvement of a research institution in the project is required and the institution should be identified and described according to the Cost Breakdown Guidance. A minimum of 40% of the research and/or analytical work in Phase I, as measured by direct and indirect costs, must be conducted by the proposing firm, unless otherwise approved in writing by the Contracting Officer. STTR efforts may include subcontracts with Federal Laboratories and Federally Funded Research and Development Centers (FFRDCs). A waiver is no longer required for the use of federal laboratories and FFRDCs; however, proposers must certify their use of such facilities on the Cover Sheet of the proposal.

(11) **Prior, Current, or Pending Support of Similar Proposals or Awards.** If a proposal submitted in response to this BAA is substantially the same as another proposal that was funded, is now being funded, or is pending with another Federal Agency, or another or the same DoD Component, you must reveal this on the Proposal Cover Sheet and provide the following information:

a. Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
b. Date of proposal submission or date of award.
c. Title of proposal.
d. Name and title of principal investigator for each proposal submitted or award received.
e. Title, number, and date of BAA(s) or solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
f. If award was received, state contract number.
g. Specify the applicable topics for each SBIR/STTR proposal submitted or award received.

Note: If this does not apply, state in the proposal "No prior, current, or pending support for proposed work."

d. **Content of the Cost Volume (Volume 3)**

Complete the Cost Volume by using the on-line cost volume form on the Defense SBIR/STTR Innovation Portal (DSIP). Some items in the Cost Breakdown Guidance may not apply to the proposed project. If that is the case, there is no need to provide information on each and every

item. What matters is that enough information be provided to allow us to understand how you plan to use the requested funds if a contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.

(2) While special tooling and test equipment and material cost may be included under Phases I, the inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Component Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.

(3) Cost for travel funds must be justified and related to the needs of the project.

(4) Cost sharing is permitted for proposals under this BAA; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

(5) A Phase I Option (if applicable) should be fully costed separately from the Phase I (base) approach.

(6) All subcontractor costs and consultant costs, such as labor, travel, equipment, materials, must be detailed at the same level as prime contractor costs. Provide detailed substantiation of subcontractor costs in your cost proposal. Volume 5, Supporting Documents, may be used if additional space is needed.

When a proposal is selected for award, you must be prepared to submit further documentation to the Component Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors). For more information about cost proposals and accounting standards, see https://www.dcaa.mil/Guidance/Audit-Process-Overview/.

e. **Company Commercialization Report (Volume 4)**

The Company Commercialization Report (CCR) allows companies to report funding outcomes resulting from prior SBIR and STTR awards. SBIR and STTR awardees are required by SBA to update and maintain their organization's CCR on SBIR.gov. Commercialization information is required upon completion of the last deliverable under the funding agreement. Thereafter, SBIR and STTR awardees are requested to voluntarily update the information in the database annually for a minimum period of 5 years.

If the proposing firm has prior DoD and/or non-DoD Phase I and/or Phase II SBIR/STTR awards, regardless of whether the project has any commercialization to date, a PDF of the CCR must be downloaded from SBIR.gov and uploaded to the Firm Forms section of DSIP by the Firm Admin. Firm Forms are completed by the DSIP Firm Admin and are applied across all proposals the firm submits. The DSIP CCR requirement is fulfilled by completing the following:

1. Log into the firm account at https://www.sbir.gov/.
2. Navigate to My Dashboard > My Documents to view or print the information currently contained in the Company Registry Commercialization Report.
3. Create or update the commercialization record, from the company dashboard, by scrolling to the "My Commercialization" section, and clicking the create/update Commercialization tab under "Current Report Version". Please refer to the "Instructions" and "Guide" documents contained in this section of the Dashboard for more detail on completing and updating the CCR. **Ensure the report is certified and submitted.**
4. Click the "Company Commercialization Report" PDF under the My Documents section of the dashboard to download a PDF of the CCR.
5. Upload the PDF of the CCR (downloaded from SBIR.gov in previous step) to the Company Commercialization Report in the Firm Forms section of DSIP. This upload action must be completed by the Firm Admin.

This version of the CCR, uploaded to DSIP from SBIR.gov, is inserted into all proposal submissions as Volume 4.

During proposal submission, the proposer will be prompted with the question: "Do you have a new or revised Company Commercialization Report to upload?". There are three possible courses of action:

a. If the proposing firm has prior DoD and/or non-DoD Phase I and/or Phase II SBIR/STTR awards, and **DOES have a new or revised CCR from SBIR.gov to upload to DSIP**, select YES.
   - If the user is the Firm Admin, they can upload the PDF of the CCR from SBIR.gov directly on this page. It will also be updated in the Firm Forms and be associated with all new or in-progress proposals submitted by the firm. If the user is not the Firm Admin, they will receive a message that they do not have access and must contact the Firm Admin to complete this action.
   - **WARNING:** Uploading a new CCR under the Firm Forms section of DSIP or clicking "Save" or "Submit" in Volume 4 of one proposal submission is considered a change for ALL proposals under any open BAAs or CSOs. If a proposing firm has previously certified and submitted any Phase I or Direct to Phase II proposals under ***any*** BAA or CSO ***that is still open***, those proposals will be automatically reopened. Proposing firms will have to recertify and resubmit such proposals. If a proposing firm does not recertify or resubmit such proposals, they will not be considered fully submitted and will not be evaluated.

b. If the proposing firm has prior DoD and/or non-DoD Phase I and/or Phase II SBIR/STTR awards, and **DOES NOT have a new or revised CCR from SBIR.gov to upload to DSIP**, select NO.
   - If a prior CCR was uploaded to the Firm Forms, the proposer will see a file dialog box at the bottom of the page and can view the previously uploaded CCR. This read-only access allows the proposer to confirm that the CCR has been uploaded by the Firm Admin.
   - If no file dialog box is present at the bottom of the page that is an indication that **there is no previously uploaded CCR in the DSIP Firm Forms**. To fulfill the DSIP CCR requirement the Firm Admin must follow steps 1-5 listed above to download a PDF of the CCR from SBIR.gov and upload it to the DSIP Firm Forms to be included with all proposal submissions.

c. If the proposing firm has **NO** prior DoD and/or non-DoD Phase I and/or Phase II SBIR/STTR awards, the upload of the CCR from SBIR.gov is not required and firm will select NO. The CCR section of the proposal will be marked complete.

While all proposing firms with prior DoD and/or non-DoD Phase I and/or Phase II SBIR/STTR awards must report funding outcomes resulting from these awards through the CCR from SBIR.gov and upload a copy of this report to their Firm Forms in DSIP, **please refer to the Component-specific instructions for details on how this information will be considered during proposal evaluations.**

f. **Supporting Documents (Volume 5)**

Volume 5 is provided for proposers to submit additional documentation to support the Technical Volume (Volume 2), and the Cost Volume (Volume 3).

All proposers are REQUIRED to submit the following documents to Volume 5:

1. Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1) (REQUIRED)
2. Foreign Ownership or Control Disclosure (BAA Attachment 2) (Proposers must review Attachment 2: Foreign Ownership or Control Disclosure to determine applicability)

Any of the following documents may be included in Volume 5 if applicable to the proposal. Refer to Component-specific instructions for additional Volume 5 requirements.

1. Letters of Support
2. Additional Cost Information
3. Funding Agreement Certification
4. Technical Data Rights (Assertions)
5. Lifecycle Certification
6. Allocation of Rights
7. Other

g. **Contractor Certification Regarding Provision of** Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment

The DoD must comply with Section 889(a)(1)(B) of the National Defense Authorization Act (NDAA) for Fiscal Year 2019, and is working to reduce or eliminate contracts with entities that use any equipment, system, or service that uses covered telecommunications equipment or services (as defined in BAA Attachment 1) as a substantial or essential component of any system, or as critical technology as part of any system.

All proposals must include certifications in Defense Federal Acquisition Regulation Supplement (DFARS) provisions 252.204-7016, 252.204-7017, and clause 252.204-7018, executed by the proposer's authorized company representative. These DFARS provisions and clauses may be found in BAA Attachment 1. **These certifications must be signed by the authorized company representative and uploaded as a separate PDF file in the supporting documents sections of Volume 5 for all proposal submissions.**

The effort to complete the required certification clauses includes due diligence on the part of the proposer and for any contractors that may be proposed as a part of the submission including research partners and suppliers. Therefore, proposers are strongly encouraged to review the requirements of these certifications early in the proposal development process. Failure to submit or complete the required certifications as a part of the proposal submission process may be cause for rejection of the proposal submission without evaluation.

h. Foreign Ownership or Control Disclosure

Proposers must review Attachment 2: Foreign Ownership or Control Disclosure to determine applicability. If applicable, an authorized firm representative must complete the Foreign Ownership or Control Disclosure (BAA Attachment 2). The completed and signed disclosure must be uploaded to Volume 5 of the proposal submission.

i. Fraud, Waste and Abuse Training (Volume 6)

The Fraud, Waste and Abuse (FWA) training is **required** for Phase I and Direct to Phase II proposals. FWA training provides information on what represents FWA in the SBIR/STTR program, the most common mistakes that lead to FWA, as well as the penalties and ways to prevent FWA in your firm. This training material can be found in the Volume 6 section of the proposal submission module in DSIP and must be thoroughly reviewed once per year. Plan ahead and leave ample time to complete this training based on the proposal submission deadline. FWA training must be completed by one DSIP firm user with read/write access (Proposal Owner, Corporate Official or Firm Admin) on behalf of the firm.

6.0 PHASE I EVALUATION CRITERIA

Proposals will be evaluated based on the criteria outlined below, unless otherwise specified in the Component-specific instructions. Selections will be based on best value to the Government considering the following factors which are listed in descending order of importance:

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.
c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

Cost or budget data submitted with the proposal will be considered during evaluation.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be included based on requirements provided in Component-specific instructions.

7.0 PHASE II PROPOSAL INFORMATION

7.1 Introduction

Unless the Component is participating in the Direct to Phase II, Phase II proposals may only be submitted by Phase I awardees. Submission of Phase II proposals are not permitted at this time and, if submitted, may be rejected without evaluation. Phase II proposal preparation and submission instructions will be provided by the DoD Components to Phase I awardees. See Component-specific instructions for more information on Direct to Phase II Program preparation and submission instructions.

7.2 Proposal Provisions

IMPORTANT -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program BAAs and solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies as early as possible. If a proposal submitted for a Phase II effort is substantially the same as another proposal that was funded, is now being funded, or is pending with another Federal Agency, or another or the same DoD Component, you must reveal this on the Cover Sheet and provide the information required in Section 5.4.c(11).

Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds, Head of Agency Determinations are now required before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact your original sponsoring agency before submitting a Phase II proposal to an agency other than the one who sponsored the original topic.

Section 4(b)(1)(i) of the SBIR/STTR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a BAA or solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact their designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. Agency disapproval of a request to change programs shall not be grounds for granting relief from any contractual performance requirement. All approved transitions between programs must be noted in the Phase II award or award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

7.3 Commercialization Strategy

At a minimum, your commercialization strategy must address the following five questions:

(1) What is the first product that this technology will go into?
(2) Who will be the customers, and what is the estimated market size?
(3) How much money will be needed to bring the technology to market, and how will that money be raised?
(4) Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
(5) Who are the proposing firm's competitors, and what is the price and/or quality advantage over those competitors?

The commercialization strategy must also include a schedule showing the anticipated quantitative commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its SBA Company Commercialization Report via "My Dashboard" on SBIR.gov at least annually. For information on formatting, page count and other details, please refer to the Component-specific instructions.

7.4 Phase II Evaluation Criteria

Phase II proposals will be evaluated based on the criteria outlined above in section 6.0, unless otherwise specified in the Component-specific instructions.

7.5 Phase II Award Information

DoD Components will notify Phase I awardees of the Phase II proposal submission requirements. Submission of Phase II proposals will be in accordance with instructions provided by individual Components. The details on the due date, content, and submission requirements of the Phase II proposal will be provided by the awarding DoD Component either in the Phase I award or by subsequent notification.

7.6 Adequate Accounting System

In order to reduce risk to the small business and avoid potential contracting delays, it is suggested that companies interested in pursuing Phase II SBIR/STTR contracts and other contracts of similar size with the Department of Defense (DoD), have an adequate accounting system per General Accepted Accounting Principles (GAAP), Generally Accepted Government Auditing Standards (GAGAS), Federal Acquisition Regulation (FAR) and Cost Accounting Standards (CAS) in place. The accounting system will be audited by the Defense Contract Audit Agency (DCAA). DCAA's requirements and standards are available on their Website at: https://www.dcaa.mil/Guidance/Audit-Process-Overview/ and https://www.dcaa.mil/Checklists-Tools/Pre-award-Accounting-System-Adequacy-Checklist/.

7.7 Phase II Enhancement Policy

To further encourage the transition of STTR research into DoD acquisition programs as well as the private sector, certain DoD Components have developed their own Phase II Enhancement policy. Under this policy, the Component will provide a Phase II awardee with additional Phase II STTR funding if the company can match the additional STTR funds with non-STTR funds from DoD acquisition programs or the private sector.

See component instructions for more details on Phase II Enhancement opportunities.

7.8 Commercialization Readiness Program (CRP)

The SBIR/STTR Reauthorization Act of 2011 establishes the Commercialization Pilot Program (CPP) as a long-term program titled the Commercialization Readiness Program (CRP).

Each Military Department (Army, Navy, and Air Force) has established a Commercialization Readiness Program. Please check the Component instructions for further information.

The Small Business and Technology Partnerships Office established the OSD Transitions SBIR Technology (OTST) Pilot Program. The OTST pilot program is an interim technology maturity phase (Phase II), inserted into the SBIR development.

For more information contact osd.ncr.ousd-r-e.mbx.sbir-sttr@mail.mil.

8.0 CONTRACTUAL REQUIREMENTS

8.1 Additional Contract Requirements

Small Business Concerns (SBCs) are strongly encouraged to engage with their Contracting/Agreements Office to determine what measures can be taken in the event contract performance is affected due to the COVID-19 situation. SBCs are encouraged to monitor the CDC Website, engage with your employees to share information and discuss COVID-19 concerns employees may have. Please identify to your Contracting/Agreements Officer potential impacts to the welfare and safety of your workforce and any contract/OT performance issues. Most importantly, keep in mind that only your Contracting/Agreements Officer can affect changes to your contract/OT.

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulation that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

Examples of general provisions:

a. **Standards of Work**. Work performed under the contract must conform to high professional standards.
b. **Inspection**. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.
c. **Examination of Records**. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.
d. **Default**. The Government may terminate the contract if the contractor fails to perform the work contracted.
e. **Termination for Convenience**. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.
f. **Disputes**. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.
g. **Contract Work Hours**. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).
h. **Equal Opportunity**. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.
i. **Affirmative Action for Veterans**. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran.
j. **Affirmative Action for Handicapped**. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. **Officials Not to Benefit**. No member of or delegate to Congress shall benefit from the contract.
l. **Covenant Against Contingent Fees**. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.
m. **Gratuities**. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.
n. **Patent Infringement**. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.
o. **Military Security Requirements**. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.
p. **American Made Equipment and Products**. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

Applicable Federal Acquisition Regulation (FAR) and/or Defense Federal Acquisition Regulation Supplement (DFARS) Clauses:

q. **Unique Identification (UID)**. If your proposal identifies hardware that will be delivered to the government be aware of the possible requirement for unique item identification in accordance with DFARS 252.211-7003.
r. **Disclosure of Information.** In accordance with FAR 252.204-7000, Government review and approval will be required prior to any dissemination or publication, except within and between the Contractor and any subcontractors, of classified and non-fundamental information developed under this contract or contained in the reports to be furnished pursuant to this contract.
s. **Animal Welfare**. Contracts involving research, development, test, evaluation, or training on vertebrate animals will incorporate DFARS clause 252.235-7002.
t. **Protection of Human Subjects**. Effective 29 July 2009, contracts that include or may include research involving human subjects in accordance with 32 CFR Part 219, DoD Directive 3216.02 and 10 U.S.C. 980, including research that meets exemption criteria under 32 CFR 219.101(b), will incorporate DFARS clause 252.235-7004.
u. **E-Verify**. Contracts exceeding the simplified acquisition threshold may include the FAR clause 52.222-54 "Employment Eligibility Verification" unless exempted by the conditions listed at FAR 22.1803.
v. **ITAR**. In accordance with DFARS 225.7901-4, Export Control Contract Clauses, the clause found at DFARS 252.225-7048, Export-Controlled Items (June 2013), must be included in all BAAs/solicitations and contracts. Therefore, all awards resulting from this BAA will include DFARS 252.225-7048. Full text of the clause may be found at https://www.govinfo.gov/content/pkg/CFR-2013-title48-vol3/pdf/CFR-2013-title48-vol3-sec252-225-7048.pdf.
w. **Cybersecurity**. Any SBC receiving an SBIR/STTR award is required to provide adequate security on all covered contractor information systems. Specific security requirements and cyber incident reporting requirements are listed in DFARS 252.204.7012. Compliance is mandatory.
x. **Safeguarding Covered Defense Information Controls.** As prescribed in DFARS 252.204-7008, for covered contractor information systems that are not part of an information technology service or system operated on behalf of the Government, the SBC represents that it will implement the security requirements specified by National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171, "Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations".
y. **Limitations on the Use or Disclosure of Third- Party Contractor Reported Cyber Incident Information.** As required in DFARS 252.204-7009, the Contractor must agree that certain

conditions apply to any information it receives or creates in the performance of a resulting contract that is information obtained from a third-party's reporting of a cyber incident pursuant to DFARS clause 252.204-7012, Safeguarding Covered Defense Information and Cyber Incident Reporting (or derived from such information obtained under that clause).

z. **Notice of NIST SP 800-171 DoD Assessment Requirements.** As prescribed by DFARS 252.204-7019, in order to be considered for award, the SBC is required to implement NIST SP 800-171. The SBC shall have a current assessment (see 252.204-7020) for each covered contractor information system that is relevant to the offer, contract, task order, or delivery order. The Basic, Medium, and High NIST SP 800-171 DoD Assessments are described in the NIST SP 800-171 DoD Assessment Methodology located at https://www.acq.osd.mil/dpap/pdi/cyber/strategically_assessing_contractor_implementation_of_NIST_SP_800-171.html. In accordance with DFARS 252.204-7020, the SBC shall provide access to its facilities, systems, and personnel necessary for the Government to conduct a Medium or High NIST SP 800-171 DoD Assessment, as described in NIST SP 800-171 DoD Assessment Methodology, linked above. Notification of specific requirements for NIST SP 800-171 DoD assessments and assessment level will be provided as part of the component instructions, topic, or award.

aa. **Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment.** In accordance with DFARS Subpart 204.21, DFARS provisions 252.204-7016, 252.204-7017, and clause 252.204-7018 are incorporated into this solicitation. This subpart implements section 1656 of the National Defense Authorization Act for Fiscal Year 2018 (Pub. L. 115-91) and section 889(a)(1)(A) of the National Defense Authorization Act for Fiscal Year 2019 (Pub. L. 115-232). Full text of the provisions and clause and required offeror representations can be found in Attachment 1 of this BAA.

bb. **Disclosure of Ownership or Control by a Foreign Government**. DFARS 252.209-7002, Disclosure of Ownership or Control by a Foreign Government (JUN 2010), is incorporated into this solicitation. In accordance with DFARS 252.209-7002, any SBC submitting a proposal in response to this solicitation is required to disclose, by completing Attachment 2 to this solicitation, Foreign Ownership or Control Disclosure, any interest a foreign government has in the SBC when that interest constitutes control by a foreign government, as defined in DFARS provision 252.209-7002. If the SBC is a subsidiary, it is also required to disclose any reportable interest a foreign government has in any entity that owns or controls the subsidiary, including reportable interest concerning the SBC's immediate parent, intermediate parents, and the ultimate parent.

8.2 Ensuring Adequate COVID-19 Safety Protocols for Federal Contractors

In accordance with Class Deviation 2021-O0009 implementing the direction provided by Executive Order 14042, the following clause 252.223-7999 will be incorporated into awards that: (a) exceed the simplified acquisition threshold of $250,000; and, (b) have been identified by the awarding DoD Component as meeting the applicability requirements as outlined in E.O. 14042 to ensure that contractors comply with all guidance for contractor and subcontractor workplace locations published by the Safer Federal Workforce Task Force at: https://www.saferfederalworkforce.gov/contractors/.

Covered contractors are cautioned to pay particular attention to "COVID 19 Workplace Safety: Guidance for Federal Contractors and Subcontractors" dated 24 September 2021 as promulgated by the Safer Federal Workforce Task Force.

252.223-7999 Ensuring Adequate COVID-19 Safety Protocols for Federal Contractors (Deviation 2021-O0009)

(a) *Definition*. As used in this clause –
United States or its outlying areas means—

(1) The fifty States;
(2) The District of Columbia;
(3) The commonwealths of Puerto Rico and the Northern Mariana Islands;
(4) The territories of American Samoa, Guam, and the United States Virgin Islands; and
(5) The minor outlying islands of Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Islands, Navassa Island, Palmyra Atoll, and Wake Atoll.

(b) *Authority*. This clause implements Executive Order 14042, Ensuring Adequate COVID Safety Protocols for Federal Contractors, dated September 9, 2021 (published in the *Federal Register* on September 14, 2021, 86 FR 50985).

(c) *Compliance*. The Contractor shall comply with all guidance, including guidance conveyed through Frequently Asked Questions, as amended during the performance of this contract, for contractor or subcontractor workplace locations published by the Safer Federal Workforce Task Force (Task Force Guidance) at *https:/www.saferfederalworkforce.gov/contractors/*.

(d) *Subcontracts*. The Contractor shall include the substance of this clause, including this paragraph (d), in subcontracts at any tier that exceed the simplified acquisition threshold, as defined in Federal Acquisition Regulation 2.101 on the date of subcontract award, and are for services, including construction, performed in whole or in part within the United States or its outlying areas.

8.3 Basic Safeguarding of Covered Contractor Information Systems

FAR 52.204-21, Basic Safeguarding of Covered Contractor Information Systems, is incorporated into this solicitation. In accordance with FAR 52.204-21, the contractor shall apply basic safeguarding requirements and procedures when the contractor or a subcontractor at any tier may have Federal contract information residing in or transiting through its information system.

FAR 52.204-21 Basic Safeguarding of Covered Contractor Information Systems (JUN 2016)

(a) Definitions. As used in this clause -

Covered contractor information system means an information system that is owned or operated by a contractor that processes, stores, or transmits Federal contract information.

Federal contract information means information, not intended for public release, that is provided by or generated for the Government under a contract to develop or deliver a product or service to the Government, but not including information provided by the Government to the public (such as on public Web sites) or simple transactional information, such as necessary to process payments.

Information means any communication or representation of knowledge such as facts, data, or opinions, in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audiovisual (Committee on National Security Systems Instruction (CNSSI) 4009).

Information system means a discrete set of information resources organized for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information (44 U.S.C. 3502).

Safeguarding means measures or controls that are prescribed to protect information systems.

(b) Safeguarding requirements and procedures.

(1) The Contractor shall apply the following basic safeguarding requirements and procedures to protect covered contractor information systems. Requirements and procedures for basic safeguarding of covered contractor information systems shall include, at a minimum, the following security controls:

(i) Limit information system access to authorized users, processes acting on behalf of authorized users, or devices (including other information systems).

(ii) Limit information system access to the types of transactions and functions that authorized users are permitted to execute.

(iii) Verify and control/limit connections to and use of external information systems.

(iv) Control information posted or processed on publicly accessible information systems.

(v) Identify information system users, processes acting on behalf of users, or devices.

(vi) Authenticate (or verify) the identities of those users, processes, or devices, as a prerequisite to allowing access to organizational information systems.

(vii) Sanitize or destroy information system media containing Federal Contract Information before disposal or release for reuse.

(viii) Limit physical access to organizational information systems, equipment, and the respective operating environments to authorized individuals.

(ix) Escort visitors and monitor visitor activity; maintain audit logs of physical access; and control and manage physical access devices.

(x) Monitor, control, and protect organizational communications (i.e., information transmitted or received by organizational information systems) at the external boundaries and key internal boundaries of the information systems.

(xi) Implement subnetworks for publicly accessible system components that are physically or logically separated from internal networks.

(xii) Identify, report, and correct information and information system flaws in a timely manner.

(xiii) Provide protection from malicious code at appropriate locations within organizational information systems.

(xiv) Update malicious code protection mechanisms when new releases are available.

(xv) Perform periodic scans of the information system and real-time scans of files from external sources as files are downloaded, opened, or executed.

(2) **Other requirements**. This clause does not relieve the Contractor of any other specific safeguarding requirements specified by Federal agencies and departments relating to covered contractor information systems generally or other Federal safeguarding requirements for controlled unclassified information (CUI) as established by Executive Order 13556.

(c) Subcontracts. The Contractor shall include the substance of this clause, including this paragraph (c), in subcontracts under this contract (including subcontracts for the acquisition of commercial items, other than commercially available off-the-shelf items), in which the subcontractor may have Federal contract information residing in or transiting through its information system.

8.4 Prohibition on Contracting with Persons that have Business Operations with the Maduro Regime

Section 890 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2020 prohibits entering into a contract for the procurement of products or services with any person that has business operations with an authority of the government of Venezuela that is not recognized as the legitimate government of Venezuela by the United States Government, unless an exception applies. See provision 252.225-7974 Class Deviation 2020-O0005 "Prohibition on Contracting with Persons that have Business Operations with the Maduro Regime.

8.5 Copyrights

With prior written permission of the Contracting Officer, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgment and disclaimer statement.

8.6 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a period of five years to allow the awardee to pursue a patent. See also Invention Reporting in Section 8.6.

8.7 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this BAA generally remain with the contractor, except that the Government obtains a royalty-free license to use such technical data only for Government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. This data should be marked with the restrictive legend specified in DFARS 252.227-7018. Upon expiration of the five-year restrictive license, the Government has unlimited rights in the STTR data. During the license period, the Government may not release or disclose STTR data to any person other than its support services contractors except: (1) For evaluation purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for

emergency repair or overhaul of items operated by the Government. See DFARS clause 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software – Small Business Technology Transfer (STTR) Program."

If a proposer plans to submit assertions in accordance with DFARS 252.227-7017, those assertions must be identified, and assertion of use, release, or disclosure restriction MUST be included with your proposal submission, at the end of the technical volume. The contract cannot be awarded until assertions have been approved.

8.8 Invention Reporting

STTR awardees must report inventions to the component within two months of the inventor's report to the awardee. The reporting of inventions may be accomplished by submitting paper documentation, including fax, or through the Edison Invention Reporting System at www.iedison.gov for those agencies participating in iEdison.

8.9 Final Technical Reports - Phase I through Phase III

a. **Content**: A final report is required for each project phase. The reports must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page," will be used as the first page of the report. submission resources at https://discover.dtic.mil/submit-documents/. In addition, monthly status and progress reports may be required by the DoD Component.

b. **SF 298 Form "Report Documentation Page" Preparation**:

(1) If desirable, language used by the company in its Phase II proposal to report Phase I progress may also be used in the final report.

(2) For each unclassified report, the company submitting the report should fill in Block 12 (Distribution/Availability Statement) of the SF 298, "Report Documentation Page," with the following statement: "Distribution authorized to U.S. Government only; Proprietary Information, (Date of Determination). Other requests for this document shall be referred to the Component SBIR/STTR Program Office."

Note: Data developed under an STTR contract is subject to STTR Data Rights which allow for protection under DFARS 252.227-7018 (see Section 8.5, Technical Data Rights). The sponsoring DoD activity, after reviewing the company's entry in Block 12, has final responsibility for assigning a distribution statement.

For additional information on distribution statements see the following Defense Technical Information Center (DTIC) Web site: https://discover.dtic.mil/wp-content/uploads/2018/09/distribution_statements_and_reasonsSept2018.pdf

(3) Block 14 (Abstract) of the SF 298, "Report Documentation Page" must include as the first sentence, "Report developed under STTR contract for topic [insert BAA topic number. [Follow with the topic title, if possible.]" The abstract must identify the purpose of the work and briefly describe the work conducted, the findings or results and the potential applications of the effort. **Since the abstract will be published by the DoD, it must not contain any proprietary or classified data and type "UU" in Block 17.**

(4) Block 15 (Subject Terms) of the SF 298 must include the term "STTR Report".

c. **Submission**: In accordance with DoD Directive 3200.12 and DFARS clause 252.235-7011, a copy of the final report shall be submitted (electronically or on disc) to:

Defense Technical Information Center
ATTN: DTIC-OA (SBIR/STTR)
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

Delivery will normally be within 30 days after completion of the Phase I technical effort.

Other requirements regarding submission of reports and/or other deliverables will be defined in the Contract Data Requirements List (CDRL) of each contract.

Special instructions for the submission of CLASSIFIED reports will be defined in the delivery schedule of the contract.DO NOT E-MAIL Classified or controlled unclassified reports, or reports containing STTR Data Rights protected under DFARS 252.227-7018.

ATTACHMENT 1

Department of Defense (DoD)
Small Business Innovation Research (SBIR) Program
Small Business Technology Transfer (STTR) Program

CONTRACTOR CERTIFICATION REGARDING PROVISION OF PROHIBITION ON CONTRACTING FOR CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT (DFARS SUBPART 204.21)

Contractor's Name	
Company Name	
Office Tel #	
Mobile #	
Email	

Name of person authorized to sign: _____

Signature of person authorized: _____

Date: _____

The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

DFARS PROVISIONS INCORPORATED IN FULL TEXT:

252.204-7016 Covered Defense Telecommunications Equipment or Services—Representation

COVERED DEFENSE TELECOMMUNICATIONS EQUIPMENT OR SERVICES—REPRESENTATION (DEC 2019)

(a) *Definitions*. As used in this provision, "covered defense telecommunications equipment or services" has the meaning provided in the clause 252.204-7018, Prohibition on the Acquisition of Covered Defense Telecommunications Equipment or Services.

(b) *Procedures*. The Offeror shall review the list of excluded parties in the System for Award Management (SAM) (https://www.sam.gov/) for entities excluded from receiving federal awards for "covered defense telecommunications equipment or services".

(c) *Representation*. The Offeror represents that it ☐ does, ☐ does not provide covered defense telecommunications equipment or services as a part of its offered products or services to the Government in the performance of any contract, subcontract, or other contractual instrument.

252.204-7017 Prohibition on the Acquisition of Covered Defense Telecommunications Equipment or Services—Representation

PROHIBITION ON THE ACQUISITION OF COVERED DEFENSE TELECOMMUNICATIONS EQUIPMENT OR SERVICES—REPRESENTATION (MAY 2021)

*The Offeror is not required to complete the representation in this provision if the Offeror has represented in the provision at 252.204-7016 , Covered Defense Telecommunications Equipment or Services—Representation, that it "**does not** provide covered defense telecommunications equipment or services as a part of its offered products or services to the Government in the performance of any contract, subcontract, or other contractual instrument."*

(a) *Definitions*. "Covered defense telecommunications equipment or services," "covered mission," "critical technology," and "substantial or essential component," as used in this provision, have the meanings given in the 252.204-7018 clause, Prohibition on the Acquisition of Covered Defense Telecommunications Equipment or Services, of this solicitation.

(b) *Prohibition*. Section 1656 of the National Defense Authorization Act for Fiscal Year 2018 (Pub. L. 115-91) prohibits agencies from procuring or obtaining, or extending or renewing a contract to procure or obtain, any equipment, system, or service to carry out covered missions that uses covered defense telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system.

(c) *Procedures*. The Offeror shall review the list of excluded parties in the System for Award Management (SAM) at https://www.sam.gov for entities that are excluded when providing any equipment, system, or service to carry out covered missions that uses covered defense telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system, unless a waiver is granted.

Representation. If in its annual representations and certifications in SAM the Offeror has represented in paragraph (c) of the provision at 252.204-7016 , Covered Defense Telecommunications Equipment or Services—Representation, that it "does" provide covered defense telecommunications equipment or services as a part of its offered products or services to the Government in the performance of any contract, subcontract, or other contractual instrument, then the Offeror shall complete the following additional representation:

The Offeror represents that it ☐will ☐will not provide covered defense telecommunications equipment or services as a part of its offered products or services to DoD in the performance of any award resulting from this solicitation.

(e) *Disclosures*. If the Offeror has represented in paragraph (d) of this provision that it "will provide covered defense telecommunications equipment or services," the Offeror shall provide the following information as part of the offer:

(1) A description of all covered defense telecommunications equipment and services offered (include brand or manufacturer; product, such as model number, original equipment manufacturer (OEM) number, manufacturer part number, or wholesaler number; and item description, as applicable).

(2) An explanation of the proposed use of covered defense telecommunications equipment and services and any factors relevant to determining if such use would be permissible under the prohibition referenced in paragraph (b) of this provision.

(3) For services, the entity providing the covered defense telecommunications services (include entity name, unique entity identifier, and Commercial and Government Entity (CAGE) code, if known).

(4) For equipment, the entity that produced or provided the covered defense telecommunications equipment (include entity name, unique entity identifier, CAGE code, and whether the entity was the OEM or a distributor, if known).

(End of provision)

252.204-7018 Prohibition on the Acquisition of Covered Defense Telecommunications Equipment or Services

PROHIBITION ON THE ACQUISITION OF COVERED DEFENSE TELECOMMUNICATIONS EQUIPMENT OR SERVICES (JAN 2021)

Definitions. As used in this clause—

"Covered defense telecommunications equipment or services" means—

(1) Telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation, or any subsidiary or affiliate of such entities;

(2) Telecommunications services provided by such entities or using such equipment; or

(3) Telecommunications equipment or services produced or provided by an entity that the Secretary of Defense reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

"Covered foreign country" means—

(1) The People's Republic of China; or

(2) The Russian Federation.

"Covered missions" means—

(1) The nuclear deterrence mission of DoD, including with respect to nuclear command, control, and communications, integrated tactical warning and attack assessment, and continuity of Government; or

(2) The homeland defense mission of DoD, including with respect to ballistic missile defense.

"Critical technology" means—

(1) Defense articles or defense services included on the United States Munitions List set forth in the International Traffic in Arms Regulations under subchapter M of chapter I of title 22, Code of Federal Regulations;

(2) Items included on the Commerce Control List set forth in Supplement No. 1 to part 774 of the Export Administration Regulations under subchapter C of chapter VII of title 15, Code of Federal Regulations, and controlled—

(i) Pursuant to multilateral regimes, including for reasons relating to national security, chemical and biological weapons proliferation, nuclear nonproliferation, or missile technology; or

(ii) For reasons relating to regional stability or surreptitious listening;

(3) Specially designed and prepared nuclear equipment, parts and components, materials, software, and technology covered by part 810 of title 10, Code of Federal Regulations (relating to assistance to foreign atomic energy activities);

(4) Nuclear facilities, equipment, and material covered by part 110 of title 10, Code of Federal Regulations (relating to export and import of nuclear equipment and material);

(5) Select agents and toxins covered by part 331 of title 7, Code of Federal Regulations, part 121 of title 9 of such Code, or part 73 of title 42 of such Code; or

(6) Emerging and foundational technologies controlled pursuant to section 1758 of the Export Control Reform Act of 2018 (50 U.S.C. 4817).

"Substantial or essential component" means any component necessary for the proper function or performance of a piece of equipment, system, or service.

(b) *Prohibition*. In accordance with section 1656 of the National Defense Authorization Act for Fiscal Year 2018 (Pub. L. 115-91), the contractor shall not provide to the Government any equipment, system, or service to carry out covered missions that uses covered defense

telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system, unless the covered defense telecommunication equipment or services are covered by a waiver described in Defense Federal Acquisition Regulation Supplement 204.2104.

(c) *Procedures*. The Contractor shall review the list of excluded parties in the System for Award Management (SAM) at https://www.sam.gov for entities that are excluded when providing any equipment, system, or service, to carry out covered missions, that uses covered defense telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system, unless a waiver is granted.

(d) *Reporting*.

(1) In the event the Contractor identifies covered defense telecommunications equipment or services used as a substantial or essential component of any system, or as critical technology as part of any system, during contract performance, the Contractor shall report at https://dibnet.dod.mil the information in paragraph (d)(2) of this clause.

(2) The Contractor shall report the following information pursuant to paragraph (d)(1) of this clause:

(i) Within 3 business days from the date of such identification or notification: the contract number; the order number(s), if applicable; supplier name; brand; model number (original equipment manufacturer number, manufacturer part number, or wholesaler number); item description; and any readily available information about mitigation actions undertaken or recommended.

(ii) Within 30 business days of submitting the information in paragraph (d)(2)(i) of this clause: any further available information about mitigation actions undertaken or recommended. In addition, the Contractor shall describe the efforts it undertook to prevent use or submission of a covered defense telecommunications equipment or services, and any additional efforts that will be incorporated to prevent future use or submission of covered telecommunications equipment or services.

(e) *Subcontracts*. The Contractor shall insert the substance of this clause, including this paragraph (e), in all subcontracts and other contractual instruments, including subcontracts for the acquisition of commercial items.

(End of clause)

ATTACHMENT 2

OMB No. 0704-0187
OMB approval expires
October 31, 2024

Department of Defense (DoD)
Small Business Innovation Research (SBIR) Program
Small Business Technology Transfer (STTR) Program

DISCLOSURE OF OFFEROR'S OWNERSHIP OR CONTROL BY A FOREIGN GOVERNMENT

In accordance with DFARS provision 252.209-7002, an offeror is required to disclose, by completing this form (and adding additional pages, as necessary), any interest a foreign government has in the offeror when that interest constitutes control by a foreign government, as defined in DFARS provision 252.209-7002. If the offeror is a subsidiary, it is also required to disclose any reportable interest a foreign government has in any entity that owns or controls the subsidiary, including reportable interest concerning the offeror's immediate parent, intermediate parents, and the ultimate parent.

DISCLOSURE		
Offeror's Point of Contact for Questions about Disclosure	Name:	
	Phone Number:	
Offeror	Name:	
	Address:	
Entity Controlled by a Foreign Government	Name:	
	Address:	
Description of Foreign Government's Interest in the Offeror		
Foreign Government's Ownership Percentage in Offeror		
Identification of Foreign Government(s) with Ownership or Control		

DFARS 252.209-7002 Disclosure of Ownership or Control by a Foreign Government (JUN 2010)

(a) Definitions. As used in this provision—

(1) "Effectively owned or controlled" means that a foreign government or any entity controlled by a foreign government has the power, either directly or indirectly, whether exercised or exercisable, to control the election, appointment, or tenure of the Offeror's officers or a majority of the Offeror's board of directors by any means, e.g., ownership, contract, or operation of law (or equivalent power for unincorporated organizations).

(2) "Entity controlled by a foreign government"—

(i) Means—

(A) Any domestic or foreign organization or corporation that is effectively owned or controlled by a foreign government; or

(B) Any individual acting on behalf of a foreign government.

(ii) Does not include an organization or corporation that is owned, but is not controlled, either directly or indirectly, by a foreign government if the ownership of that organization or corporation by that foreign government was effective before October 23, 1992.

(3) "Foreign government" includes the state and the government of any country (other than the United States and its outlying areas) as well as any political subdivision, agency, or instrumentality thereof.

(4) "Proscribed information" means—

(i) Top Secret information;

(ii) Communications security (COMSEC) material, excluding controlled cryptographic items when unkeyed or utilized with unclassified keys;

(iii) Restricted Data as defined in the U.S. Atomic Energy Act of 1954, as amended;

(iv) Special Access Program (SAP) information; or

(v) Sensitive Compartmented Information (SCI).

(b) Prohibition on award. No contract under a national security program may be awarded to an entity controlled by a foreign government if that entity requires access to proscribed information to perform the contract, unless the Secretary of Defense or a designee has waived application of 10 U.S.C. 2536(a).

(c) Disclosure. The Offeror shall disclose any interest a foreign government has in the Offeror when that interest constitutes control by a foreign government as defined in this provision. If the Offeror is a subsidiary, it shall also disclose any reportable interest a foreign government has in any entity that owns or controls the subsidiary, including reportable interest concerning the Offeror's immediate parent, intermediate parents, and the ultimate parent. Use separate paper as needed, and provide the information in the following format:

Offeror's Point of Contact for Questions about Disclosure
(Name and Phone Number with Country Code, City Code and Area Code, as applicable)

Name and Address of Offeror

Name and Address of Entity Controlled by a Foreign Government

Description of Interest, Ownership Percentage, and Identification of Foreign Government

(End of provision)

VERSION 4

DEPARTMENT OF THE NAVY (DON)
22.A Small Business Technology Transfer (STTR)
Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to STTR topics only:**
  - **N22A-T001 through N22A-T026**
- **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.

INTRODUCTION

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

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

The 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	Program Managers list in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic. Refer to the Proposal Fundamentals section of the DoD SBIR/STTR Program BAA for details.
	BAA Open	DoD SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions)

		Refer to the Proposal Fundamentals section of the DoD SBIR/STTR Program BAA for details.
Electronic submission to the DoD SBIR/STTR Innovation Portal (DSIP)	Always	DoD Help Desk via email at dodsbirsupport@reisystems.com
Navy-specific BAA instructions and forms	Always	Navy-sbir-sttr.fct@navy.mil

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

Topic Numbers	Point of Contact	SYSCOM	Email
N22A-T001 to N22A-T008	Mr. Shawn Slade (Acting)	Naval Air Systems Command (NAVAIR)	navair.sbir@navy.mil
N22A-T009 to N22A-T015	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N22A-T016 to N22A-T026	Mr. Steve Sullivan	Office of Naval Research (ONR)	onr-sbir-sttr.fct@navy.mil

PHASE I SUBMISSION INSTRUCTIONS

The following section details what is required for a Phase I proposal submission to the DoD SBIR/STTR Programs.

(NOTE: Proposers 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). Proposers 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. Proposers submitting through DSIP for the first time will be asked to register. It is recommended that firms register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Proposals that are not successfully certified electronically in DSIP by the Corporate Official prior to BAA Close will NOT be considered submitted and will not be evaluated by DON. Please refer to the DoD SBIR/STTR Program BAA for further information.

Proposal Volumes. The following six volumes are required.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR Program BAA.
- **Technical Proposal (Volume 2)**
  - Technical Proposal (Volume 2) must meet the following requirements or it 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.
- Phase I Base Period of Performance must be exactly six (6) months.
- Phase I Option Period of Performance must be exactly six (6) months.

- Additional information:
  - It is highly recommended that proposers 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, proposers 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 it 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 firm, and a minimum of 30% of the work is performed by the single research institution. The percentage of work is measured by both direct and indirect costs. To calculate the minimum percentage of effort for the proposing firm the sum of all direct and indirect costs attributable to the proposing firm represent the numerator and the total proposals costs (i.e., costs before profit or fee) is the denominator. The single research institution percentage is calculated by taking the sum of all costs attributable to the single research institution as the numerator and the total proposal costs (i.e., costs before profit or fee) as the denominator.
  - 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 proposers must review and submit the following items, as applicable:
  - **Telecommunications Equipment Certification.** Required for all proposers. 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 proposers 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.
  - **Disclosure of Offeror's Ownership or Control by a Foreign Government.** All proposers must review to determine applicability. In accordance with DFARS provision 252.209-7002, a proposer is required to disclose any interest a foreign government has in the proposer when that interest constitutes control by foreign government. All proposers must review the Foreign Ownership or Control Disclosure information to determine applicability. If applicable, an authorized firm representative must complete the Disclosure of Offeror's Ownership or Control by a Foreign Government (found in Attachment 2 of the DoD SBIR/STTR Program BAA) and upload as a separate PDF file in Volume 5. Please refer to instructions provided in the Phase I Proposal section of the DoD SBIR/STTR Program BAA.

  - Additional information:
    - Proposers 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 proposer may want to include in Volume 5:
      - Additional Cost Information to support the Cost Volume (Volume 3)
      - SBIR/STTR Funding Agreement Certification
      - Data Rights Assertion
      - Allocation of Rights between Prime and Subcontractor
      - Disclosure of Information (DFARS 252.204-7000)
      - Prior, Current, or Pending Support of Similar Proposals or Awards
      - Foreign Citizens
    - Do not include documents or information to substantiate the Technical Volume (Volume 2) (e.g., resumes, test data, technical reports, or publications). Such documents or information will not be considered.
    - A font size smaller than 10-point is allowable for documents in Volume 5; however, proposers 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.

VERSION 4

PHASE I EVALUATION AND SELECTION

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

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

- **Proposal Cover Sheet (Volume 1).** Not evaluated. The Cover Sheet (Volume 1) will undergo a compliance review (prior to evaluation) to verify the proposer has met eligibility requirements.

- **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. "Best value" is defined as approaches containing innovative technology solutions to the Navy's technical challenges for meeting its mission needs as reflected in the SBIR/STTR topics. This is not a FAR Part 15 evaluation and proposals will not be compared to one another. Cost is not an evaluation criteria and will not be considered during the evaluation process. 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 proposer has met the following requirements or it 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.
  - Phase I Base Period of Performance must be exactly six (6) months.
  - Phase I Option Period of Performance must be exactly six (6) months.

- **Cost Volume (Volume 3).** Not evaluated. The Cost Volume (Volume 3) will undergo a compliance review (prior to the proposal evaluation) to verify the proposer has complied with not to exceed values for the Base ($140,000) and Option ($100,000). Proposals exceeding either the Base or Option not to exceed values will be REJECTED without further consideration.

- **Company Commercialization Report (Volume 4).** Not evaluated.

- **Supporting Documents (Volume 5).** Not evaluated. Supporting Documents (Volume 5) will undergo a compliance review to ensure the proposer has included items in accordance with the PHASE I SUBMISSION INSTRUCTIONS section above.

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

VERSION 4

ADDITIONAL SUBMISSION CONSIDERATIONS

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

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. Firms may request, in their Phase I Cost Volume (Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award. The TABA amount, of up to $25,000, is to be included as part of the award amount and is limited by the established award values for Phase II by the SYSCOM (i.e. within the $1,700,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee by the proposer and must be inclusive of all applicable indirect costs. 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 TABA Report, detailing the results and benefits of the service received, will be required annually by October 30.

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
- Total TABA provider(s) cost, number of hours, and labor rates (average/blended rate is acceptable)

TABA must NOT:

- Be subject to any profit or fee by the STTR proposer
- Propose a TABA provider that is the STTR proposer
- Propose a TABA provider that is an affiliate of the STTR proposer
- Propose a TABA provider that is an investor of the STTR proposer
- Propose a TABA provider that is a subcontractor or consultant of the requesting firm 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 (Volume 5) – a detailed request for TABA (as specified above) specifically identified as “Discretionary Technical and Business Assistance” in the section titled Additional Cost Information.
- 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 "Discretionary Technical and Business Assistance" in the section titled Additional Cost Information.

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 proposer requests and is awarded TABA in a Phase II contract, the proposer 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 attend a one-day DON STP meeting during the first or second year of the Phase II contract. This meeting is typically held in the spring/summer in the Washington, D.C. area. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

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 proposer 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 firm 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 proposers 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, proposers should confirm that they are registered to receive contracts (not just grants) and the address in SAM matches the address on the proposal.

Notice of NIST SP 800-171 Assessment Database Requirement. The purpose of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 is to protect Controlled Unclassified Information (CUI) in Nonfederal Systems and Organizations. As prescribed by DFARS 252.204-7019, in order to be considered for award, a firm 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 proposer 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.onr.navy.mil/work-with-us/how-to-apply/compliance-protections/Research-Protections/Human-Subject-Research.aspx . 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 firm proposal 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. Protests of Phase I and II selections and awards must be directed to the cognizant Contracting Officer for the DON Topic Number, or filed with the Government Accountability Office (GAO). Contact information for Contracting Officers may be obtained from the DON SYSCOM Program Managers listed

in Table 2. If the protest is to be filed with the GAO, please refer to instructions provided in the Proposal Fundamentals section of the DoD SBIR/STTR Program BAA.

Protests to this BAA and proposal submission must be directed to the DoD SBIR/STTR Program BAA Contracting Officer, or filed with the GAO. Contact information for the DoD SBIR/STTR Program BAA Contracting Officer can be found in the Proposal Fundamentals section of the DoD SBIR/STTR Program BAA.

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 proposer, 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 firm per topic. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $1,700,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $1,700,000 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.

VERSION 4

PHASE II GUIDELINES

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

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

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

PHASE III GUIDELINES

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

VERSION 4

Navy STTR 22.A Phase I Topic Index

VERSION 4

N22A-T019	Enhanced Thermal, Mechanical, and Physical Properties of Ceramic Matrix Composites Through Novel Additives
N22A-T020	Lidar-like 3D Imaging System for Accurate Scene Understanding
N22A-T021	Affordable Stabilized Directional Antennas for Small Platforms
N22A-T022	High Resolution Underwater Optical Ranging
N22A-T023	Aquatic Soft Robotic STEM Education Kit
N22A-T024	Marine Atmospheric Boundary Layer Profiles via Satellite-based Remote Sensing Data Fusion
N22A-T025	Enhanced Long-Range Maritime Vessel Classification
N22A-T026	Low-Cost, Low-Power Vibration Monitoring and Novelty Detection

VERSION 4

N22A-T001 TITLE: Visual Display Design for Mitigation of Helicopter and Tiltrotor Brownout Spatial Disorientation

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Air Platforms;Human Systems

OBJECTIVE: Design, build, and demonstrate a vertical lift platform (i.e., helicopter or tiltrotor) cockpit visual display that mitigates spatial disorientation during brownout landings and takeoffs. The display must be compatible with DoD vertical lift/aircrew systems currently in use.

DESCRIPTION: The term “brownout” refers to degradation of out-the-window cockpit visibility during landings or takeoffs from areas with loose, dry, ground soil. During brownouts, loss of visibility occurs when a helicopter or tiltrotor’s main rotor blades stir up dirt, dust, or sand, which is then re-circulated through the blades and over the windscreen during low ground hover operations. The Joint Air Power Competence Centre (JAPCC) reported that the most dangerous action a helicopter pilot can take is land in brownout conditions. Additionally, it cited a USAF Institute of Technology report which states that the U.S. Department of Defense (DoD) had over 100 million USD in costs attributed to brownout mishaps. Furthermore, 65% of non-hostile fatalities have been from brownout hover and low speed flight. A final conclusion from the JAPCC’s report was that while many phases of helicopter flight can be performed with only instrument scanning, landing and hovering cannot [Ref 1].

During vertical hover landings or takeoffs with good outside visibility, rotary-wing and tiltrotor pilots maintain spatial orientation by using two types of outside visual cues. The first is a distant view of a horizontal reference that can be used for detecting unintended roll or pitch motions, and the second is a view of nearby fixed ground objects used as references for detecting unintended yaw, side drift, or forward and aft motion. With Visual Meteorological Conditions (VMC), primary spatial cues for rotary-wing and tiltrotor pilots are defined as fixed foveal views of distant (horizon) or near (ground) references. In contrast, secondary spatial cues have been defined as unstabilized peripherally viewed objects (such as cockpit components or outside airframe structures) that are perceived as being in motion as they change retinal position relative to the stabilized primary cue. Together, fixed primary and moving secondary spatial cues create a dynamic sight picture that allows pilots to use a VMC spatial strategy for determining aircraft attitude and directional rate of movement [Ref 2]. If visibility of either primary cue type is blocked by circulating particles within the rotor blade vortex ring, the pilot will suffer an immediate loss of critical spatial information, which unfortunately, also creates a high potential for spatial disorientation (SD) and incorrect control inputs.

When brownouts cause pilots to suddenly lose their outside visual cues seconds before touchdown, they are forced instantly to decide whether to attempt a rapid instrument transition or continue with an outside scan, hoping to see a visual ground reference seconds before setting down. Unfortunately, when transitioning from an outside view to head down instruments, the Federal Aviation Administration (FAA) has documented that establishing full instrument control after the loss of surface visual reference can take as much as 35 seconds [Ref 3]. With brownout conditions, sudden loss of the primary spatial cues (horizon and ground) and the limited time available to successfully transition to instruments, creates a high risk for SD.

Researchers have demonstrated that pilots exhibit specific reflexive head and eye movements that influence sight picture dynamics in a manner that aids with development of VMC spatial strategies [Refs 2, 4, and 5]. Brownout visual countermeasures that accommodate these normal pilot behaviors may help reduce pilot spatial problems known to occur with less than optimum display designs. To mitigate this

risk, the DoD is seeking a non-energy signature emitting visual display system with a presentation that will mimic pilot outside spatial strategies when encountering degraded visual environments (DVE).

Proposed display designs should enable a seamless transition time between real-world spatial cues and display symbology and consideration should be given for incorporation of flight path predictor type symbology. Design proposals should also describe, in general terms, compatibility with existing rotary-wing and tiltrotor systems such as (but not limited to): weight issues, cost estimate assessment, display transition time, and usability with both day and night conditions.

The prototype display should be constructed in a manner compatible with both stationary (non-motion) flight simulator and a motion-based flight simulator with six degrees of freedom (6DOF). The first stage of the evaluation should involve non-motion flight simulation with brownout conditions and the second stage should repeat stage one in a simulated flight environment with full 6DOF motion. Since the combined motion and visual environments of rotary-wing and tiltrotor brownout usually involve 6DOF, the Navy Disorientation Research Device (DRD) at the Naval Medical Research Unit Dayton, Wright-Patterson Air Force Base, Ohio, may be considered as a potential test facility for Phases II and III efforts. It is expected that a fully operational and complete (hardware and software) brownout mitigation visual display prototype will not require input from airframe emitted sensory energy and will operate using open-source software that is compatible with desktop Microsoft CPU systems. Device prototype and test subject raw performance data collected in ASCII format during test and evaluation with motion and non-motion based brownout simulations. Phase II final report that contains a detailed schematic and a complete description for operation of the brownout mitigation visual display system. The final report should also include a detailed analysis of the performance testing data collected during motion and non-motion brownout simulations.

Test and evaluation should demonstrate the prototype display capability for preventing SD during sudden and unexpected encounters with brownout conditions during high workload conditions. The experimental design for evaluating the working prototype should include DoD rotary-wing and tiltrotor pilots as test subjects and have a statistical power of 0.80 or higher. Dependent variables for display assessment should include, but not be limited to, pilot landing and takeoff tracking performance (roll, pitch, yaw, ascent, descent, airspeed, and drift), Opto-Kinetic Cervical Reflex (OKCR) response, eye tracking, Control Reversal Errors (CRE), subjective workload assessment, and motion sickness susceptibility.

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 Initial Phase II 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: Develop, describe, and define potential methodologies and designs for a visual display system that will prevent loss of spatial awareness during DVE encountered with brownout conditions. During the Phase I process, plans for designing an optimum visual countermeasure for brownout should take into consideration the types of cognitive processing pilots use with inflight spatial strategies, during both VMC and Instrument Meteorological Conditions (IMC). Provide detailed Phase I final report that includes concepts and plans to develop and test a brownout mitigation visual display for rotary-wing aircraft in stationary and 6DOF simulators. 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.

VERSION 4

PHASE II: Develop a working prototype visual display for mitigating or eliminating pilot SD during brownout takeoffs and landings.

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

PHASE III DUAL USE APPLICATIONS: Integrate display design into a 6DOF motion simulator and vertical lift platform. Final end user testing, validation, and verification of the display system in DVE conditions.

Private sector or corporate transportation services that utilize vertical lift platforms (i.e., helicopters) can experience degraded visual environments due to unexpected weather conditions or terrain challenges. These conditions can lead to mishaps due to resulting spatial disorientation. In addition, federal (e.g., USCG, DHS, FBI), state (National Guard units, Civil Air Patrol), or local (e.g., Firefighter/Paramedics, life flight) government search and rescue that utilize vertical lift platforms may benefit from the use of an advanced display design to mitigate spatial disorientation associated with DVE conditions. A secondary application may be in the display system used with unmanned aerial systems with vertical lift capabilities.

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2. Patterson, F. R., Cacioppo, A. J., Gallimore, J. J., Hinman, G. E., & Nalepka, J. P. (1997). "Aviation spatial orientation in relationship to head position and attitude interpretation." Aviation, Space, and Environmental Medicine, 68(6), 463–471. https://www.researchgate.net/publication/14033635_Aviation_spatial_orientation_in_relationship_to_head_position_and_attitude_interpretation.
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4. Patterson, F. R., & Muth, E. R. (2010, September 9). "Cybersickness onset with reflexive head movements during land and shipboard head-mounted display flight simulation, Report Number 10-43." Naval Aerospace Medical Research Laboratory. https://apps.dtic.mil/sti/pdfs/ADA528015.pdf.
5. Moore, S. T., MacDougall, H. G., Lesceu, X., Speyer, J. J., Wuyts, F., & Clark, J. B. (2008). "Head-eye coordination during simulated orbiter landing." Aviation, Space, and Environmental Medicine, 79(9), 888-898. https://doi.org/10.3357/ASEM.2209.2008.
6. Naval Medical Research Unit Dayton. (n.d.). "Disorientation research device: The Kraken(TM)." Retrieved March 24, 2021, from https://www.med.navy.mil/sites/nmrc/NAMRUDayton/Directorates/Admin/Pages/Disorientation-Research-Device.aspx.

KEYWORDS: Degraded visual environment; DVE; future vertical lift; spatial disorientation; display symbology; display design; human factors

VERSION 4

N22A-T002 TITLE: Multifunctional Heat Exchanger for Aerodynamic Aircraft Inlets

OUSD (R&E) MODERNIZATION PRIORITY: Directed Energy (DE);General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Air Platforms

OBJECTIVE: Develop an aerodynamic, multifunctional heat exchanger that is capable of dissipating a large amount of aircraft waste heat while improving inlet flow distortion upstream of a gas turbine engine.

DESCRIPTION: Inlet guide vanes offer a potentially attractive way to remove heat from aircraft and engine coolants. Doing so, however, adds complexity and volume to conventional guide vanes, which are also ill-suited for convoluted inlets with complex aerodynamics. The volume added to conventional guide vanes results in aerodynamic losses and weight penalties that can negate the gains from multifunctionality. More elegant, combined aerodynamic/heat exchanger solutions may be feasible given the current state-of-the-art in multi-objective optimization, additive manufacturing, and custom flow tailoring. Advanced diffuser designs often involve flow separation and large-scale unsteady flow features which reduce the diffuser efficiency and subject the downstream turbomachinery to extreme flow distortions. Solutions are sought for a new heat exchanger technology that can simultaneously improve inlet diffuser aerodynamic performance. The heat transfer and aerodynamic flow field characteristics of the proposed technology need to be fully understood to ensure gas turbine engine compatibility and enable future, advanced Navy propulsion systems.

The proposed solutions will be required to demonstrate the following criteria:

- Heat exchanger effectiveness greater than, or equal to, 0.4.
- A total pressure drop across the heat exchanger no greater than 8%.
- A decrease in the element average circumferential and radial distortions as defined in SAE AIR 1419C [Ref 5].
- The front face of the heat exchanger positioned no more than two (2) diameters upstream of the Aerodynamic Interface Plane (AIP).

Though not required criteria, proposed solutions are encouraged to consider impacts and capabilities on the air platform as a whole. Metrics such as weight, serviceability, propulsion performance, and working fluid are important aspects to overall feasibility and utility. Values are not imposed so that the design space is not overly constrained. It is advised that total system estimated weight (including installation and plumbing) not to exceed 50lbm, and must fit within an existing inlet geometry (Ref 3 may be used for a defined geometry).

It is recommended to collaborate with an original equipment manufacturer (OEM) for Phase II studies, and Phase III integrated testing to identify representative installation configurations and performance needs.

PHASE I: Demonstrate feasibility of the proposed technology through computational and system-level analysis of a proposed concept, and in a simplified flow environment at the bench level. Detailed benefits of this concept, relative to existing technologies, should be identified. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: A prototype device should be designed, built, and tested to evaluate heat exchanger effectiveness, pressure loss, and distortion reduction in a representatively complex inlet (serpentine, varying cross-sectional area and shape; Ref 3).

VERSION 4

PHASE III DUAL USE APPLICATIONS: Integrated test should be performed to evaluate the impact the multifunctional heat exchanger has on power plant performance. Transition the technology to applicable naval platform or lab.

Heat dissipation and flow straightening are not military specific concerns. Commercial aircraft/rotorcraft could also take advantage of this topic. Improvements to air flow into engines provide great operational safety and reliance for air vehicles.

Commercialization of this technology may include industrial applications for flow conditioning and heat exchangers, as well as advanced concepts for commercial transport aircraft and automotive applications.

This technology could also be applied for regenerative engine cycles. The ability to utilize the waste exhaust thermal energy of a power cycle to heat incoming air can provide an increase in cycle efficiency and decrease in fuel consumption. Additive manufacturing could provide the opportunity to retrofit existing systems to take advantage of regeneration.

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2. Nessler, C. A., Copenhaver, W. W., & List, M. G. (2013, January 7-10). "Serpentine diffuser performance with emphasis on future introduction to a transonic fan [Paper presentation]." In 51st AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition, Grapevine (Dallas/Ft. Worth Region), TX, United States. https://doi.org/10.2514/6.2013-219.
3. Maghsoudi, I., Mahmoodi, M., & Vaziri, M. A. (2020, January 28). "Numerical design and optimization of mechanical vane-type vortex generators in a serpentine air inlet duct." European Physical Journal Plus, 135(2), 139. https://doi.org/10.1140/epjp/s13360-020-00124-1.
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KEYWORDS: Thermal management; Inlets; Heat Exchangers; Propulsion Performance; Inlet Distortion; Additive Manufacturing

VERSION 4

N22A-T003 TITLE: Novel Multiphysics Modeling of Electroplating Process for Metallic Aerospace Components

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML)

TECHNOLOGY AREA(S): Air Platforms;Materials / Processes

OBJECTIVE: Develop a coupled electro-chemo-mechanical model to optimize electroplating parameters, and to predict the influence of surface roughness, porosities/defects, and residual stresses due to zinc-nickel (Zn-Ni) coating on fatigue strength of high strength steel (HSS) aerospace components.

DESCRIPTION: Naval aircraft operate routinely in a very severe saltwater environment, and corrosion damage is the leading cause affecting fleet readiness and total life cycle cost. The Navy spends about $3.7 billion a year on corrosion maintenance and repairs. Corrosion fatigue can also lead to catastrophic failures of aircraft primary structures. Electrodeposition of cadmium coating on high strength steel (HSS) components has been very effective in providing protection against corrosion. However, cadmium—a known carcinogen—creates environmental hazards, and occupational safety and health (OSH) risks. Recently, a new alkaline Zn-Ni coating process has been developed and shown promises as a suitable replacement for cadmium plating.

HSS alloys such as 300M and 4340 are susceptible to hydrogen embrittlement. During the electroplating process, the released hydrogen gas could be absorbed into the substrate, which can cause the loss of ductility, static, and fatigue strength of the base metal. Furthermore, hydrogen can also be absorbed into the HSS components when the coating corrodes in service. This hydrogen re-embrittlement (H-RE) mechanism could also lead to premature structural failures.

In addition, surface roughness, coating thickness/uniformity, porosities/microcracking, residual stresses, and pre- and post-treatment can have a significant impact on not only the effectiveness and durability of the coating system, but also on the components' fatigue performance. Electrolyte chemical composition, current density, part geometries, and anode-cathode placement/spacing and surface areas are also contributors to the plating variations.

Current process characterization, optimization, and qualification are predominantly empirical based requiring extensive testing, a costly and very time-consuming effort. This must be repeated for each of the HSS alloys.

The Navy requires an integrated suite of software tools that accelerate the optimization and qualification process, and quickly assess the impacts of electroplating on the structural integrity, including material properties and fatigue performance of HSS aircraft components (e.g., landing gears) subjected to naval operating environments. The modeling approach should consider the interplay between residual stresses, porosities/defects, and microstructure evolution on fatigue strength of the metallic materials. The proposed research should also provide a two-way coupling between the corrosion damage and mechanical stresses (internal/residual and externally applied) for capturing the synergistic effects of mechanical loading and corrosion on the integrity of the electroplated parts.
The specific aims are: (a) modeling residual stress generation during electrodeposition, (b) predicting fatigue strength of the base metal considering surface roughness, porosities/defects, and residual stresses, and (c) developing multiobjective optimization algorithm for the plating process.

PHASE I: Develop a modeling concept and computational framework for electrodeposition and optimization of Zn-Ni coating on a HSS (300M or 4340) structural component (e.g., landing gears). Demonstrate feasibility of the proposed concept to predict residual stresses, coating thicknesses, and

fatigue performance of the electroplated part under constant and variable amplitude spectra. Develop a qualification testing plan for the optimized coating. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop multiobjective optimization algorithm for electroplating process. Develop and demonstrate a beta software tool for electroplating Zn-Ni coating on HSS (300M or 4340) parts. Validate the model predictions with experimental test coupons and representative structural parts subjected to constant and variable amplitude spectra. Perform qualification testing for the optimized coating in accordance with the test plan developed in Phase I. Demonstrate by testing that the corrosion protection and fatigue performance of the optimized Zn-Ni plated component under constant amplitude and variable amplitude spectrum to be equivalent or better than the cadmium plated part.

PHASE III DUAL USE APPLICATIONS: Demonstrate the scalability and effectiveness of the tools for different HSS alloys such as Aermet100, 17-4PH and HYTUF. Perform qualification testing on a full-scale component to validate the software predictions. Transition the tools to U.S. Government depots and commercial industries.

In addition to aerospace, the transportation industry—such as automotive—will benefit greatly from this technology for optimizing plating of transmission gears made from high strength steel alloys for better corrosion and wear resistance performance.

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KEYWORDS: electroplating; zinc-nickel coating; high strength steel; fatigue strength; corrosion protection; wear resistance

VERSION 4

N22A-T004 TITLE: Automatic Hexahedral Mesh Generator for the Electromagnetic Modeling of Complex Navy Platforms with Array Antennas and Radomes

OUSD (R&E) MODERNIZATION PRIORITY: Networked C3

TECHNOLOGY AREA(S): Air Platforms

OBJECTIVE: Develop an advanced tool for automatically generating hexahedral meshes for high-fidelity simulation of electronically scanned array antennas on Navy platforms.

DESCRIPTION: Currently, many powerful fully automatic mesh generation tools are available that employ tetrahedral cells to mesh complex geometries, including full aircraft Computer-aided Design (CAD) models. These tetrahedral meshes are in general unable to provide the same level of solution accuracy as hexahedral meshes. Another important advantage of a hexahedral mesh over a tetrahedral mesh is the reduction in the number of elements for the same level of analysis accuracy. However, creating hexahedral meshes, especially for complex geometries such as full aircraft, is a tedious and time-consuming process that significantly burdens many realistic engineering analyses and design cycles.

Conducting performance analysis of very complex antennas on full aircraft configuration for Navy applications can be significantly improved by employing a hexahedral mesh. Such antennas include passive phased array (PESA), active electronically scanned array (AESA), hybrid beam forming phased array, and digital beam forming (DBF) array. These types of antennas have small-scale complex internal features that need to be precisely captured by a given mesh. At the same time, the location of these antennas on the aircraft is also important and needs to be optimized. As such, the combination of greatly varying mesh scales and the number simulations that need to be performed are significant factors that can take advantage of a hexahedral mesh that will allow for better accuracy with significantly reduced overall simulation time. The ability to produce highly accurate on-aircraft antenna responses at the element level (fractions of a dB in the main beam) while reducing run-time by adaptively meshing the model is critical. Taking advantage of the latest developments in hexahedral meshing technology [Refs 1–3] to create fully hexahedral or strongly hex-dominant (98% or more hex) meshes for applications involving installed phased array antennas on full aircraft configurations is a possible means to address this topic. The approach should provide capabilities to import CAD models (IGES, STEP, STL, etc.) and subsequent geometry cleanup and preparation for meshing. Provide capabilities to write out mesh in CGNS format for subsequent use with EM simulation tools.

PHASE I: Demonstrate the feasibility of an automatic hexahedral mesh, or a hexahedral dominant mesh generation tool, for simulation of complex phased array antennas on full aircraft platforms. Initiate development work on a user friendly Graphic User Interface (GUI) or integrate into an existing mesh generation tool to enable the user to efficiently (relative to that of existing commercial codes using tetrahedral meshing), set up a geometry model and create a hexahedral mesh capturing details of the antenna and aircraft geometry. The demonstration should compare accuracy of simulations using the hexahedral meshes with those using tetrahedral meshes for a variety of canonical electromagnetic problems.. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype hexahedral mesh generator tool. Continue work on further development and improvement of the algorithm initiated during Phase I. Complete the related GUI development work. Include performance metrics using advanced EM simulation tools to show expected performance efficiencies compared to conventional tetrahedral meshes. Show ease of use and operability utilizing realistic CAD models of installed phased array antennas on the aircraft. Provide the option of creating tetrahedral meshes as needed by the end user.

VERSION 4

PHASE III DUAL USE APPLICATIONS: Complete development, and perform final testing of a commercial grade application for use by radar, antenna, and computational electromagnetics engineers.

The approach is applicable to any electrically large complex system including commercial aircraft or automobiles.

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KEYWORDS: computational electromagnetics; Hexahedral Mesh; modeling and simulation; antennas; radome; antenna array

VERSION 4

N22A-T005 TITLE: Spatial Disorientation Assessment and Evaluation Tool

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Air Platforms;Human Systems

OBJECTIVE: Develop and validate a survey-based assessment tool aimed at measuring perceptions regarding the experience and severity of a spatial disorientation-related illusion, as well as to evaluate the effectiveness of knowledge/skill acquisition and attitudinal changes from spatial disorientation training protocols.

DESCRIPTION: Spatial disorientation (SD) is one of the most cited accident-causing factors in aviation and accounts for 33% of all aviation accidents [Ref 2]. This trend has increased over time due to the rise in licensed pilots and hours flown; however, little research has been done to address the measurement of knowledge, skills, and attitudes required to combat an SD incident. Rather, the majority of current and prior literature focuses on improving the technology utilized to improve SD training. While technological updates to modern SD training simulations have been shown to improve SD-related outcomes [Refs 3–6] (i.e., subjective identification of SD illusions, successful simulation, and elicitation of illusions), the lack of observational and survey scales to assess the true effect that SD training methods have on aviators is concerning. Specifically, no current or prior literature attempts to analyze and present the specific knowledge, skills, and abilities (KSA) that their study's training conditions were meant to target. This systematic lack of KSA identification during training assessment is concerning as they remain the most predictive and valid metrics of competencies that relate to an individual’s abilities to perform a task [Ref 1].

Recent advances in the SD training domain have sought to mitigate this challenge by producing a set of training competencies that are believed to be associated with SD training outcomes. A recent Training Systems Requirements Analysis focused on advanced spatial disorientation was developed via a subject matter expert review of prior SD training and competency literature. Various current and prior SD training programs also informed this analysis in order to ensure that the information taught in future SD training programs, to both indoctrination and refresher aviators, will improve their knowledge of SD, their skills in employing tactics against it, and their attitudes towards utilizing training and safety procedures for SD. However, while previous analyses provide the most comprehensive list of competencies for SD training to date, the competencies and methods of measuring said competencies have not undergone documented validation. Psychometric validation is a statistically quantitative process concerned with determining if the metrics utilized to measure latent constructs (i.e., illusion identification ability) are measuring latent constructs reliably and consistently. Without the validation of questions and behavioral observations to underpin analysis results, it is unclear whether the protocols will truly target key SD avoidance, mitigation, and countermeasure competencies required by aviators. Further, it is possible that without appropriate psychometric validation, future efforts will have opposing effects on SD training by missing key components of the required KSA.

Developing a validated SD assessment and evaluation tool provides an opportunity to formulate a data-driven method to both measure SD mitigation and countermeasure knowledge and behavior, while also providing a differential measurement to assess training effectiveness resulting in validated training methods. A software-based assessment tool would assist trainers in not only developing more effective training protocols and procedures, but also personalizing SD training feedback to student aviators. The final decision support tool product will enable a standardized, reliable, and valid measurement of real-time training SD episode mitigation and reaction knowledge and skills. The hardware and software must meet the system DoD accreditation and certification requirements to support processing approvals for use through the policy cited in Department of Defense Instruction (DoDI) 8510.01, Risk Management

Framework (RMF) for DoD Information Technology (IT) [Refs 7, 8], and comply with appropriate DoDI 8500.01, Cybersecurity [Refs 7, 8, 9]. Finally, research into the effectiveness of the instructional strategies and technologies developed based on these concepts is necessary to determine feasibility prior to transition.

PHASE I: Develop a psychometrically-based validation protocol to assess relevant SD competencies (e.g., application of procedures, communication, safety of flight management, automated and/or manual aircraft control, leadership, crew resource management, problem solving, decision making, situation awareness, workload management). Design the framework of the software-based tool to ensure a high level of end-user use reliability and usability. Develop the user-interaction architecture of the software tool for user input, output, and modification of the validated survey. Deploy psychometric validity testing. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a validated questionnaire and observation tool of SD mitigation and countermeasure KSA from validity testing. Incorporate the initial questionnaire and observation tool into the software-based application for prototype demonstration and testing. Deploy confirmatory testing of validated questionnaire and observation tool. Finalize the questionnaire and observational assessment tool.

PHASE III DUAL USE APPLICATIONS: Obtain management framework certification for an authority to operate to successfully transition to a NAVAIR program office. Based on Phase II results, finalize and refine the methodology (questionnaire/observation tool) and software developed to meet training requirements for a wider variety of SD events/scenarios or platforms to support transition and commercialization of the product. Investigate the potential of expanding the software-based application to validate additional relevant training environments to extend transition applicability.

The validation framework and evaluation software has applicability to commercial industries including commercial airlines and corporate training. Demonstration of a methodologically sound software technology to validate training system needs has broader DoD and commercial applicability.

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10. FREQUENTLY ASKED QUESTIONS https://navysbir.com/n22_a/N22A-T005_FAQs.pdf

KEYWORDS: Spatial disorientation; training; validated training methods; decision support tool; psychometric validation; training competencies

VERSION 4

N22A-T006 TITLE: Modeling Platform Level Electromagnetic Compatibility Performance Based on Component Level Testing

OUSD (R&E) MODERNIZATION PRIORITY: Networked C3

TECHNOLOGY AREA(S): Air Platforms

OBJECTIVE: Develop a simulation tool that will evaluate the risk to a platform given a component that has failed to meet its electromagnetic compatibility (EMC) test requirements (e.g., MIL-STD-461; [Ref 1]).

DESCRIPTION: In order to work toward successful platform level integration, there is a long-established workflow for EMC. In this procedure, individual electronic modules are designed and tested to certain standards, usually based on MIL-STD-461 [Ref 1], which impose limits on radiated and conducted emissions and radiated and conducted susceptibility. Any unit that passes those tests is assumed to be ready for integration onto the platform for its application with the expectation that it will not interfere with neighboring equipment and will operate in its intended electromagnetic environment.

As long as this process has been in place, there were countless examples of modules that failed to pass the mandated requirements. Each time this happens the standard process step was to instruct the supplier to redesign the module until it meets the specified requirements. However, there are often counter arguments that these redesigns can add cost, weight, and potentially jeopardize schedules. Engineers are often left to evaluate the potential risk of allowing a given noncompliant module to waive certain requirements based on past experience, personal judgement, and general heuristics.

The goal of this STTR effort is to give engineers in that position a tool that will allow them to take component-level testing data and model the potential effects when that module is placed in a realistically modeled platform. This involves developing a program to read in radiated emissions or susceptibility data from a test report. It would then create a model of a source or victim by backwards propagating the test data (usually taken at 1 m separation distance). That source or victim unit would then be placed in a model of the full platform with realistic grounding, bonding, and cable routing. A simulation would then be run to determine if emissions from the offending unit had negative impacts on neighboring systems or the external environment, or to see if the exterior electromagnetic environment would be likely to cause susceptibility upsets in the unit. The end result would not be to achieve an exact simulation result to compare to future testing, but instead to give engineers an analysis to show that the units' behavior will likely be severely noncompliant, marginal, or very benign. This will allow for more accurate data-driven risk assessments in the cases of noncompliant modules seeking waivers to requirements. An objective is to identify at least 90% of severely non-compliant situations using this simulation.

PHASE I: Develop a workflow that ties together all the necessary steps for the analysis: reading in test report data; converting it to a usable format; mathematically back-propagating the source or victim that yields the emissions or susceptibility profile; assigning those properties to a module that can be placed in a CAD model of a full platform with worst-case assumptions about grounding, bonding, and cable-routing; and running a simulation to compare the unit's performance to platform level requirements. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a prototype new user interface and computational engine for the simulation capabilities and integrate the capabilities into an existing simulation product. Validate the workflow developed in Phase I with historical data sets that show measurements of noncompliant components and full platforms tests performed with those components installed. Demonstrate the prototype in a lab or live environment.

VERSION 4

PHASE III DUAL USE APPLICATIONS: Complete development and perform final testing of a commercial grade application for use by platform level EMC engineers.

The simulation tool is suitable for electromagnetic compatibility evaluation of any civilian or military electronic system. Such system would be present on aircraft, ships, armored vehicles, space craft, automobiles, trucks, trains or even factories.

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KEYWORDS: electromagnetic compatibility; electronic vulnerability; electromagnetic interference; radiated emissions; radiated susceptibility; modeling and simulation.

VERSION 4

N22A-T007 TITLE: Heteroepitaxy of Indium Phosphide-Based Quantum Cascade Lasers on Silicon Substrates

OUSD (R&E) MODERNIZATION PRIORITY: Cybersecurity;General Warfighting Requirements (GWR);Microelectronics

TECHNOLOGY AREA(S): Materials / Processes

OBJECTIVE: Design and develop a heteroepitaxy growth process that enables epitaxial growth of high-performance and high-reliability Indium Phosphide-based Quantum Cascade Lasers on silicon substrates.

DESCRIPTION: Monolithic integration of Quantum Cascade Lasers (QCLs) on silicon (Si) would enable a mechanically stable substrate that could take advantage of the best of both worlds: existing high-performance Si-based electronic and optical circuits (e.g., multiple-function, high-speed electronic circuitry; low-loss passive Si optical waveguides; active Si optical modulators and phase-shifters; etc.); and III-V semiconductor-based photonics (e.g., high-performance QCLs, and photo-detectors, etc.). Such compact systems with monolithically integrated mid-infrared sources with Si electronics have applications in infrared countermeasures, integrated transceivers for free-space optical communications, phased-array beam-steerable sources for laser detection and ranging, various passive- and active-optical sensing systems, etc. Moreover, two- and three-photon absorption losses are minimal in the mid-infrared wavelength range, thereby enabling low-loss optical transmission over integrated Si waveguides.

Fabry-Perot (FP) [Ref 1] and distributed-feedback (DFB) [Ref 2] QCLs emitting at 4.6 μm have been demonstrated by wafer bonding on Silicon-on-Nitride-on-Insulator (SONOI) substrates. Transfer printing on silicon-on-sapphire has also enabled monolithic integration of mid-IR QCL on Si [Ref 3]. However, precise alignment limits further advance of such techniques making them less cost-effective. Direct heteroepitaxial growth of QCLs on Si would, potentially, offer a substantially lower cost, large-scale wafer-scale manufacturable approach for optoelectronic integration via growing III-V epitaxial layers on much cheaper and larger Si substrates, as the mature complementary metal oxide semiconductor (CMOS) processing on large Si wafers have proven excellent throughput and yields, thereby offering the most competitive performance and economic advantages.

Nevertheless, heteroepitaxy of III-V semiconductor alloys on Si is quite challenging due to: (a) 8% lattice mismatch between Indium Phosphide (InP) and Si; (b) 50% mismatch in thermal coefficient of expansion; and (c) the formation of antiphase boundaries and domains, which can occur during the growth of polar III-V compounds on nonpolar Si substrates. To overcome these issues, metamorphic-buffer-layers (MBLs) are generally required, which can provide a low-defect-density growth platform of same lattice constant as InP, for the subsequent growth of QCL device structures. Such approaches have been recently successful in realizing high-performance, quantum-dot, active-region diode lasers operating in the near-infrared wavelength regions (1.3-1.55 μm) on Si substrates [Ref 4]. III-V growth on patterned V-grooves alleviates the problems of antiphase domain formation and acts as a filter for dislocations and stacking faults [Ref 5]. Indium Arseide/Indium Aluminum Gallium Arsenide (InAs/InAlGaAs) quantum dots (QDs) have also shown to be effective threading-dislocation (TD) filters for InP MBLs [Ref 6]. However, there are very few studies reporting on direct growth of mid-IR QCLs on Si, in spite of the tremendous aforementioned size, performance, and cost advantages of the game-changing optoelectronic integration.

Molecular beam epitaxy-grown mid-IR QCLs, operating at low temperatures (170 K), have been demonstrated on Si substrates with 6°-miscut towards crystal orientation [111], by employing both a Germanium (Ge) buffer and a compositionally graded Aluminum Indium Arsenide (AlInAs) MBL to target the InP lattice constant [Ref 7]. MBLs, based on QD-dislocation filtering on exact (001) Si, have

also been employed for the growth of QCL active regions by MOCVD [Ref 8]. Residual threading dislocation densities have been estimated to be rather high (1E8 cm^2 range) in both cases. The use of (001)-oriented Si substrates is key to achieving compatibility with Si-CMOS processing. Since QCLs are unipolar devices, they are expected to be insensitive to nonradiative recombination centers. However, dislocations can perturb the QCL superlattice active region and thus interfere with the coherent tunneling process. Thus, it is the objective of this project to reduce the residual-dislocation densities substantially and provide a low-surface roughness platform for the growth of high-performance, high-reliability QCLs on Si, equal with the performance specifications of 5 Watts continuous wave (CW) output at room temperature, wall-plug efficiency no less than 25%, and almost diffraction-limited beam quality with M2 < 1.5.

PHASE I: Develop a path for achieving low-defect density (< 1 x 1E7 /cm^2) buffer layers on Si suitable for the growth of mid-IR QCLs. Complete the design of experiments for Phase II to establish room-temperature CW QCL operation on Si substrates. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Demonstrate room-temperature CW QCL operation on Si substrates employing direct-growth methods based on the epitaxial growth methods, and conditions, discovered in Phase I. The performance requirements of the QCL on Si substrates include 5 Watts CW output at room temperature, wall-plug efficiency no less than 25%, and almost diffraction-limited beam quality with M2 < 1.5.

PHASE III DUAL USE APPLICATIONS: Fabricate, test, and finalize the technology based on the design and demonstration results developed during Phase II. Develop a prototype using the finalized design and transition the technology with the final specifications for DoD applications in the areas of Directed Infrared Countermeasures (DIRCM), advanced chemicals sensors, and Laser Detection and Ranging (LIDAR).

The commercial sector can also benefit from this crucial, game-changing technology development of monolithic integration of QCLs with electronics on silicon substrate in the areas of detection of toxic gas environmental monitoring, non-invasive health monitoring and sensing, and industrial manufacturing processing.

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KEYWORDS: Silicon; quantum cascade laser; QCL; monolithic integration; complementary metal oxide semiconductor; CMOS; heteroepitaxial; distributed feedback

VERSION 4

N22A-T008 TITLE: Smart Image Recognition Sensor with Ultralow System Latency and Power Consumption

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR);Microelectronics;Quantum Science

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop a novel smart visual image recognition system that has intrinsic ultralow power consumption and system latency, and physics-based security and privacy.

DESCRIPTION: Image-based recognition in general requires a complicated technology stack, including lenses to form images, optical sensors for opto-to-electrical conversion, and computer chips to implement the necessary digital computation process. This process is serial in nature, and hence, is slow and burdened by high-power consumption. It can take as long as milliseconds, and require milliwatts of power supply, to process and recognize an image. The image that is digitized in a digital domain is also vulnerable to cyber-attacks, putting the users' security and privacy at risk. Furthermore, as the information content of images needs to be surveilled and reconnoitered, and continues to be more complex over time, the system will soon face great challenges in system bottleneck regarding energy efficiency, system latency, and security, as the existing digital technologies are based on digital computing, because of the required sequential analog-to-digital processing, analog sensing, and digital computing.

It is the focus of this STTR topic to explore a much more promising solution to mitigate the legacy digital image recognition latency and power consumption issues via processing visual data in the optical domain at the edge. This proposed technology shifts the paradigm of conventional digital image processing by using analog instead of digital computing, and thus can merge the analog sensing and computing into a single physical hardware. In this methodology, the original images do not need to be digitized into digital domain as an intermediate pre-processing step. Instead, incident light is directly processed by a physical medium. An example is image recognition [Ref 1], and signal processing [Ref 2], using physics of wave dynamics. For example, the smart image sensors [Ref 1] have judiciously designed internal structures made of air bubbles. These bubbles scatter the incident light to perform the deep-learning-based neuromorphic computing. Without any digital processing, this passive sensor can guide the optical field to different locations depending on the identity of the object. The visual information of the scene is never converted to a digitized image, and yet the object can be identified in this unique computation process. These novel image sensors are extremely energy efficient (a fraction of a micro Watt) because the computing is performed passively without active use of energy. Combined with photovoltaic cells, in theory, it can compute without any energy consumption, and a small amount of energy will be expended upon successful image recognition and an electronic signal needs to be delivered to the optical and digital domain interface. It is also extremely fast, and has extremely low latency, because the computing is done in the optical domain. The latency is determined by the propagation time of light in the device, which is on the order of no more than hundreds of nanoseconds. Therefore, its performance metrics in terms of energy consumption and latency are projected to exceed those of conventional digital image processing and recognition by up to at least six orders of magnitude (i.e., 100,000 times improvement). Furthermore, it has the embedded intrinsic physics-based security and privacy because the coherent properties of light are exploited for image recognition. When these standalone devices are connected to system networks, cyber hackers cannot gain access to original images because such images have never been created in the digital domain in the entire computation process. Hence, this low-energy, low-latency image sensor system is well suited for the application of 24/7 persistent target recognition surveillance system for any intended targets.

VERSION 4

In summary, these novel image recognition sensors, which use the nature of wave physics to perform passive computing that exploits the coherent properties of light, is a game changer for image recognition in the future. They could improve target recognition and identification in degraded vision environment accompanied by heavy rain, smoke, and fog. This smart image recognition sensor, coupled with analog computing capability, is an unparalleled alternative solution to traditional imaging sensor and digital computing systems, when ultralow power dissipation and system latency, and higher system security and reliability provided by analog domain, are the most critical key performance metrics of the system.

PHASE I: Develop, design, and demonstrate the feasibility of an image recognition device based on a structured optical medium. Proof of concept demonstration should reach over 90% accuracy for arbitrary monochrome images under both coherent and incoherent illumination. The computing time should be less than 10 μs. The throughput of the computing is over 100,000 pictures per second. The projected energy consumption is less than 1 mW. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design image recognition devices for general images, including color images in the visible or multiband images in the near-infrared (near-IR). The accuracy should reach 90% for objects in ImageNet. The throughput reaches over 10 million pictures per second with computation time of 100 ns and with an energy consumption less than 0.1 mW. Experimentally demonstrate working prototype of devices to recognize barcodes, handwritten digits, and other general symbolic characters. The device size should be no larger than the current digital camera-based imaging system.

PHASE III DUAL USE APPLICATIONS: Fabricate, test, and finalize the technology based on the design and demonstration results developed during Phase II, and transition the technology with finalized specifications for DoD applications in the areas of persistent target recognition surveillance and image recognition in the future for improved target recognition and identification in degraded vision environment accompanied by heavy rain, smoke, and fog.

The commercial sector can also benefit from this crucial, game-changing technology development in the areas of high-speed image and facial recognition. Commercialize the hardware and the deep-learning-based image recognition sensor for law enforcement, marine navigation, commercial aviation enhanced vision, medical applications, and industrial manufacturing processing.

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KEYWORDS: Image recognition; wave mechanics; low latency; passive computing; sensors; deep learning

VERSION 4

N22A-T009 TITLE: DIGITAL ENGINEERING - Sonar Dome Anti-Fouling Tracking and Prediction Tool

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop a capability to collect, analyze, and predict levels of Tributyltin Oxide (TBTO) in deployed sonar domes.

DESCRIPTION: A sonar dome protects the acoustic transducers, to reduce noise and enable optimal sonar performance. Crucial to its function is that the dome does not foul. Historically, this has been done by imbuing sonar domes with Tributyltin Oxide (TBTO) during the manufacturing process. Research to prevent fouling has not developed an alternative that is qualified for the domes on surface combatants. Even when a new anti-fouling method may be identified, there will be scores of sonar domes imbued with TBTO, with decades of remaining service. A combatant is at sea for about eight years before maintenance carried out at dry dock. Conventional, off-the-shelf antifouling approaches do not work with sonar domes, because they are made of rubber.

The Naval Research Laboratory (NRL) has recently developed a rapid, non-destructive, and inexpensive method to measure TBTO (or other anti-fouling systems) in sonar domes while a ship is dry docked. This will provide, for the first time, the data necessary for a nuanced understanding of the anti-fouling efficacy, throughout its service life.

The Navy seeks technology that will enable central management of these measurements from USN sonar domes that are deployed to locations and environments around the world, together with an ontological framework to record pertinent information about the sonar dome, such as manufacturing details and service life history. It is also desired that the architecture of the proposed technology accommodate a methodology for predicting anti-fouling life and updated algorithms as data supports algorithm refinement. Development of an initial predictive algorithm could fall within the scope of this STTR topic.

The Navy seeks a centralized capability for collecting this information, populating an ontological framework with pertinent data (such as sonar dome manufacturing details and service life history) for each measurement, and predicting future TBTO levels to understand both:

1. When sonar domes will need to be replaced due to depletion of TBTO.
2. When it may be appropriate to reduce the amount of TBTO (or future anti-foulant) used in new-construction sonar domes with changes in dome material or anti-foulant.

The centralized capability will enable the Navy to minimize maintenance while also minimizing harm to the marine environment.

The framework described herein must include:

- A method to capture data from a measurement tool for utilization in a Fleet-wide physics-based model designed for modular updating manually via future re-assessment of an updated database.
- A graphical user interface (GUI) that displays tracked values of interest.

Examples of potential elements to this ontology are:

- Measured anti-foulant loading remaining in coating.
- Models of TBTO degradation as a function of time and combatant travel profile.
- Predicted remaining lifespan of sonar dome TBTO based on measurements and predicted travel profile.

- Updated physics-based model calculations.

Any additional ontological elements that would improve the model would be welcome.

The physics-based model shall also incorporate:

1. Input parameters, including service conditions, that may vary over a deployment. Variables of primary considerations are surface ocean temperature and salinity, but others may be added.
2. Capability to change the input properties, to accommodate updated material specifications and other improvements.

PHASE I: Develop a concept for a physics-based database and GUI for diffusion from a sonar dome that meets all the parameters in the Description. Demonstrate the concept is feasible through analysis, simulation, and modelling. Preliminary experimental data will be provided by NRL. The Phase I Option, if exercised, will include the initial design specifications and a capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype physics-based database and GUI for the TBTO collection and prediction capability. Demonstrate the prototype meets the required range of desired performance attributes given in the Description. Feasibility will be demonstrated through system performance with information from initial TBTO measurements that will be collected. Develop a Phase III commercialization plan.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Navy use as software to collate, analyze, and manage TBTO data collected and tested via a hardware measurement capability maintained by IWS 5.0. Demonstrate and report on performance during laboratory testing.

This technology can be used in a wide range of products where measurements of toxins or other material dopants of specified loadings are collected and predictions of future state are dependent on numerous variables which are not entirely dependent on one another. With the appropriate modifications, it may be used to monitor performance of commercial antifoulant systems, particularly when a new system is being adopted. The technology would be of greatest use in cases where environmental impact of a substance is of national or global concern, particularly in water / wastewater management or aquaculture settings.

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KEYWORDS: Sonar dome; tributyltin oxide; TBTO; anti-fouling for sonar domes; ontological framework; predicting anti-fouling life; water management; wastewater management; aquaculture

VERSION 4

N22A-T010 TITLE: Kilowatt Class-k Fiber Optical Isolator for Submarine High Energy Laser Amplifier

OUSD (R&E) MODERNIZATION PRIORITY: Directed Energy (DE)

TECHNOLOGY AREA(S): Weapons

OBJECTIVE: Design and develop a compact and robust fiber optical isolator for kW class fiber lasers/amplifiers.

DESCRIPTION: Optical isolators transmitting light only in one direction while blocking light in the opposite direction have been extensively used to protect laser systems from the influence of the backward light. Fiber lasers have seen significant developments during the last two decades and kW class fiber lasers have been deployed in different platforms for DoD applications. This has created demand for high power compact and robust optical isolators that can be used to protect these kW class fiber lasers. Commercial free-space bulk optical isolators capable of handling optical average powers up to kW level are becoming available. However, the packaging volume, thermal resistance, reliability, and even the power handling cannot meet most DoD applications. Fiber-coupled or fiber-based optical isolators have the advantages of small format, easy operation, and high robustness while exhibiting the promise of high-power handling. Currently, the power handling capability of fiber-coupled isolators is limited to 100 W. This STTR topic seeks innovative device design, advanced Faraday material, new magnet material, and novel power polarizers that can be combined for the development of kW class fiber optical isolators. This topic supports the development of a prototype with the parameters listed below at the end of Phase II:

- Operating Wavelengths: 1µm, 1.55 µm, and 2 µm• Average Power handling: Threshold 3 kW; Objective 5 kW per amplifier
- Bandwidth: Threshold 20 nm; Objective 50 nm
- Insertion Loss: Threshold < 1 dB; Objective < 0.5 dB
- Isolation: Threshold > 30 dB; Objective > 40 dB
- Polarization extension ratio (FER) > 30 dB
- Reliability: Lifetime > 5000 hours
- Thermo Electric (TEC) or Water cooling preferred

Under the Phase II Option II, if exercised, a prototype kW class Fiber optic isolator will be delivered to a Navy lab to evaluate the performance of the system in terms of its optical isolation > 40 dB for HEL system.

PHASE I: Develop a concept that uses the Faraday material, magnet material, and polarizers for a best-performance optical isolator construction that can be used for kW class fiber lasers. Demonstrate the power handling scalability of the new isolator material and device. The isolator concepts will be designed to meet the performance capabilities identified in the Description section. Demonstrate the feasibility of the concept to meet the parameters listed in the Description through modeling, simulation, and analysis.

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

PHASE II: Develop and deliver a prototype based on the results of Phase I, supporting the parameters listed in the description. Optimize the design and development of the Phase I kW class optical isolator to a prototype compact and robust fiber optical isolators for kW class fiber lasers.

VERSION 4

Deliver a prototype kW class Fiber optic isolator to a Navy lab to evaluate the performance of the system in terms of its optical isolation > 40 dB for HEL system as described in the Phase II SOW. Any test data collected at Navy facilities shall be Government use only.

PHASE III DUAL USE APPLICATIONS: Transition of kW class Fiber optic isolator to Navy use for the purpose of HEL technology integration at 1 to 2 μm MW class laser. Identify the final kW class fiber isolator product and describe how the company will support transition to Phase III. Ultimately, the HEL system will be deployed in a submarine or other Navy platform advancing future Navy warfighting capabilities.

Fiber optical isolators with high power handling capability can be used in various HEL laser systems for DoD and industrial applications such as welding, cutting, soldering, marking, cleaning, and material processing.

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KEYWORDS: Optical isolator; fiber isolator; kW class fiber lasers; Faraday rotator; magneto-optical material; polarizer

VERSION 4

N22A-T011 TITLE: Shipboard Creepage and Clearance Analysis

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop test equipment to measure electrical properties related to shipboard environmental factors that affect creepage and clearance in Medium Voltage (MV) Naval electrical power systems.

DESCRIPTION: Naval electrical power systems and associated high power combat systems are increasingly employing Medium Voltage (MV) power in the range of 1 to 35 kiloVolt (kV) AC or DC. Creepage and clearance requirements are a major driver in power density of MV equipment. Clearance is the shortest “air” distance between two exposed conductors while creepage is the distance along insulation surfaces between two exposed conductors. Setting these values too conservatively results in excessively large equipment; setting them too low results in equipment failure due to flashover. MVDC requirements have not yet been established, and the appropriateness of the MVAC requirements is not known. MVAC requirements are based on terrestrial commercial standards which have never been validated to apply to the marine environment. Naval ships have experienced arcing fault flashovers that have caused significant amounts of damage and lost operational time.

The most significant factor for establishing safe clearance distances is the electrical properties of the air, which is affected by pollutants, salts, and other air contaminants. The air in different spaces onboard ship is certain to have varying electrical properties.

Similarly, the most significant factor for establishing safe creepage distances is the electrical properties of the surface contaminants on insulators, which will vary significantly throughout the ship. Currently, there are no Navy or commercial products that are designed to measure creepage or clearance within a naval ship environment.

The Navy seeks a portable testing apparatus to measure the electrical properties of air and surface contaminants onboard a naval ship at a threshold level of 20kV and objective of 35kV. A method is also needed to use these measurements as Objective Quality Evidence (OQE) for developing safe creepage and clearance requirements for inclusion in applicable equipment specifications and military standards. The portable testing apparatus measurements shall be accurate and repeatable enough to enable the Navy to employ the method to establish the creepage and clearance requirements.

The Navy anticipates using multiple test apparatuses to create an initial survey of shipboard spaces over an extended period of time in operational conditions and industrial conditions. Following initial surveys, the Navy intends to employ the test apparatus in both prognostic and forensic procedures to understand the shipboard environment in specific ships.

PHASE I: Provide a concept design for an apparatus that measures the electrical properties of air and surface contaminants onboard a naval vessel. Provide evidence, either through experimentation or simulation, that the concept design is feasible. Also provide a method to use measurements from the apparatus as Objective Quality Evidence (OQE) for developing safe creepage and clearance requirements for inclusion in applicable equipment specifications and military standards. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype apparatus in Phase II.

PHASE II: Provide, demonstrate, and deliver an initial prototype apparatus that measures the electrical properties of air and surface contaminants onboard a naval vessel. Demonstrate the method to use

measurements from the prototype apparatus as OQE for developing safe creepage and clearance requirements for inclusion in applicable equipment specifications and military standards. Based on feedback from demonstrations of the initial prototype apparatus, incorporate improvements in the apparatus design and produce two additional prototype apparatuses. Demonstrate these two prototypes function as intended and deliver to the U.S. Government.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Update the prototype design to a final production configuration and develop supporting training documentation. The Government anticipates using multiple test apparatuses to create an initial survey of shipboard spaces over an extended period of time in operational conditions and industrial conditions. Following initial surveys, the Government intends to employ the test apparatus in both prognostic and forensic procedures to understand the shipboard environment in specific ships.

This device should also prove useful in both the naval and commercial marine sectors to ensure the air and surface contaminants onboard ship are not more severe than for contaminants the shipboard equipment was designed for.

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KEYWORDS: Creepage; Clearance; Air Contamination Electrical Properties; Surface Contamination Electrical Properties; Medium Voltage; MV; MVAC; MVDC; Flashover

VERSION 4

N22A-T012 TITLE: Survivable Minefield Mission Data Module

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Ground / Sea Vehicles

OBJECTIVE: Develop a hardened data module that can withstand blast effects from detonation of underwater explosives while preserving accumulated mission essential data from Unmanned Undersea Vehicles (UUV) and Remotely Operated Vehicles (ROV) systems.

DESCRIPTION: The Maritime Expeditionary MCM Unmanned Undersea Vehicle (MEMUUV) and Maritime Expeditionary Standoff Response (MESR) systems provide Navy Expeditionary forces with specialized UUV and ROV systems that deploy for search, detection, localization, neutralization and disposal of naval mines and underwater improvised explosive devices (IEDs). Mines and IEDs are often detonated by acoustic and magnetic noise from ships and subsurface platforms in the vicinity and by UUVs and ROVs conducting time-intensive mine and IED clearance operations in undersea environments. Although UUV and ROV platforms are not deployed as expendable platforms, they are susceptible to and not sufficiently hardened against inadvertent arming and detonation of a mine or IED while performing clearance missions. The blast effects from an inadvertent detonation may result in loss of essential mission data accumulated during hours of UUV/ROV operations. Mission data collected during a single, 20-hour sortie may result in an accumulation of up to 10 terabytes of data. Wireless data transfer bandwidth limitations for expeditionary platforms (typically between 5 kilobits per second up to 150 megabits per second) preclude real-time data exfiltration from the platforms; most mission essential information must be downloaded post-mission.

This STTR topic seeks to develop a compact, survivable “black box” mission module to collect mission data prior to a detonation. The solution must preserve the data and allow system operators to retrieve the data post-detonation. Data preservation can occur either by retrieval of the module or via secure wireless data transfer following an underwater explosive detonation event occurring within 10 meters of a 2500-pound TNT-equivalent net explosive weight (NEW) object on the seabed in up to 300 meters of water depth, which could result in total loss of a UUV or ROV platform. The module must have interface capabilities to facilitate recovery or autonomous data transfer and must be designed to protect the module and information from recovery by adversaries.

Aircraft flight recorders are not suitable in size, nor in the types of mission data they collect as a survivable mission module for undersea platforms; however, the basic concept is the same. There are currently no known solutions for preservation of mission essential data from UUV missions. Mission data collected on objects in the water column and on the seabed, including accumulated geo-referenced imagery up to the point where a mine explosion which destroys or incapacitates a UUV, is important for time constrained clearance operations. Proposed concepts must be compact for integration into small, volume-constrained UUV and ROV systems without adversely impacting trim, balance, or hydrodynamic performance of the platform. Size, weight and power (SWaP) constraints will vary depending on design concept. A self-contained module should not exceed 20 cubic inches in volume (e.g., a ~1 inch diameter x 6 inches long cylinder). Weight/mass should enable a neutrally buoyant solution in seawater. For a completely self-contained hardware solution mounted externally to a platform, a neutrally buoyant, hydrodynamic form factor must be sufficiently small and streamlined as not to add drag or impact platform endurance while maneuvering. Additionally, concepts must be powered independently. Power endurance requirements vary based on the concept for data retrieval; however, proposed solutions should have sufficient power and longevity to enable recovery while also being able to erase data if not recovered. If lithium chemistry batteries are proposed as a component of the independent power system design, solutions should incorporate batteries which have previously been certified for Navy shipboard

use, storage and transportation in accordance with NAVSEA Instruction 9310.1, or should include evaluation of battery safety suitability within the scope of the proposed concept validation. To align for successful future transition following a successful demonstration, concepts should consider hardware and software solutions that will either satisfy or be easily adaptable to satisfy cyber security compliance for DoD/Navy use in accordance with DoD Instruction 8500.1 and Department of the Navy Cyber Security Policy compliance (SECNAVINST 5239.3C of 2 May 16).

Testing of the key performance parameters and key system attributes will be performed in a relevant environment to verify that the task objectives were met. To demonstrate some aspects of the technical performance (e.g., survivability of large explosive charges), modeling and simulation coupled with technical analysis is deemed an acceptable approach.

PHASE I: Develop an innovative concept for a blast-survivable mission data module that meets the design constraints listed in the description. Establish feasibility by modeling and simulation, analysis, and/or laboratory experimentation, as appropriate.

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

PHASE II: Develop and deliver a prototype of the survivable data module compatible for demonstration and characterization of key performance parameters, key system attributes, and objectives. Conduct testing of the key performance parameters and key system attributes in a relevant environment to verify that the task objectives were met. To demonstrate some aspects of the technical performance (e.g., survivability of large explosive charges), consider modeling and simulation coupled with technical analysis. Based on lessons learned in Phase II through the prototype demonstration, a substantially complete design of the data module should be completed and delivered that would be expected to pass Navy qualification testing.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use through system integration and qualification testing of a survivable mission data module. The final survivable minefield mission data module product will need to conform to all specifications and requirements. A full-scale prototype will be operationally tested at sea and certified by the Navy.

Innovative concepts offer a broader opportunity for use of a “black box” solution across many military activities collecting and transporting high value sensitive data, on autonomous subsurface and surface platforms, at risk of being destroyed in the course of their mission.

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3. Secretary of the Navy Instruction 5239.3C dated 2 May 2016. (Department of the Navy Cyber Security Policy).
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KEYWORDS: Mine Countermeasures; Survivability; Unmanned Undersea Vehicles; Remotely Operated Vehicles; Mines; Improvised Explosive Devices.

VERSION 4

N22A-T013 TITLE: Damage-Free High Power Emission from Indium Phosphide-Based Solid State Waveguides in the Long Wave Infrared

OUSD (R&E) MODERNIZATION PRIORITY: Directed Energy (DE)

TECHNOLOGY AREA(S): Sensors

OBJECTIVE: Develop a capability that enables reliable emission of high power, single lateral mode, long wave infrared laser beams from Indium Phosphide-based solid state waveguides.

DESCRIPTION: Infrared (IR) photonic integrated circuits, especially those incorporating solid state laser diodes operating in the long wave infrared (LWIR) band, often employ the Indium Phosphide (InP) III-V semiconductor system. Optical signals are transmitted in solid state waveguides fabricated directly in epilayers grown on the InP substrate, which are usually designed for light propagation in a single lateral mode. In many applications, the optical power may be emitted to free space at an edge facet or from some other surface. However, the emitted power is sometimes quite high and the maximum power density at the center of the beam can be exceedingly intense. Furthermore, the efficient extraction of optical power from the facet is typically aided by the deposition of an anti-reflection (AR) coating that minimizes the reflection of light back into the waveguide.

Current InP-based waveguides operating in the 9-11 μm spectral band are susceptible to optical damage at the AR-coated output facet, which limits the maximum continuous wave or average power that can be emitted to less than 2 W. This limitation severely constrains the usefulness of technologies that could otherwise enable higher levels of integration, such as beam combining by an arrayed waveguide grating (AWG). Therefore, the Navy needs an LWIR InP-based waveguide and output coupling technology that reliably increases the maximum power that can be emitted to at least 10 W.

The goal is to demonstrate damage-free operation in both the waveguide and at the output interface over long term operation. Propagation in the waveguide shall be in a single lateral mode and the transmission at the output surface should be at least 90%. The output should be in a nearly diffraction-limited beam with maximum M2 factor of 2.0 (M2 defined according to ISO Standard 11146). The output interface is considered to be to the atmosphere, at sea-level.

Methods for injecting optical power into the waveguide for testing are not a subject of this effort. However, accurate measurement of the output coupling efficiency is expected. In addition, the ability to vary the transmitted power, incrementally or continuously, in order to “test to failure” is highly desirable. Prototype solutions may be demonstrated at any wavelength (or combination of multiple wavelengths) between 9 and 11 μm. However, test wavelengths should be chosen for maximum atmospheric transmission in order to minimize uncertainties in testing and all prototypes should be tested at the same wavelengths. While testing at all wavelengths across the LWIR band is not required, the solution should be suitable for applications that combine multiple LWIR wavelengths spanning the entire upper LWIR band (8-14 μm) in the same beam. Solutions that are “tuned” to specific wavelengths or narrow bands are unacceptable.

Potential solutions may include improvements in ridge geometry, improved AR coatings with lower absorption in the LWIR, tapering of the waveguide along one or both axes, improved heat dissipation at the output surface, surface-emitting (versus edge-emitting) geometries, or other solutions employing innovative architectures and materials. However, acceptable solutions must be capable of fabrication through normal integrated circuit manufacturing processes and work flow. The objective is to develop a technology that can be incorporated into multiple photonic integrated circuit designs. Therefore, coatings

and bonding processes are acceptable but solutions that require the addition of "off-chip" elements or require labor-intensive "touch time" assembly are unacceptable. Assembly steps that are performed solely to incorporate diagnostic elements or are performed for fixturing or calibration and do not form a part of the actual technical solution are acceptable. For example, process and assembly steps required to inject optical power into the device for demonstration and testing are not considered to be part of the solution.

As this effort is assumed to be necessarily iterative in nature, it is expected that multiple prototype devices will be produced during its course. In addition, a staged approach in which prototypes capable of 5 W output are first demonstrated and then extensively tested over long term cyclical operation (a minimum of 100 hours of operation with 50 on-off cycles) to assess cumulative damage effects is highly desirable. Testing will be performed in a laboratory environment provided by the proposer. At the end of the effort, the five best performing prototype devices (which have not been "tested to failure") shall be delivered to the Naval Research Laboratory (NRL). Any specialized equipment (e.g., power sources, test equipment and test fixtures, calibration standards, etc.) specifically built or acquired for testing of the devices, along with test data on the devices, shall also be delivered to NRL.

PHASE I: Develop a concept for a high-power LWIR InP-based waveguide technology with transmission, out-coupling, and power-handling characteristics that meet the objectives stated in the Description. Define the architecture and materials required for the concept, and demonstrate its feasibility for meeting the Navy need. Feasibility shall be demonstrated by a combination of analysis, modelling, and simulation. Identify key manufacturing steps and challenges. Define the test configuration, including the method for injecting and measuring the power introduced to the waveguide. The Phase I Option, if exercised, will include formulation of the device specification, test specifications, interface requirements, and the manufacturing requirements necessary to build and evaluate device prototypes in Phase II.

PHASE II: Develop and deliver a prototype high-power LWIR InP-based waveguide transmission and out-coupling technology based on the concept, analysis, architecture, and specifications resulting from Phase I. Demonstrate that the prototype waveguides operate without damage as detailed in the Description. Demonstrate the technology through production and testing of prototypes in a laboratory environment provided by the proposer. It is expected that multiple prototypes will be produced during execution of this Phase as the design process is assumed to be necessarily iterative in nature. At the conclusion of Phase II, five samples employing the best-performing prototype solution (or solutions) shall be delivered to the Naval Research Laboratory, along with complete test data and any specialized equipment needed to replicate testing.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use. Identify specific manufacturing steps and processes that require further development, mature those steps and processes, establish a hardware configuration baseline, create production-level documentation, and insert the technology into specific semiconductor fabrication processes. Assist the government in integrating the technology into specific photonic integrated circuit designs meeting requirements supplied by the government and transitioning those designs into production.

Commercial, and scientific applications include use in laser spectroscopy for remote detection of chemicals and explosive compounds, and free-space optical communications (backhaul networks).

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KEYWORDS: Long Wave Infrared; Anti-Reflection Coating; Beam Combining; Indium Phosphide; Solid State Waveguides; Photonic Integrated Circuits.

VERSION 4

N22A-T014 TITLE: Visible to Near Infrared Laser Array with Integral Wavelength Beam Combining

OUSD (R&E) MODERNIZATION PRIORITY: Directed Energy (DE)

TECHNOLOGY AREA(S): Sensors

OBJECTIVE: Develop an array of visible to near-infrared (VNIR) lasers with integral (on-chip) wavelength beam combining for a single, high quality output beam.

DESCRIPTION: Many threats to surface ships employ imagers and detectors operating in the visible to near-infrared (VNIR) band. These include lethal threats as well as aircraft and unmanned aerial systems performing routine surveillance. To combat these threats, shipboard countermeasures are needed and, for the most sophisticated threats, lasers are the fundamental component of the electro-optic (EO) countermeasure suite. For compactness and simplified power and control circuitry, semiconductor lasers are a highly attractive solution. However, in order to achieve the output powers required, multiple individual laser diodes must be combined in a laser “module” with a single output. This solution also provides spectral coverage across the wavelength band (or a specified portion of the band) as laser diodes of different wavelengths are combined ? a highly desirable feature for countermeasure applications. However, the architecture presents a considerable cost in manufacturing as the exacting tolerances required result in high component costs and the assembly process is highly labor-intensive. The assembly cost of the laser diode combiner typically accounts for as much as half the cost of the finished laser module.

Other possible laser sources are either bulky, even more expensive, or have other undesirable characteristics such as multi-mode operation. For example, some high brightness semiconductor lasers require an additional pump source or other free-space optics which increases size and cost. Other solutions involve frequency doubling to produce single wavelength output that would still have to be combined with the output from other lasers to achieve spectral coverage. Currently, there is no off-the-shelf laser source that can produce any significant power (> 1.5 W) across the VNIR waveband at an affordable price and in a sufficiently compact form factor.

The Navy needs compact and affordable laser sources in the VNIR band, specifically the wavelengths covering 0.5 through 0.85 microns. In this context, a “laser source” is understood as being distinct from a simple laser, in that the laser source combines the output of multiple individual lasers into a single output beam. In the case of the laser module described above, this is done through the assembly, integration, and alignment of multiple individual laser diodes with external optical components that perform the beam combining. However, it may also be done by integration of the combining optics directly on the same semiconductor substrate that contains the laser diodes, creating a photonic integrated circuit that is effectively a miniature laser “module” on a chip. With the exception of packaging and alignment of the output optics, this “on-chip” combining eliminates almost all of the assembly steps required for the discrete-component laser module. And while the cost of semiconductor fabrication increases, the overall cost of the resulting laser source can be significantly reduced, provided the technical challenges of on-chip combining in the VNIR can be overcome.

The goal of this topic is to demonstrate a laser source operating in the VNIR and designed for optimum size, weight, and power (SWaP), while also reducing the cost (SWaP-C). The source should be a laser array integrated on the same chip and combined into a single output, which is considered to be the key technical achievement of the effort. The minimum required continuous wave (CW) output power is 1.5 W, and the power should be distributed in at least six spectral lines. More lines are desirable, and increasing the number of integrated lasers represents an acceptable way of scaling to the required power

output. The source should cover the entire VNIR band, with at least 20% of the total output power appearing in each of the sub-bands: 0.5-0.6 microns, 0.6-0.7 microns, and 0.7-0.85 microns. The output should also be placed at spectral lines corresponding to wavelengths of maximum atmospheric transmission. While the maximum number of discrete laser diodes that can be integrated on a single chip is fundamentally limited by die size and beam-combining losses, nothing about the chosen architecture should preclude further power scaling by external (off-chip) combining of multiple integrated laser arrays. In particular, the combined beam output from the chip should be of high quality, with M2 less than 2.0 and with 1.5 as a goal (note that M2 is defined by ISO Standard 11146 for this effort).

The solution must demonstrate the laser source as a packaged prototype laser module. Of fundamental importance is low SWaP, with a size goal of less than 20 cubic inches for the entire laser module and a weight goal of less than one pound. In this context, the “laser module” comprises the integrated on-chip combined laser array (which is the laser source), the mount (including thermal stack-up), the optics required for transmitting the output beam, and the packaging (including electrical and coolant connectors), but does not include the mounting hardware or power supplies. External optics for shaping the beam are acceptable, so long as they fit within the specified total module volume. Although the prototype module produced during Phase II need not be environmentally hardened, it must be contained within a closed package rather than an open breadboard.

The laser module prototype is intended for laboratory demonstration and limited outdoor range testing. However, for ease of use and in order to inform future system concepts, the laser module will be integrated with a closed-loop cooler, power supplies, and control circuitry to form a system demonstrator prototype. The system demonstrator will accept normal 60 Hz 120 V prime power and employ air cooling (convective or forced). The system demonstrator also need not be environmentally hardened, but should be capable of operation in ambient temperatures ranging from 40 to 90°F. Other than electrical prime power, the demonstrator should be self-contained and no larger than 300 cubic inches, including the laser module. The total weight of the demonstrator is not restricted. While the laser module is an integral part of the demonstrator, it should be removable to accommodate the possibility of substituting different laser modules in the future (for example, modules emitting with different spectral line placement). As a benchmark, the demonstrator prototype should be designed to meet a cost goal of $10,000 per unit when manufactured in a volume of 1,000. At the conclusion of the effort, the demonstrator unit will be delivered to the Naval Research Laboratory.

PHASE I: Develop a concept for a compact high-power integrated VNIR laser source that meets the objectives stated in the Description. Define the laser source architecture and demonstrate the feasibility of the concept in meeting the parameters of the Description. Feasibility shall be demonstrated by a combination of analysis, modelling, and simulation. The cost estimate for the concept shall be obtained by analyzing the key manufacturing steps and processes, their maturity and availability within the industry, the cost and availability of key components, and by comparison to the manufacture of similar items. The Phase I Option, if exercised, will include the laser source specification, the laser demonstrator system specification, test specifications, interface requirements, and capabilities description necessary to build and evaluate the full system demonstrator prototype in Phase II.

PHASE II: Develop and deliver a prototype compact high-power integrated VNIR laser source based on the results in Phase I. The integrated laser source (within the laser system demonstrator) shall be demonstrated by producing and testing a prototype (or multiple prototypes) in a laboratory environment. Multiple prototypes (or partial prototypes) may be produced as the design process is assumed to be necessarily iterative in nature. However, at the conclusion of Phase II, the final (best performing) prototype laser source, integrated with the system demonstrator, shall be delivered to the Naval Research Laboratory along with complete test data, a final manufacturing analysis, and final production cost estimate.

VERSION 4

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology for Government use. Specific manufacturing steps and processes that require development will be identified. Iterative testing will establish a hardware configuration baseline, produce production level documentation, and transition the laser source into production. Assist the Government in incorporating the integrated laser source into next higher assemblies and deployable systems.

Law enforcement, commercial, and scientific applications include use of VNIR lasers as sources for laser spectroscopy in detection of hazardous materials and chemical substances. The technology should also find application in the telecommunications sector as sources for wavelength multiplexed communications.

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KEYWORDS: VNIR Lasers; Near-Infrared; Laser Source; Semiconductor Lasers; Beam Combining; Laser Diodes.

VERSION 4

N22A-T015 TITLE: Additive Manufacturing of High Performance Copper-Based Components and Materials

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Materials / Processes

OBJECTIVE: Develop additive manufacturing (AM) processes to produce high performance copper-based components and materials.

DESCRIPTION: Additive manufacturing (AM) has matured rapidly over the past decade and is currently a viable manufacturing process in many industries. This is especially true in the production of polymer parts. AM not only allows production of specialized components in small quantities, but it also makes possible the creation of devices and materials that cannot be otherwise produced by traditional means. Additive manufacturing of metals has also matured rapidly; however, the utility of metal AM has not been realized as fully as for polymer processes. This is especially true in the defense electronics and defense systems industries.

To a large extent, AM has been seen as a tool for the production of solid models (rapid prototyping), on-demand manufacturing, and in the fabrication of complete parts where traditional fabrication techniques would require the joining of multiple components. However, the full potential of AM lies in the fabrication of parts and materials that cannot be realized by any other means. This is already being exploited in polymer AM processes where the material constituents can be changed “on the fly” during the fabrication process to achieve gradations in material properties that create specific performance characteristics. For example, the current state of the art for polymer-based materials allows the dielectric constant of a part to be varied throughout the part using advanced additive techniques.

In defense electronics, stringent requirements place unparalleled demands on materials selection and performance, which directly increases cost. Mechanical and especially thermo-mechanical properties of metals used in high performance radio frequency (RF) and laser systems are a primary concern during design and material selection. These metals typically serve as mechanical supports and heat transfer paths for high power electronics. In other applications they serve directly as RF circuit components (such as connectors, transmission lines, waveguides, and antenna elements). Modern vacuum electronics use metal and ceramic construction exclusively, with material purity and performance being of paramount concern.

The Navy has a compelling interest in developing components and materials that increase the overall performance of high-power sensor (radar and electronic warfare) and weapon systems. Specifically, for this topic, this means developing AM processes for copper and copper-based materials and structural elements (at very small scales) that provide performance characteristics exceeding what can be obtained through traditional manufacturing processes. “Copper-based materials” include both copper alloys and metal matrix composites (including hybrid composites) where the primary metal constituent is copper. For structural (three-dimensional vice planar) elements, the interior dimensions of WR-10 waveguide (0.100 X 0.050 inches) serve as the benchmark for the feature size and aspect ratio desired. That is, RF circuit components are assumed to require this level of resolution and cooling channels should achieve these dimensions (or smaller) to be useful.

There are two key aspects to this STTR topic: (1) the demonstration of three-dimensional structures with fine (high aspect ratio) features, tight tolerances and smooth surfaces, and (2) the development of innovative materials. Either may be selected and addressed, both may be addressed separately, or both may be addressed in combination. For the demonstration of three-dimensional structures, a 10X improvement in feature aspect ratio, tolerance, and surface roughness over the current state of the art is

the goal. The objective is to demonstrate through the production and testing of prototypes the ability of the innovative process (or combination of processes) to deliver parts that cannot be manufactured by traditional (non-AM) means. And while either new structures or new materials may be addressed under this effort, innovative AM processes and techniques that demonstrate multiple benefits and utility for wide application are most desirable.

Of particular interest to the Navy are materials and components for thermal management of high power electronic modules. These may be solid heat spreaders or small cooling structures (base plates) incorporating small channels for liquid cooling. Along these lines, thin oscillating heat pipes (OHPs) are an area that embodies multiple technical challenges of particular interest (for example, feature size, tolerance, finish, and affordability). Typically, these components find their most challenging application in transmit and receive (T/R) modules incorporating high power monolithic microwave integrated circuit (MMIC) amplifiers and in high power laser modules incorporating large numbers of solid-state laser diodes. In these cases, differences in the coefficient of thermal expansion (CTE) between the device being cooled and the module structural elements create significant design challenges. Therefore, materials that show superior heat transfer and CTE matching performance through the gradation of material constituents and properties are of great interest. Likewise, innovative structures or composites that provide built-in strain relief as well as superior thermal performance are also of interest. In either approach, AM solutions that provide comparable performance (to the current state of the art) while reducing overall cost (target of 50%) through the elimination of other components or assembly steps are also desired.

Another particularly challenging application of interest is the fabrication of components for vacuum electron devices (VEDs), especially high frequency (>28 GHz) amplifiers such as traveling wave tubes (TWTs). The metal components used in fabrication of a TWT are, by nature, three dimensional with large aspect ratios, require demanding mechanical tolerances, and exhibit high standards of finish and metallurgical quality. Copper is widely used in all VEDs for its good electrical and thermal conductivity properties and for the vacuum properties copper exhibits when produced in its high purity grade. However, copper is relatively soft, deforms and melts at relatively low temperatures, and can be difficult to machine. Consequently, VED fabrication typically includes the joining of copper to other metals and ceramics through brazing and, to a lesser extent, welding. So, AM processes that produce superior copper parts for VED fabrication are also of great interest. This includes processes that improve mechanical and heat transfer performance, improve the joining of parts, and reduce cost by the elimination of traditional machining steps. Again, this may be done through the development of innovative structures or innovative copper-based materials (or combinations of both).

The Navy seeks to develop an AM capability that benefits the RF and electro-optical electronics industry and not to produce any particular part. The solution is assumed to include the development of new AM hardware, feedstock, tooling, design methodologies, and fabrication steps. It also includes the identification of, development of, refinement of, and application of measurement techniques for use both as in-process checks and for use post-fabrication to assess the efficacy of the new capability. Copper is chosen because of its relevance to the electronics industry and because of the particular challenges it presents to AM. Prototype devices and structures should be selected to demonstrate the innovative AM capability. These prototypes should be “real” components that demonstrate relevance to the electronics industry, not just material samples (“blanks”) for testing. Prototype components and devices should demonstrate utility and performance that cannot be achieved through manufacturing by traditional means. Otherwise, the selection of prototypes is not restricted and the examples cited above are not exhaustive. It should also be noted that the overall solution may include traditional treatment techniques such as annealing, chemical polishing, and hot isostatic pressing. However, solutions that require extensive “clean-up” machining are not considered sufficiently additive in nature and will not be considered. Processes that use traditionally fabricated parts or stock as foundations for further fabrication of AM structures and materials are acceptable.

VERSION 4

PHASE I: Propose a concept for additive manufacturing of high performance copper and copper-based materials that meets the objectives stated in the Description. The concept shall include specific prototypes by which the proposed AM process technology will be demonstrated. These prototypes will subsequently be produced and used (in Phase II) to verify, by testing and analysis, the efficacy of the proposed AM concept. During Phase I, feasibility of the concept shall be demonstrated by a combination of analysis, modelling, simulation, and evaluation of proposed process steps against established manufacturing methods. The Phase I Option, if exercised, will include the initial process specifications, AM equipment requirements, test specifications, and capabilities description to build a prototype additive manufacturing facility in Phase II.

PHASE II: Develop and demonstrate a prototype facility for AM of high performance copper-based components and materials. In this context, “facility” refers to the combination of equipment, tooling, and process steps required to demonstrate the end-to-end additive manufacturing capability provided by the proposer, not the actual physical facility. Demonstration of the AM process (or multiple processes) shall be accomplished by fabrication and evaluation of the prototype components and materials identified during Phase I. Multiple prototype components and samples are expected during execution of this Phase as the process development is assumed to be necessarily iterative in nature. However, at the conclusion of Phase II, at least one example of each proposed prototype component or material sample shall be delivered to the Government with no fewer than five total prototype samples delivered overall. Test data shall also be delivered with each prototype sample delivered.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use. Identify specific products and material formulations appropriate to the new AM processes and, in conjunction with the broader industry, develop specific production flows and process parameters to either market finished copper-based AM products or transition the technology to produce them in quantity.

The technology resulting from this effort is anticipated to have broad commercial application in the electronics industry as well as niche application to the broader industry for applications such as heat exchangers and thermal management components for electrical power conversion.

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KEYWORDS: Copper Alloys; Metal Matrix Composites; Thermal Management; Heat Spreaders; Oscillating Heat Pipes; Vacuum Electron Devices

VERSION 4

N22A-T016 TITLE: DIGITAL ENGINEERING - Data-Driven Hypersonic Turbulence Modeling Toolset

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);Hypersonics

TECHNOLOGY AREA(S): Air Platforms;Weapons

OBJECTIVE: Formulate, implement, and validate data-driven turbulence models for Reynolds Averaged Navier-Stokes (RANS) closure applicable to hypersonic flows with favorable pressure gradients, adverse pressure gradients, shock wave/turbulent boundary layer interaction (STBLI), and high heat flux.

DESCRIPTION: Hypersonic weapons are exposed to harsh operating environments requiring careful calculation of turbulent boundary layers to accurately estimate heat transfer and design thermal protection systems. Given the wide range of altitudes and velocities hypersonic vehicles operate in, the Navy requires a flexible modeling approach. However, direct numerical simulation data, let alone flight test or even wind tunnel experimental data, is expensive to develop and covers only very specific flight profiles. Faster, cheaper modeling approaches are needed to enable design for entire mission profiles. Modeling approaches, such as RANS equations that are well established for incompressible flow, provide inconsistent results, deviating by more than 50% from data when modeling relevant hypersonic flows, especially for STBLI [Refs 2, 3]. The principal problem lies in the models used to determine Reynolds Shear Stresses and turbulent heat flux required to close the RANS equations; existing methods are inadequate for hypersonic flow.

Over the last decade, improvements have been made in the development of data-driven techniques to close the RANS equations. Application of machine learning (ML) provides a powerful extension to empirical and semi-empirical methods common for developing and tuning closure models. ML allows application of much larger data sets with higher accuracy, removing some of the need for assumptions in traditional closures. These approaches typically use available Direct Numerical Simulations (DNS) or Large Eddy Simulations (LES) data sets to train ML models that can then be used on flows for which no high fidelity, scale-resolved results are available. Wang et al. [Ref 4] have improved on legacy RANS closures in square ducts with varying Reynolds number and flows with massive separation with varying Reynolds number and varying geometry. Wang et al. [Ref 5] extended the technique to hypersonic flat plate turbulent boundary layers and obtained substantial improvements over RANS on Mach 8 flow, even using only Mach 2 DNS results; even better results were obtained from an aggregate of Mach 6 and Mach 2 models. Wang's [Ref 5] results point to the potential applicability of data-driven approaches to improve RANS modeling for more generalized hypersonic flow fields. Not only have these approaches been able to provide more accurate modeling, they also can be used to quantify uncertainty [Ref 1]. Uncertainty quantification is especially important for ML and other empirical approaches, which can experience losses in accuracy away from design conditions.

These data-driven applications are, however, not straightforward. Developing these models requires addressing such problems as defining input and output flow field variables for ML that have physical significance, are normalized, and have Galilean invariance [Ref 6]. Additionally, ML on DNS data cannot be used to simply replace terms in the RANS models, as ill-conditioning of the RANS equations and errors in mean flow quantities will result [Ref 1]. ML approaches are commonly used to predict discrepancies between RANS and DNS data [Refs 1, 4, 5] to train the model to predict the discrepancies between RANS calculations and DNS data throughout the flow field, but how this information is used to improve predictions of quantities of interest (such as heat transfer or separation region location) varies. These discrepancies can be used to adjust existing closure models [Ref 1], adjust model parameters [Ref 10], or to correct Reynolds Stress terms [Refs 4, 5]. Added to this is the general difficulty of ML in

determining the scope of applicability of results, amplified in studying hypersonic flow by variations in Mach number, Reynolds number, flow geometry, and shock geometry that can substantially change the character of flow.

Data driven approaches offer great potential for improving the speed and accuracy of existing hypersonic turbulence models, but product development must take into account the facts that (1) ML corrections to RANS models apply only to a range of flight profiles and vehicle geometries, (2) we must know when a particular ML model loses accuracy due to a change in flow configuration, and (3) ML models can be developed using a wide range of training sets with different choices as to which ML approach (i.e., random forest, neural network, etc.) and different approaches to using the model data to obtain quantities of interest.

PHASE I: Formulate and assess methodologies to improve RANS turbulence models for hypersonic flows using data driven approaches. Specifically, we are seeking a proof of concept for an add-on compatible with existing CFD codes. Significant improvements in the prediction of heat transfer, skin-friction and pressure in attached and separated hypersonic flows are required. Validation against relevant hypersonic experimental data and DNS will be a key consideration towards successful phase transition. The analysis must show that the proposed methodology improves agreement with existing datasets over a wide range of relevant flow conditions. Develop a Phase II plan.

PHASE II: Expand the capabilities and flow configurations of the add-on developed in Phase I. Emphasis should be placed on expanding the models to a wider range of flow geometries, Mach numbers, Reynolds numbers, wall temperature ratios and flight enthalpies. For instance, add ML models based on different training datasets and a variety of data-driven approaches to provide improved accuracy for different flow regimes. Generation of new DNS training datasets can be performed as needed to eliminate gaps in existing datasets. Inclusion of boundary layer transition effects (i.e., length and shape of the transition region and heat transfer overshoot) are needed to increase the applicably of RANS to flow with laminar, transitional and fully turbulent regions. Any new features should be assessed for accuracy.

PHASE III DUAL USE APPLICATIONS: Automate user choice in specific model and flow parameters. Apply uncertainty estimation methods such as those surveyed in Ref 1 to determine which of the expanded training sets, ML models, and closure methods (i.e., Reynolds Stress estimation, coefficients, closure models) will provide the best result for the particular flow profile under consideration, taking into account factors such as geometry, Mach number, Reynolds number, and target quantities of interest (i.e., separation region location and size, heat transfer, etc.). Provide an automated, flexible means of assessing turbulent boundary layers, especially in STBLI without requiring dedicated knowledge and experienced judgment needed to determine the ideal data and model for different flow problems. As with Phase II, specific details of breadth of flows that automation is applicable to and depth of accuracy and detail available, is left to assessment of market need and available developmental resources.

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KEYWORDS: Turbulence modeling; data-driven; machine learning; ML; hypersonics; boundary layers; Reynolds-averaged Navier–Stokes equations; RANS; Direct Numerical Simulations; DNS; Large Eddy Simulations; LES

VERSION 4

N22A-T017 TITLE: DIGITAL ENGINEERING - Rapid Personal Protective Equipment (PPE) Design Exploration

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Biomedical;Human Systems;Materials / Processes

OBJECTIVE: Develop a digital design tool for personal protective equipment (PPE) that allows for rapid exploration of the entire design space.

DESCRIPTION: Developing high-performing, detailed designs of PPE require a thorough examination of conceptual designs and experimental testing. Testing numerous designs is costly and time consuming, both of which contribute to delayed product development and deployment. Moreover, traditional non-biofidelic physical human surrogates limit the translation from testing to the actual response of the warfighter in theater. To facilitate faster and rational design decisions, modeling and simulation utilizing biofidelic human body models can streamline the design process. However, even current state-of-the-art models can still be
time consuming to develop, modify, and analyze. New digital technology that allows for rapid design exploration to couple with state-of-the-art models is needed in order to leverage the advantages of computational modeling. PPE design parameters (e.g., fit, form, weight, material) can be extensively probed on digital human models with accurate injury risk analysis prior to the first physical prototype.

PHASE I: Conceive of and clearly articulate a feasible formulation for a digital design tool for PPE using digital engineering principles used by the DoD. A complete plan for the PPE digital design tool should be developed and the methods of creation for this tool should be fully explained. A methodology for a future approach to validation of the PPE design tool should be presented including how the tool would reduce system design costs, how the tool would allow novel designs to be explored, and how the design tool would specify the characteristics of the PPE under development. Develop a Phase II plan.

PHASE II: Build a functional prototype PPE development tool with a Graphical User Interface (GUI) and the required related environment. Integrate the prototype PPE software tool with a human digital twin that is created in the physics-based solvers, LS-Dyna and FEBio finite element software packages. Create a functional system using both the PPE development tool and the human digital twin with two novel PPE designs that demonstrate the ability to estimate injury risk for any given PPE design as well as the characteristics of the PPE itself (e.g., coverage, dimensions, material). Conduct a cost savings analysis to compare the PPE design tool to more traditional design methods for creating novel PPE items to demonstrate the value of the design tool to reduce acquisition costs.

PHASE III DUAL USE APPLICATIONS: Build and deploy a functional PPE design tool at a Navy organization, preferably within the Naval aviation realm. Verify and validate the ability of the PPE design tool to produce protective gear that are functional, achievable with currently available materials and material handling processes, and provide the protection and injury risk reduction as predicted by the design tool during in silico design processes.

Develop a plan for the sustainment and improvement of the design software tool over time so that the tool does not become outdated or irrelevant due to advances in injury risk prediction, human body modeling, personal protective equipment fundamentals; development of new protective materials, system optimization methodologies, application of AI/ML, or technological advances in related technologies and supporting data sets such as constitutive properties of biological tissues and materials used in PPE systems. Address how the PPE design software tool can address the requirements for military and dual-

use PPE, especially body armor, helmets, sensory system protection (e.g., goggles, wearable noise abatement systems), bomb suits, as well as civilian PPE systems such as hard hats, football helmets, and PPE for manufacturing facilities. Software tool can be formulated to be sustained and improved over time to remain functional. Commercialization must include DoD applications and may include non-DoD applications.

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KEYWORDS: digital engineering; personal protective equipment; PPE; body armor design; helmet design; systems engineering; structural analysis; injury risk reduction; human digital twin; risk analysis; verification and validation models; design models; manufacturing

VERSION 4

N22A-T018 TITLE: Enhanced Sensory Perception via Advanced Synthetic Skins

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);Autonomy;Microelectronics

TECHNOLOGY AREA(S): Electronics;Materials / Processes;Sensors

OBJECTIVE: Develop an innovative, wide-area synthetic skin that utilizes advances in machine perception to enhance the sensory capabilities of the device or system to which the skin is applied and for enhanced investigative capabilities in low-visibility, undersea environments.

DESCRIPTION: A key characteristic of a high-performing synthetic sensory skin is the ability to remain fully operational when stretched, deformed, or used in undersea operations conducted in harsh environments. There are technical risks associated with the implementation of synthetic skins with human-like sensory capability such as manufacturability, resiliency, sensors, and data processing. This STTR topic seeks to develop innovative, wide-area, synthetic sensory skin technologies that address these risks. Solutions should provide high-functioning synthetic sensory skin that augments operations in low-access, low-visibility environments as well as in missions requiring teleoperations of critical systems.

PHASE I: Conduct a proof-of-concept study, culminating in a design package and a demonstrable simulation and/or laboratory experiment, that proves the feasibility of achieving the desired synthetic sensory skin requirements. Produce a detailed report summarizing simulation and/or testing results, a presentation of the initial design, and plans for prototyping the synthetic skin in Phase II.

PHASE II: Finalize design details through Preliminary and Critical Design Reviews, provide a manufacturability analysis, and develop and demonstrate the prototype synthetic skin in a relevant environment.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to a program of record for operational use. Potential medical applications include telemedicine, where it could enable a medical clinician to replicate the physical contact they have when they evaluate a patient in person, and as a covering for prosthetic limbs. Another commercial application includes using it to enable robots to work more safely around humans.

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KEYWORDS: artificial intelligence; perception; underwater; robotics; synthetic skin; bio-inspired; materials; microelectronics; sensors

VERSION 4

N22A-T019 TITLE: Enhanced Thermal, Mechanical, and Physical Properties of Ceramic Matrix Composites Through Novel Additives

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR);Hypersonics;Space

TECHNOLOGY AREA(S): Air Platforms;Materials / Processes;Space Platforms

OBJECTIVE: Enhance and optimize oxidation resistance and thermal, mechanical, and physical properties of ceramic matrix composites (CMCs) through computational-directed and validated design and the addition of additive(s) to the CMC.

DESCRIPTION: The service life of ultra-high temperature materials such as CMCs in gas turbine engines or hypersonic applications is dependent on a complex combination of temperature-stress- environment-time conditions. Maximizing thermal transport to avoid local hot spots on leading edges of reusable hypersonic structures and optimizing tensile strength require a thorough understanding of CMC phenomena. Additives such as nanoparticles and micron-sized chopped fibers have been reported to reduce localized mechanically and thermally-induced stresses thereby increasing overall strength and toughness. Informed design will enhance interphase coatings and reduce CMC porosity. Modeling strength and deformation processes of CMCs as a function of CMC structure and additive load will lead to fabrications processes that maximize CMC component strength.

PHASE I: Using Integrated Computational Materials Engineering (ICME) functionalities, establish models to predict the effect of composition on phase stability and key properties in ceramic matrices such as thermomechanical and thermochemical behavior with and without the application of additives as a function of temperature. The ICME effort needs to be combined with experimental approaches to generate requisite information for model validation. Develop a process for applying novel additives to CMC fibers. Evaluate the oxidation resistance and creep resistance of SiC CMC fibers with and without the addition of novel additives as a function of temperature up to 2000oC, if possible. Develop a Phase II plan.

PHASE II: Apply validated models, developed in Phase I, to the synthesis of advanced matrices and coatings, initially as monolithic materials and later in sub-systems and complete EBC/CMC systems. In coordination with an appropriate original equipment manufacturer (OEM), establish and execute a test plan that will provide sufficient data for preliminary assessment of design allowables for critical and relevant design requirements. These requirements will be developed in conjunction with an OEM and ONR. Test samples will be manufactured with different testing geometries (necessitated by uniformity and testing hardware requirements) for determination of thermal and mechanical property data, including: density, hardness, thermal conductivity, thermal expansion, tensile strength, modulus, creep, and creep rupture, and vibrational and dynamic fatigue.

Test conditions shall include controlled stress, temperature, and time under environmental conditions, including simulated turbine engine by-products of combustion gases with and without sodium sulfate and water present. By the end of the Phase II, ensure that data will be available to initiate constituent modeling of modified CMCs with lifetime predictions of oxidation resistance and thermal-mechanical-creep performance up to 100 hours. Also ensure that thermal-mechanical-creep tests will reach up to 1000 hours at 2000°C or more.

PHASE III DUAL USE APPLICATIONS: Adoption of models/optimized matrix by an OEM for further maturation to manufacture robust self-healing matrix CMC components that can operate in complex environments with less maintenance, lower overall life cycle cost, and improved operational capabilities.

VERSION 4

Coordinate with an engine OEM on work toward further maturation of the knowledge and/or process to fabricate CMC engine components for military and commercial platforms or show how the CMCs with additives can perform at temperature exceeding 2000°C.

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KEYWORDS: Ceramic Matrix Composite; CMC; gas turbines; hypersonics; nanoparticles; ultra-high temperatures; oxidation resistance; metal carbines

VERSION 4

N22A-T020 TITLE: Lidar-like 3D Imaging System for Accurate Scene Understanding

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);Autonomy

TECHNOLOGY AREA(S): Information Systems;Sensors

OBJECTIVE: Develop inexpensive Lidar-like 3D imaging sensors that have high depth and lateral resolution, have a large field-of view for reliable object detection, respond in real time, and work at medium to long ranges in indoor and outdoor environments.

DESCRIPTION: 3D scene understanding (i.e., 3D scene segmentation and parsing, depth estimation, object detection and recognition) are essential components in a vision system. 3D sensors similar to Microsoft Kinect are inexpensive and high resolution but have limited range outdoors, thus not suited for many robotics applications. Lidars have long range and high depth accuracy, but are very expensive; for example, those used in self-driving cars are typically several times more expensive than other car components. Another drawback of current Lidars is their small “vertical” field-of-view, which results in limited vertical resolution and accuracy in object detection because Lidars (even the more expensive ones) have at most 64 scan lines, which could fail to detect small objects even at medium range distances.

The goal of this STTR topic is to develop inexpensive, high-resolution, high-accuracy 3D imaging sensors for wide use on a variety of large and small ground and aerial robotic platforms that can work in dynamic environments under different conditions. ONR expects recent promising advances along a number of directions including machine learning-based algorithms for improved depth estimation with stereo cameras [Refs 2, 5], active illumination technologies [Ref 1], and optimal time-of-flight coding [Ref 3], etc., open new approaches to building hybrid systems that combine optical cameras and laser ranging for developing such 3D imaging sensors. Combining these advances (ML-based stereo imaging, utilizing active illumination for 3D imaging, and novel time-of-flight coding for improved range estimation) requires innovative approaches.

PHASE I: Design the system architecture including sensors and computing hardware, and processing and inference algorithms for building inexpensive, high-resolution, accurate, 3D imaging sensors. Since these sensors are intended for use on various UGVs and UAVs deployed in dynamic and cluttered environments, the design should consider tradeoff estimates among size, weight, and power (SWAP), as well as resolution, detection accuracy, operating range, frame rate, and cost. Develop a breadboard version to demonstrate the feasibility of the design. Develop a Phase II plan.

PHASE II: Perform experiments in a variety of situations and refine the system. Goals for Phase II are: (a) the system should have a field-of-view and resolution comparable to optical cameras; (b) Demonstrate the system’s capability for human detection. Normal vision can detect humans up to a distance of about 300m in daylight. At nighttime, typical headlights illuminate the road up to a distance of about 60m [Ref 4]. The minimum detection range should be the aforementioned distances in daylight and nighttime. (c) Develop a compact prototype imaging system that is small, lightweight, and low power, suitable for portability by personnel and small autonomous platforms (UxVs).

PHASE III DUAL USE APPLICATIONS: Perform additional experiments in a variety of situations and further refine the system for transition and commercialization. Ensure that the real-time imaging system is operable in real-world dynamic environments, thus extending the imaging to handle real-time acquisition, that is, at least 30 fps. This technology could be used in the commercial sector for self-driving cars, and in surveillance and navigation on any land or air vehicle.

VERSION 4

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KEYWORDS: Lidar-like 3D imaging sensor; hybrid imaging; high-resolution sensor with large field of vision; FOV; outdoor imaging; indoor imaging

VERSION 4

N22A-T021 TITLE: Affordable Stabilized Directional Antennas for Small Platforms

OUSD (R&E) MODERNIZATION PRIORITY: Networked C3

TECHNOLOGY AREA(S): Battlespace Environments;Electronics;Ground / Sea Vehicles

OBJECTIVE: Develop a low-cost inertially stabilized mechanism for motion compensation on antenna beam pointing and tracking aboard buoys and small crafts subject to winds, waves, and vehicle motion. Capability goals include low Size/Weight/Power (SWAP), high fault tolerance, and ability for customization and integration with representative antennas.

DESCRIPTION: Current small radio implementations for sensor exfil, telemetry, and data-on-the move lack the performance capabilities to connect small unmanned platforms to communication gateways separated by extended communication link ranges. Recent advances in antenna structures have proven significant increases in gain performance, thereby enabling link closure at farther ranges without increased transmit power. However, advanced inertial measurement electronics and algorithms are needed that can provide fine beam pointing, acquisition, tracking, stabilization (PATS) accuracy required in various environments. It is paramount this innovative solution has low cost, low size/weight/power (SWAP), high fault tolerance, ability for customization, and easy integration into different antenna configurations.

PHASE I: System engineering and trade study for phased array antenna motion-compensating electronics that consists of (i) industrial-grade low-cost commercial off-the-shelf (COTS) IMU/GPS, and (ii) signal processing of incoming IMU data to provide RF beam steering corrections at a rate 100 Hz or higher. Develop varied designs for acquisition, beam pointing and tracking accuracy and performance as a function of electronics/sensor cost, power consumption and size, taking into consideration the requirements for antenna beam width and PATS loss. Develop a case study with detailed design and architecture for integrating the beam correction to a representative phased array antenna up to sea state 4, or for land-based vehicle, on the move. Modeling and simulation results that captures and visualize real-time environmental dynamics and perturbations and their impact on maintaining the RF link stability is highly desirable. Propose solutions for identified gaps and performance improvements. Develop Phase II plans.

Produce knowledge-based deliverables: (1) technical trades and systems engineering addressing cost-size-weight-power and beam PATS loss; (2) architectural designs of stabilized antenna with integrated pointing/tracking in a few frequency bands of interest; and (3) down select prototype design to targeted small radio and antenna systems offering highest value-benefit for Naval stakeholders.

PHASE II: Develop working experimental prototypes based on initial architectural designs delivered in Phase I. Demonstrate the capabilities of developed prototypes in a relevant lab environment up to TRL 4/5. Continue additional integration and tests activities to elevate and achieve TRL 6 during the option Phase, if exercised.

Knowledge-based deliverables: Finalized targeted prototype design.

Hardware & Software deliverables: Prototype system(s) capable of being lab tested up to TRL 4/5. Over-the air limited range test desirable.
Metrics: Objective Size (< 10 cu. in.), weight (< 8 oz), and power (< 1 W); Low cost; Good Pitch/roll/heading accuracy at refresh rate up to 100 Hz; PATS loss < 3 dB for data link at maximum range

VERSION 4

The Phase II Option, if exercised, will include the following deliverables and metrics: Integrated system(s) with local at-sea TRL 6 demonstrations of range and stabilization performance.

PHASE III DUAL USE APPLICATIONS: Develop and refine the final design based on Phase II. Include varied stress testing (extended temperature range, vibration, etc.). Demonstrate autonomous communication capabilities at extended ranges over various sea state environments.

Deliverables: Fully integrated systems on which to conduct rigorous testing with variable beam widths for robust autonomy, stabilization up to sea state 4 and on-the-move platforms, including SATCOM applications.

Private sector commercial potential includes autonomous observation systems, remote monitoring, ocean Internet-of-Things (IOT), and oil and gas exploration.

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KEYWORDS: Phased array beam stabilization; Inflatable Antenna; Autonomous Communications

VERSION 4

N22A-T022 TITLE: High Resolution Underwater Optical Ranging

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Sensors;Weapons

OBJECTIVE: Develop techniques to enable high resolution optical ranging in underwater environments that rely on the encoding and decoding of the optical phase and/or the temporal signature of a blue-green laser source while providing accurate range measurements of underwater objects.

DESCRIPTION: Laser-based techniques offer the potential of providing range measurements with high speed and accuracy. When such techniques are used in the underwater environment, they must overcome the challenges of optical absorption and scattering in water. Blue-green wavelengths minimize absorption, but scattering distributes the optical signal in both time and space and reduces range accuracy. Techniques which reduce the contribution of scattered light to the range measurement can enhance optical ranging in challenging underwater environments. The challenge is to develop solutions that provide accurate range measurements (less than 5cm error) with processing speeds that are compatible with a moving underwater platform. Current techniques use time-encoded optical waveforms and subsequent time-resolved detection to discriminate between scattered and unscattered light. Such techniques involve hardware that is not compatible with small platforms and/or have insufficient dynamic range to operate in challenging underwater environments.

PHASE I: Provide model and/or low fidelity proof of concept results for a proposed optical ranging solution. The results should demonstrate how the proposed approach improves optical ranging in underwater environments. Develop a Phase II plan.

PHASE II: Develop a ruggedized hardware prototype that can be operated in relevant laboratory and/or in-situ environments. The prototype should fit within a 10 to 30 inch diameter cylindrical underwater vehicle, and there should be a path to meet the size, weight, and power requirements of a small unmanned underwater platform. Results from the prototype testing should demonstrate improved optical ranging in challenging underwater environments.

PHASE III DUAL USE APPLICATIONS: Work with the Government to transition the prototype hardware to a specific platform meeting that platform's size, weight, and power limitations. Dual use opportunities include unmanned underwater vehicle (UUV) surveying (pipeline inspection) and automotive light detection and ranging (LIDAR).

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KEYWORDS: laser ranging; underwater ranging; scattering; optical vortex; turbid; time of flight; LIDAR; undersea weapon; mine detection, mine countermeasure; underwater sensor

VERSION 4

N22A-T023 TITLE: Aquatic Soft Robotic STEM Education Kit

OUSD (R&E) MODERNIZATION PRIORITY: Biotechnology;General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Ground / Sea Vehicles;Materials / Processes

OBJECTIVE: Develop next-generation STEM Education aquatic robotics kits that employ soft, flexible, and waterproof materials and designs that will become widely accessible to students at various education levels (grades K-12); and support the workforce demands of a technically savvy and innovative current Naval enterprise.

DESCRIPTION: Recent research has shown that students are most challenged to use critical thinking skills when tasked to build around a specific application with specific design criteria [Ref 1]. Therefore, this STTR topic seeks the development of a STEM education toolkit that addresses a specific Naval application (aquatic soft robots) relevant for building the critical skills for future Naval technologies. Building aquatic robots from flexible materials requires a multidisciplinary skill set centered on math, physics, biology, and materials design, all which are valuable to nurture the expertise of the future Naval workforce [Ref 2]. The principles that would be achieved through this aquatic soft robotics toolset would modernize current robotic programs and offer students new and innovative skill sets (manufacturing, material science, mechanical, design and human-robot cooperation) by advancing the state of the art. The toolset should serve educational purposes as well as provide competition and engagement opportunities for building an evolving and growing community.

PHASE I: Demonstrate feasibility through scientifically sound design of a robotic kit that is built using flexible materials that are waterproof. Focus should be on physical concepts such as forces, motion, and friction; and robotics concepts such as actuation, pneumatics and controls; and how all of these can relate to biology. Attention must be paid to the educational instructions, guides, and design in addition to the robotic design. The kit should be adaptable for lesson plans, workshops, home, and school use. Consider educational value through thoughtful design and application of educational principles for each age group. Develop a Phase II plan.

PHASE II: Develop, demonstrate and validate the underwater soft robot prototype educational kit based on the Phase I design concept. Test and evaluate the prototype using meaningful metrics with the appropriate target student populations (as cited in the Description). Develop educational instructions and guides. Ensure that the kit is adaptable for lesson plans, workshops, and home and in-school use. Feasibility of the educational value should be considered through thoughtful design and application of educational principles for each age group.

PHASE III DUAL USE APPLICATIONS: Transition prototype to a partner in the educational sector.

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VERSION 4

KEYWORDS: Science Technology Engineering Mathematics Education; STEM; Robotics; Soft materials; Aquatic; Biomimetic; Bioinspired

VERSION 4

N22A-T024 TITLE: Marine Atmospheric Boundary Layer Profiles via Satellite-based Remote Sensing Data Fusion

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);Space

TECHNOLOGY AREA(S): Battlespace Environments;Information Systems

OBJECTIVE: Develop novel software algorithms to characterize vertical thermodynamic profiles in the lowest 2-3 km of the atmosphere, leveraging satellite-based environmental monitoring (SBEM) data that combines information from at least 2 of the following observing methods: optical, infrared, microwave, radio occultation.

DESCRIPTION: While characterization of the marine atmospheric boundary layer (MABL) environment is fundamental for Naval operations (e.g., directed energy, C4ISR, and communication applications), there is a lack of sufficient data in areas of interest to analyze and predict tactical scale environmental conditions. Current satellite data methods to measure MABL thermodynamics have limitations based on physical observing characteristics, such as horizontal resolution, vertical resolution, refractivity, or temporal refresh. With the proliferation of broader environmental data availability and smallsat platforms, there exists the potential to improve vertical profiles of temperature, water vapor, and/or refractivity in the boundary layer by combining data from two or more observed mediums. Innovation is sought to develop the theory, algorithm, and software to demonstrate, verify, and validate such a satellite data fusion technique. This development will result in valuable knowledge and technology advances beyond DoD specific applications for the entire meteorological analysis and forecasting community.

PHASE I: Determine and demonstrate the technical capability to leverage at least two different environmental satellite remote sensing observation types (including, but not exclusive to, optical channels, infrared channels, microwave imagers, microwave sounders, radio occultation, synthetic aperture radar, etc.) to add value to current single source atmospheric profiling techniques. Identify those factors that will contribute to enhanced understanding of the MABL compared to conventional methods using historical meteorological data from available defense, civil, research, international partner, and/or commercial data streams. Develop a final summary report, including literature review and overall conclusions/recommendations, to be presented at the end of this Phase. Develop a Phase II plan.

PHASE II: Expand technical development and validation of a robust prototype system for retrieval of MABL thermodynamics in a variety of maritime environments. Given feeds of meteorological satellite information, the algorithm should produce near-real time estimates of temperature, water vapor, refractivity at a higher spatial resolution than conventional satellite retrievals, on the order of 250 m vertical and 10 km horizontal. This prototype software should be capable of interoperating alongside conventional satellite algorithms in a similar computing environment, including both a stand-alone server for single algorithmic demonstration and high performance computing cluster for parallelization of near-real time satellite feeds. Demonstration during a government meteorological field event will be coordinated to provide additional verification and validation opportunities. Characterization of data quality and uncertainty will also be necessary to support potential for data assimilation into numerical modeling systems. It is anticipated that the prototype software will be expanded, or in a position to be expanded, to other satellite platforms and/or sensing methods at the conclusion of Phase II efforts, such demonstration/research sensors being demonstrated in near-realtime by NASA. Delivery of a prototype software package and final verification report is expected at the end of this Phase.

PHASE III DUAL USE APPLICATIONS: This development will result in valuable knowledge and technology advances for the entire meteorological analysis and forecasting community. Naval

applications will immediately benefit from a significant increase in environmental data and prediction availability/quality where the Navy operates. Other civil and commercial applications will benefit from enhanced data streams for broad blue-water maritime applications, improved predictability in numerical weather prediction, and increased cross-over between civil and commercial satellite remote sensing activities. Specifically, environmental characterization and prediction efforts by NOAA will be improved by augmenting meteorological analysis and data assimilation with new observations. Commercial meteorological entities will be able to add value with targeted local enhancement to atmospheric characterization and forecasting by leveraging such data and techniques. This effort has the potential to fill a data gap in all aspects of meteorological analysis as well as provide a proof of concept for additional data fusion opportunities.

REFERENCES:

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3. Lindsey, Daniel T.; Grasso, Louie; Dostalek, John F. and Kerkmann. Jochen. "Use of the GOES-R Split-Window Difference to Diagnose Deepening Low-Level Water Vapor." Journal of Applied Meteorology and Climatology 53, 8, 2014. https://journals.ametsoc.org/view/journals/apme/53/8/jamc-d-14-0010.1.xml?tab_body=pdf.
4. Sun, B.; Reale, A.; Tilley, F.H.; Pettey, M.E.; Nalli, N.R. and Barnet, C.D. "Assessment of NUCAPS S-NPP CrIS/ATMS Sounding Products Using Reference and Conventional Radiosonde Observations." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 10, no. 6, June 2017, pp. 2499-2509. doi: 10.1109/JSTARS.2017.2670504.

KEYWORDS: Meteorology; Boundary Layer; Sounding; Profile; Satellite; Remote Sensing; Algorithm; Temperature; Water Vapor; Refractivity

VERSION 4

N22A-T025 TITLE: Enhanced Long-Range Maritime Vessel Classification

OUSD (R&E) MODERNIZATION PRIORITY: General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Battlespace Environments;Electronics;Sensors

OBJECTIVE: Develop techniques to exploit ship structural vibrations appearing as micro-Doppler signatures in remote Inverse Synthetic Aperture Radar (ISAR) imagery for the purposes of improved vessel classification.

DESCRIPTION: Significant advancements have been made in the automated classification of ships at long ranges using feature extraction from ISAR imagery. The most capable of these seek to classify a particular ship to the fine naval class level. While physical dimensions of major structural elements of the ship provide the primary classification clues, other micro-Doppler based signatures such as those associated with rotating antennas can provide important additional information to support separation among similar ship classes [Ref 1]. This STTR topic seeks to expand the scope of signatures further. Ship structural vibrations may be another important signature to improve overall classification performance. The sources of structural vibrations are generally understood; however whether they are reliably exploitable for classification clues is unanswered.

Multiple authors have shown that radar-sensed micro-Doppler can be used to remotely monitor the vibration of buildings and bridges [Refs 2, 3]. The vibrations generated by an automobile or truck engine has shown to be detectable by radar micro-Doppler signals returned from the surface of the vehicle [Ref 4]. In principle, ship hull and superstructure vibrations primarily driven by propulsion systems should be similarly detectable. Essential to such a technique is the ability to sense the small-scale vibrations of the vessels while they are in motion [Ref 5]. The exploitation of the vessel hull and superstructure vibrations remotely using legacy Navy airborne maritime surveillance radar systems is desired. In addition to single channel monostatic operation, consideration should be given to interferometric and multi-static techniques. If the vibrations are exploitable at long range by these radar systems, they may provide a hull class specific classification feature that in combination with other features will improve overall classification performance. The signatures may also provide information comparable to a fingerprint if it is found that the spectral characteristics are hull specific.

PHASE I: Utilizing open-source ship hull and superstructure vibration measurements such as those described in [Ref 6] or simulated data, analyze the feasibility of remote micro-Doppler sensing by x-band maritime surveillance radar systems. Single channel monostatic, multi-channel interferometric, and multi-static operation should be considered. An initial assessment of signal processing approaches should be completed. Develop a Phase II plan.

PHASE II: Develop and demonstrate a ship vibration micro-Doppler exploitation mode using collected field data supplied by the Navy sponsor. Assess the performance as a function of range, dwell time, and illumination geometry. Develop mode design and tactical utilization recommendations for radar systems identified by the Navy sponsor.

PHASE III DUAL USE APPLICATIONS: Complete development, perform final testing, and integrate and transition the final solution to naval airborne radar systems either through the radar system OEM or through third party radar mode developers. The technology developed from this STTR topic is applicable to Coast Guard Missions.

REFERENCES:

VERSION 4

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2. Luzi, G. et al. “Radar Interferometry for Monitoring the Vibration Characteristics of Buildings and Civil Structures: Recent Case Studies in Spain.” Centre Tecnòlogic de Telecomunicaciòns de Catalunya (CTTC/CERCA), Geomatics Division, Avinguda Gauss, 7, E-08860 Castelldefels (Barcelona), Spain. https://www.mdpi.com/1424-8220/17/4/669/htm.
3. Luzi, G. et al. “The Interferometric Use of Radar Sensors for the Urban Monitoring of Structural Vibrations and Surface Displacements.” IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 9, Issue 8, August 2016. https://ieeexplore.ieee.org/document/7493683.
4. Chen, V.C. et al. “Micro-Doppler Effect in Radar: Phenomenon, Model, and Simulation Study.” IEEE Transactions on Aerospace and Electronic Systems, Vol. 42, No. 1, January 2006. http://www.geo.uzh.ch/microsite/rsl-documents/research/SARlab/GMTILiterature/Ver09/PDF/CLHW06.pdf.
5. Rodenbeck, C. et al. “Vibrometry and Sound Reproduction of Acoustic Sources on Moving Platforms Using Millimeter Wave Pulse-Doppler Radar.” IEEE Access (Volume 8), 04 February 2020, pp. 27676-27686. https://ieeexplore.ieee.org/document/8981984.
6. Weintz, Brett. “Ship vibration.” Brabon Engineering Services, 15 June 2021. https://brabon.org/tech-notes/ship-vibration/.

KEYWORDS: Inverse Synthetic Aperture Radar; ISAR; Synthetic Aperture Radar; SAR; ship classification; hull and superstructure vibration; radar

VERSION 4

N22A-T026 TITLE: Low-Cost, Low-Power Vibration Monitoring and Novelty Detection

OUSD (R&E) MODERNIZATION PRIORITY: Artificial Intelligence (AI)/Machine Learning (ML);Autonomy;Microelectronics

TECHNOLOGY AREA(S): Electronics;Ground / Sea Vehicles;Materials / Processes

OBJECTIVE: Develop a device to bring the benefits of machine health and usage monitoring to a broad spectrum of Navy and Marine Corps assets, especially those of lower value that cannot afford full-up Health, Usage, and Monitoring System (HUMS) systems by developing powerful, inexpensive processing hardware at a target price of less than $100.00 per node.

DESCRIPTION: Lower cost USN/USMC platforms (especially land systems) cannot afford conventional HUMS sensors/processors typically priced at over $1,000.00 per node. Direct sensing of relevant features and the extraction of "actionable" information may be accomplished by purpose-built signal processing hardware. On-chip integration of neural networks (trained offline) holds the promise for self-contained smart sensors that are both extremely powerful and affordable for all platforms. This capability is vital for those platforms deployed and operating at (or beyond) the tactical edge. Very high risk with extremely high payoff is possible if successful. The envisioned device (or family of devices) is expected to be self-contained in a rugged package able to be permanently installed on vehicle components.

This STTR topic seeks innovation in the development of onboard analytics (e.g., neural networks) that operate at the component level and are able to detect and identify anomalous signatures. State of the art is to attach sensors to the component and wire them to conventional signal conditioning hardware in data acquisition components. Digital Signal Processing (DSP) and other computations are done to convert the raw sensor values into information on centralized processors. Some sensors are directly connected to serial buses on the platform with analog-to-digital (A/D) inside the sensor package. The intent is to push the processing into the sensor package, leveraging integration of neural networks and other Artificial Intelligence/Machine Learning (AI/ML) tools at the chip scale to combine the data acquisition and health determination into a single, low-cost device.

PHASE I: Define and develop a concept for a compact device able to monitor, detect, and identify symptoms of failure on typical rotating mechanical equipment. Vibration, temperature, and electrical current signature are typical measurands of interest. The device should be inobtrusive in size and rugged to the ground vehicle’s under-hood environment. Approximately 1 cubic inch volume and less than $100 unit cost. The intent is for the device to be self-contained conducting measurement, analysis, and communications within the package. Ideally it should be environmentally powered or contain energy storage capable of design operation for 1 to 3 years. It should support wired (e.g., CAN bus) or wireless (e.g., IEEE 1451) communications. Perform modeling and simulation to provide an initial assessment of the concept and exercise alternatives. Develop a Phase II plan.

PHASE II: Develop a Phase II prototype for evaluation based on the results of Phase I. The prototype will be evaluated to determine its capability to meet the performance goals defined in the Phase II Statement of Work (SOW) and the Naval need for detection and diagnosis of typical faults in military ground vehicles. In production, the device will be a part of an integrated system of similar devices monitoring different symptoms of faults on a single machine, other similar devices on other machines, and additional control system parametric data captured from existing onboard buses or traditional sensors. The intent is to detect early stage faults at a component level and merge the information to understand the impact of the faults on the mission capability of the platform. Conduct further evaluation of the feasibility of the prototype to evolve into a hardened device capable of surviving in the target environment, meeting

required cost targets, and performing the necessary analytics. The device should support other third party analytics as well as provide native analytic capability. A family of devices with different processing, memory, and sensing capacity for different applications is anticipated. Testing will be performed on laboratory equipment at the proposer's facility to demonstrate performance. Cybersecurity is a key attribute; “cyber-invisible” is the goal. Formal approval is not to be sought during Phase II, but the design must consider the cyber environment from the outset and incorporate the ability to be properly secured when produced.

PHASE III DUAL USE APPLICATIONS: The technology developed in this effort is intended to comprise a part of an onboard, health monitoring and processing system providing Autonomic Readiness Management (ARM) applicable to all types of naval vehicles. The ARV acquisition program is an ideal target for a rapid maturation and integration into the production process. The FFG-62 Mission Readiness Support System (MRSS) is another acquisition program with need for CBM+ and ARM to which this device could apply.

Commercial uses of the device are everywhere. Interest in condition monitoring for all classes of vehicles is high and lack of an affordable implementation has limited the deployment of the capability. The device developed here is an inherent member of the Internet of Things (IoT) and could be adapted to a variety of applications beyond condition monitoring for vehicles. The fundamental capability to measure, monitor, detect, and project are capabilities that have broad applications across the IoT.

Specific commercial industries/markets that could use and benefit from the technology include: commercial trucking, heavy construction equipment, manufacturing, aircraft and related equipment, commercial maritime, and infrastructure monitoring (e.g., bridges, locks, damns).

REFERENCES:

1. Liobe, J.; Fiscella, M.; Moule, E.; Balon, M.; Bocko, M. and Ignjatovic, Z. “DS Sentry: an acquisition ASIC for smart, micro-power sensing applications.” Proceedings Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XVI, Vol. 8017, 2011, p. 80170H. https://www.spiedigitallibrary.org/conference-proceedings-of-spie/8017/80170H/DS-Sentry--an-acquisition-ASIC-for-smart-micro-power/10.1117/12.884253.short?SSO=1.
2. Liobe, J.; Ignjatovic, Z. and Bocko, M. “Ultra-low overhead signal acquisition circuit for capacitive and piezoelectric sensors.” 2008 51st Midwest Symposium on Circuits and Systems, August 2008, pp. 33-36. https://ieeexplore.ieee.org/document/4616729.
3. Japkowicz, N.; Myers, C. and Gluck, M. "A novelty detection approach to classification." IJCAI'95: Proceedings of the 14th International Joint Conference on Artificial Intelligence, Volume 1, August 1995, pp. 518–523. https://dl.acm.org/doi/10.5555/1625855.1625923.

KEYWORDS: Condition-based maintenance; CBM; Internet of Things; IoT; neural network chips; wireless sensors; integrated processing; anomaly detection

AIR FORCE
22.A SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) Phase I
PROPOSAL PREPARATION INSTRUCTIONS

Air Force (AF) Phase I proposal submission instructions are intended to clarify the Department of Defense (DoD) Broad Agency Announcement (BAA) as it applies to the topics solicited herein. **Firms must ensure proposals meet all requirements of the 22.A STTR BAA posted on the DoD SBIR/STTR Innovation Portal (DSIP) at the proposal submission deadline date/time.**

Complete proposals **must** be prepared and submitted via https://www.dodsbirsttr.mil/submissions/ (DSIP) on or before the date published in the DoD 22.A STTR BAA. Offerors are responsible for ensuring proposals comply with the requirements in the most current version of this instruction at the proposal submission deadline date/time.

Please ensure all e-mail addresses listed in the proposal are current and accurate. The AF is not responsible for ensuring notifications are received by firms changing mailing address/e-mail address/company points of contact after proposal submission without proper notification to the AF. **If changes occur to the company mail or email addresses or points of contact after proposal submission, the information must be provided to the AF SBIR/STTR One Help Desk.** The message shall include the subject line, "22.A Address Change".

Points of Contact:

- General information related to the AF SBIR/STTR program and proposal preparation instructions, contact the AF SBIR/STTR One Help Desk at usaf.team@afsbirsttr.us.
- Questions regarding the DSIP electronic submission system, contact the DoD SBIR/STTR Help Desk at dodsbirsupport@reisystems.com.
- For technical questions about the topics during the pre-announcement and open period, please reference the DoD 22.A STTR BAA.
- Air Force SBIR/STTR BAA Contracting Officers (CO):
    - Ms. Kristina Croake, kristina.croake@us.af.mil
    - Mr. James Helmick, james.helmick.2@us.af.mil

General information related to the AF Small Business Program can be found at the AF Small Business website, http://www.airforcesmallbiz.af.mil/. The site contains information related to contracting opportunities within the AF, as well as business information and upcoming outreach events. Other informative sites include those for the Small Business Administration (SBA), www.sba.gov, and the Procurement Technical Assistance Centers (PTACs), http://www.aptacus.us.org. These centers provideGovernment contracting assistance and guidance to small businesses, generally at no cost.

CHART 1: Air Force 22.A STTR Phase I Topics Information at a Glance

Topic Number	Performance Period	Max STTR Funding	Technical Volume Contents
AF22A-T001	9 months	$150,000	White Paper NTE 10 Pages
AF22A-T002	9 months	$150,000	White Paper NTE 10 Pages
AF22A-T003	9 months	$150,000	White Paper NTE 10 Pages
AF22A-T004	9 months	$150,000	White Paper NTE 10 Pages
AF22A-T005	9 months	$150,000	White Paper NTE 25 Pages
AF22A-T006	9 months	$150,000	White Page NTE 25 Pages

PHASE I PROPOSAL SUBMISSION

DoD 22.A STTR BAA, https://www.dodsbirsttr.mil/submissions/login, includes all program requirements. Phase I efforts should address the feasibility of a solution to the selected topic's requirements. See Chart 1 (AF-1) for proposal dollar values, periods of performance, and technical volume content.

Limitations on Length of Proposal

The Phase I Technical Volume page limits identified in Chart 1 do not include the Cover Sheet, Cost Volume, Cost Volume Itemized Listing (a-j). The Technical Volume must be no smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. Only the Technical Volume and any enclosures or attachments count toward the page limit. In the interest of equity, pages/slides in excess of the stated limits will not be reviewed. The documents required for upload into Volume 5, "Other", do not count toward the specified limits.

Phase I Proposal Format

Proposal Cover Sheet: If selected for funding, the proposal's technical abstract and discussion of anticipated benefits will be publicly released. Therefore, do not include proprietary information in these sections.

Technical Volume: The Technical Volume should include all graphics and attachments but should not include the Cover Sheet, which is completed separately. Phase I technical volume (uploaded in Volume 2) shall contain the required elements found in Chart 1. Make sure all graphics are distinguishable in black and white.

Key Personnel: Identify in the Technical Volume all key personnel who will be involved in this project; include information on directly related education, experience, and citizenship.

- A technical resume of the Principal Investigator, including a list of publications, if any, must be included.
- Concise technical resumes for subcontractors and consultants, if any, are also useful.
- Identify all U.S. permanent residents to be involved in the project as direct employees, subcontractors, or consultants.
- Identify all non-U.S. citizens expected to be involved in the project as direct employees, subcontractors, or consultants. For all non-U.S. citizens, in addition to technical resumes, please provide countries of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project, as appropriate. Additional information may be requested during negotiations in order to verify the foreign citizen's eligibility to participate on a contract issued as a result of this announcement.

Phase I Work Plan Outline

NOTE: The AF uses the Phase I Work Plan Outline in lieu of a Statement of Work (SOW). DO NOT include proprietary information in the Work Plan Outline. This will necessitate a request for revision and may delay contract award, if selected.

In the Work Plan section, start with a Work Plan Outline in the following format:

1) Scope: List the major requirements and specifications of the effort.
2) Task Outline: Provide a brief outline of the work to be accomplished over the span of the Phase I effort.
3) Milestone Schedule
4) Deliverables
    a. Kickoff meeting within 30 days of contract start
    b. Progress reports
    c. Technical review within 6 months
    d. Final report with SF 298

Cost Volume: Cost information should be provided by completing the Cost Volume in DSIP and including the Cost Volume Itemized Listing specified below. The Cost Volume detail must be adequate to enable Air Force personnel to determine the purpose, necessity and reasonability of each cost element. Provide sufficient information (a-i below) regarding funds use if an award is received. The DSIP Cost Volume and Itemized Cost Volume Information will not count against the specified page limit. The itemized listing may be submitted in Volume 5 under the "Other" dropdown option.

a. **Special Tooling/Test Equipment and Material**: The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness to the work proposed. Special tooling and test equipment purchases must, in the opinion of the CO, be advantageous to the Government and relate directly to the effort. It may include such items as innovative instrumentation and/or automatic test equipment.

b. **Direct Cost Materials**: Justify costs for materials, parts, and supplies with an itemized list containing types, quantities, prices and where appropriate, purpose.

c. **Other Direct Costs**: This category includes, but it not limited to, specialized services such as machining, milling, special testing or analysis, and costs incurred in temporarily using specialized equipment. Proposals including leased hardware must include an adequate lease vs. purchase justification.

d. **Direct Labor**: Identify key personnel by name, if possible, or by labor category if not. Direct labor hours, labor overhead and/or fringe benefits, and actual hourly rates for each individual are also necessary.

e. **Travel**: Travel costs must relate to project needs. Break out travel costs by trip, number of travelers, airfare, per diem, lodging, etc. The number of trips required, as well as the destination and purpose of each, should be reflected. Recommend budgeting at least one trip to the Air Force location managing the contract.

f. **Subcontracts**: Involvement of a research institution in the project is required. Involvement of other subcontractors or consultants may also be desired. Describe in detail the tasks to be performed in the Technical Volume and include information in the Cost Volume for the research institution and any other subcontractors/consultants. The proposing SBC must perform a minimum of 40% of the Phase I R/R&D and the research institution must perform a minimum of 30%. Work allocation is measured by direct and indirect costs AFTER REMOVAL OF THE SBC's PROPOSED PROFIT. This work allocation requirement is codified in statute; therefore, the Government CO cannot waive it. STTR efforts may include subcontracts with Federal Laboratories and Federally Funded Research and Development Centers (FFRDCs). NOTE: Not all Federal Laboratories or FFRDCs qualify as research institutions.

Support subcontract costs with copies of executed agreements. The supporting agreement documents must adequately describe the work to be performed. At a minimum, each planned subcontractor's information must include a SOW with a corresponding detailed cost proposal.

g. **Consultants**: Provide a separate agreement letter for each consultant. The letter should briefly state what service or assistance will be provided, the number of hours required, and hourly or daily rate.

h. **DD Form 2345**: For proposals submitted under export-controlled topics, either by International Traffic in Arms or Export Administration Regulations (ITAR/EAR), a copy of a certified DD Form 2345, Militarily Critical Technical Data Agreement, or evidence of application submission must be included. The form, instructions, and FAQs may be found at the United States/Canada Joint Certification Program website, http://www.dla.mil/HQ/InformationOperations/Offers/Products/LogisticsApplications/JCP/DD2345Instructions.aspx. The DD Form 2345 must be approved prior to award if proposal is selected for negotiations and funding.

NOTE: Restrictive notices notwithstanding, proposals may be handled for administrative purposes only, by support contractors TEC Solutions, Inc., APEX, Oasis Systems, Riverside Research, Peerless Technologies, HPC-COM, Mile Two, Wright Brothers Institute, and MacB (an Alion Company). In addition, only Government employees and technical personnel from Federally Funded Research and Development Centers (FFRDCs) MITRE and Aerospace Corporations working under contract to provide technical support to AF Life Cycle Management Center and Space and Missiles Centers may evaluate proposals. All support contractors are bound by appropriate non-disclosure agreements. Please contact one of the Contracting Officer identified on A-1 with any concerns.

i. **Cost Sharing**: Cost share is not accepted as part of Phase I proposals.

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD SBIR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by the Air Force during proposal evaluations.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)
The Air Force does not participate in the Discretionary Technical and Business Assistance (TABA) Program. Proposals in response to Air Force topics should not include TABA.

PHASE I PROPOSAL SUBMISSION CHECKLIST
Firms shall register in the System for Award Management (SAM), https://www.sam.gov, to be eligible for proposal acceptance. Follow instructions therein to obtain a Commercial and Government Entity (CAGE) code and Dunn and Bradstreet (DUNS) number. Firms shall also verify "Purpose of Registration" is set to "I want to be able to bid on federal contracts or other procurement opportunities. I also want to be able to apply for grants, loans, and other financial assistance programs", NOT "I only want to apply for federal assistance opportunities like grants, loans, and other financial assistance programs." Firms registered to compete for federal assistance opportunities only at the time of proposal submission will not be considered for award. Addresses must be consistent between the proposal and SAM at award. Previously registered firms are advised to access SAM to ensure all company data is current before proposal submission and, if selected, award.

1) The Air Force Phase I proposal shall follow the topic-specific information in Chart 1.

2) It is mandatory complete proposal submission -- DoD Proposal Cover Sheet, Technical Volume with any appendices, Cost Volume, Itemized Cost Volume Information, Company Commercialization Report, and Fraud, Waste and Abuse Certificate of Training Completion -- be executed electronically through DSIP.

Please note the FWA Training shall be completed prior to proposal submission. When training is complete and certified, DSIP will indicate completion of the Volume 6 requirement. The proposal cannot be submitted until the training is complete. The AF recommends completing submission early, as site traffic is heavy prior to solicitation close, causing system lag. **Do not wait until the last minute.** The AF will not be responsible for proposals not completely submitted prior to the deadline due to system inaccessibility unless advised by DoD.

AIR FORCE PROPOSAL EVALUATIONS
The AF will utilize the Phase I proposal evaluation criteria in the DoD 22.A STTR BAA with the factors in descending order of importance.

The AF will utilize Phase II evaluation criteria in the DoD 22.A STTR BAA with the factors in descending order of importance.

Proposal Status and Feedback

The Principal Investigator (PI) and Corporate Official (CO) indicated on the Proposal Cover Sheet will be notified by e-mail regarding proposal selection or non-selection. Small businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the Proposal Number and Topic Number referenced.

Feedback will not be provided for Phase I proposals determined Not Selectable. Feedback is provided only for Phase II proposals determined Not Selectable.

IMPORTANT: Proposals submitted to the AF are received and evaluated by different organizations, handled topic by topic. Each organization operates within its own schedule for proposal evaluation and selection**.** Updates and notification timeframes will vary. If contacted regarding a proposal submission, it is not necessary to request information regarding additional submissions. Separate notifications are provided for each proposal.

It is anticipated all the proposals will be evaluated and selections finalized within approximately 90 calendar days of solicitation close. Please refrain from contacting the BAA COs for proposal status before that time.

Refer to the DoD STTR Program BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Air Force SBIR/STTR BAA Contracting Officers.

AIR FORCE SUBMISSION OF FINAL REPORTS

All final reports will be submitted to the awarding AF organization in accordance with the purchase order or contract. Companies will not submit Final Reports directly to the Defense Technical Information Center (DTIC).

PHASE II PROPOSAL SUBMISSIONS

AF organizations may request Phase II proposals while technical performance is on-going. This decision will be based on the contractor's technical progress, as determined by an AF TPOC's review using the DoD 22.A STTR BAA Phase I review criteria. All Phase I awardees will be provided an opportunity to submit a Phase II proposal unless the Phase I purchase order has been terminated for default or due to non-performance by the Phase I company.

Phase II is the demonstration of the technology found feasible in Phase I. Only Phase I awardees are eligible to submit a Phase II proposal. All Phase I awardees will be sent a notification with the Phase II proposal submittal date and detailed Phase II proposal preparation instructions. If the physical or email addresses or firm points of contact have changed since submission of the Phase I proposal, correct information shall be sent to the AF SBIR/STTR One Help Desk as instructed on A-1. Phase II dollar values, performance periods, and proposal content will be specified in the Phase II request for proposal.

NOTE: AF primarily awards Phase I and II contracts as Firm Fixed Price. However, awardees are strongly urged to work toward a Defense Contract Audit Agency (DCAA) approved accounting system. If the company intends to continue work with the DoD, an approved accounting system will allow for competition in a broader array of acquisition opportunities. Please address questions to the Phase II CO, if selected for award.

All proposals must be submitted electronically via DSIP by the date indicated in the Phase II request for proposal. Note: Only ONE Phase II proposal may be submitted for each Phase I award.

AIR FORCE STTR PROGRAM MANAGEMENT IMPROVEMENTS

The AF reserves the right to modify the Phase II submission requirements. Should the requirements change, all Phase I awardees will be notified. The Air Force also reserves the right to change any administrative procedures at any time to improve management of the AF STTR Program.

AIR FORCE 22.A STTR Phase I Topic Index

AF22A-T001 TITLE: Active techniques for ground-based space domain awareness

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Sensors; Electronics; Battlespace

OBJECTIVE: The objective of this project is to develop and demonstrate key components that would help make sodium-beacon or Rayleigh-beacon adaptive optics practical for military, ground-to-space imaging applications. Current commercial laser systems used to produce sodium and Rayleigh beacons were developed for astronomical applications. These commercial lasers are not suited for smaller military telescopes, which are typically installed in locations with much worse turbulence, when compared to astronomical telescopes. The objective is to develop these laser components and demonstrate them on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. These components could be demonstrated on government, university, or civilian telescopes.

DESCRIPTION: AFRL supports the US Space Force in researching and developing effective, affordable techniques to identify, track, and characterize satellites in earth orbit. Radar, although it is expensive to build and operate, works for satellites in low-earth orbit. However, because of the distances involved, only a few specialized ground-based radars are capable of tracking satellites in geosynchronous orbit. Compared to ground-to-space radars, ground-based optical telescopes are less expensive to build and operate; in addition, they work well for satellites in all orbits. However, atmospheric turbulence limits the resolution and effectiveness of ground-based optical telescopes. Laser-beacon adaptive optics is an established technique to overcome the effects of atmospheric turbulence.

However, there remain significant challenges to improving the utility and effectiveness of laser beacon adaptive optics for military applications. There are two main types of laser beacons used in adaptive optics, Rayleigh beacons and sodium beacons. Rayleigh beacons are formed by scattering light from molecules of nitrogen and oxygen lower in the atmosphere; typical altitudes range from 10 km to 20 km. Pulsed lasers are typically used for Rayleigh beacons so that the light may be sampled from a particular altitude by using a technique called range gating. Because Rayleigh scattering is much stronger for shorter wavelengths of light, common wavelengths for Rayleigh beacons are 355 nm and 532 nm.

Because Rayleigh beacons rely on scattering from air molecules, they are limited to relatively low altitudes where the density of air molecules is higher. Light from the beacon traverses a cone of air above the telescope, with the beacon at the apex of the cone and the telescope pupil at the base of the cone. If a Rayleigh beacon is used for a larger telescope, the cylindrical column of air above the telescope will not be well sampled. Because of this cone effect, Rayleigh beacons are suitable only for smaller telescopes of up to 2 m in diameter. Sodium beacons are formed from scattering light from a layer of ionic sodium that is centered at an altitude of 90 km above the ground. Because of their high altitude, sodium beacons sample a much larger cone of air when compared to Rayleigh beacons. So, they are better suited for use with large telescopes.

Lasers for bright Rayleigh and sodium beacons are large and heavy; they are difficult to mount on typical military telescopes, which tend to be much smaller than astronomical telescopes. In addition,

military telescopes are typically deployed to locations where the atmospheric turbulence is much worse than locations for astronomical observatories. To make matters worse, when a ground-based telescope tracks a satellite in low-earth orbit, it must slew quickly across the sky. This, in effect, creates a situation that is equivalent to a strong wind blowing across the aperture of the telescope. The combination of these two factors means a laser beacon for military purposes must be much brighter than a laser beacon for astronomy.

Another factor to consider is the risk that laser beacons pose to the safe operation of aircraft. Visible laser beacons are not eye-safe, thus considerable effort is necessary to avoid blinding aircraft pilots. Ultra-violet lasers are not transmitted by aircraft windscreens, but the silver mirror coatings typically used in telescopes do not reflect ultra-violet wavelengths well. Furthermore, the quantum efficiency of typical wave-front sensor cameras is low at ultra-violet wavelengths. Thus, AFRL is seeking development of key components that would help to make sodium-beacon or Rayleigh-beacon adaptive optics practical for military ground-to-space imaging applications. These components are listed below.
• On-telescope (side- or center-launched) Rayleigh beacon laser (ultra-violet and visible)
• Ultra-violet (eye-safe) laser beacon
• Uplink compensation of laser beacon to reduce beacon size
• Polychromatic laser beacon for sensing tilt and high-order aberrations
• Laser-beacon (Rayleigh and sodium) simulator for laboratory bench-top testing
• Hybrid Rayleigh-sodium beacon adaptive optics
• Tilt anisoplanatism compensation
• Electronic camera shutter or low-radio-frequency-interference Pockels cell for gating Rayleigh beacon return • Using adaptive optics telemetry in near-real-time for improving laser-beacon imaging and detection of closely spaced objects
• Advanced wave-front sensors and cameras for laser beacon adaptive optics

PHASE I: Phase I deliverables include a report that describes thoroughly concepts, analyses, and simulations for laser beacon components that are suitable for military ground-to-space imaging applications. These analyses and simulations must show that the proposed components are effective and affordable. The report should describe the components at a level suitable for a conceptual design review. (See the references section for the contents of a conceptual design review.) The report shall include a plan for demonstrating the laser components on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites.

PHASE II: Phase II deliverables include a detailed design of laser beacon components suitable for military ground-to-space imaging applications. This design must illustrate the proposed components are effective and affordable. The design documents should describe the components at a level suitable for preliminary and critical design reviews. (See the references section for the contents of preliminary and critical design reviews.)

The report shall include a detailed plan for demonstrating the laser components on-sky, in conditions representative of typical sites for ground-based observations of earth-orbiting satellites. As cost and schedule constraints allow, a prototype component shall be built, tested, and demonstrated on-sky at government, university, or civilian observatory.

PHASE III DUAL USE APPLICATIONS: A Phase III effort would require identifying a suitable transition partner, which could be a government program office, a government contractor or other commercial entity, or a civilian astronomical observatory.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR Help Desk: usaf.team@afsbirsttr.us

REFERENCES:
1. Laser beacons or laser guide stars https://en.wikipedia.org/wiki/Laser_guide_star;
2. Conceptual Design Review
https://en.wikipedia.org/wiki/Engineering_design_processConcept_Generation

KEYWORDS: laser beacon; laser guide star; Rayleigh beacon; polychromatic beacon; adaptive optics; tilt anisoplanatism; wave-front sensor; electronic shutter

AF22A-T002 TITLE: Additive Manufacturing Techniques for Astronomical Mirror

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: This topic's outcome will be ability to create a telescope mirror not requiring much/any figuring to be usable for observing space objects.

DESCRIPTION: Efforts will aim to develop techniques/technologies to allow 3D printing at nanometer scales to produce parabolic/spherical mirrors requiring little to no figuring or modification. Visible light is in the range of 400 - 700 nm and typical figuring of astronomical telescopes is to the wavelength/10 or better.

Achieving this level of figuring with a 3D printer will require either the ability to print at the nanometer scale, or some technique to get the nanometer figure at a larger print scale. The Air Force is looking for a solution eventually providing the ability to mass produce custom size/shape mirrors for use in telescopes supporting Space Domain Awareness at reduced costs and at lighter weights to improve performance.

PHASE I: Investigate the capabilities of various Additive Manufacturing devices and techniques for micrometer-to-nanometer-scale accuracies. Research how those capabilities could be improved to provide required accuracy to 3D print a quality mirror. Research various printing materials providing the strength required for a size-able mirror to retain its shape when used in a telescope. Investigate techniques to make the process scalable; being able to 3D print a meter-class mirror for a telescope could provide additional opportunities for successful technology transition.

PHASE II: The contractor will demonstrate the ability to 3D print a high-quality mirror that can be used for astronomical purposes by printing an 8-inch mirror with an approximate focal length of 840mm (F/4 focal ratio) and a surface figure of wavelength/10 (./10). The mirror will be assembled into a Newtonian telescope design to demonstrate its ability to hold its shape in actual use. The contractor will, in the course of this phase also demonstrate the tradeoffs of time to print vs. the quality of the printed mirror (./4 vs. ./10 figuring). The contractor should make contact with telescope manufacturers during this phase to garner interest in their technique/potential products. The resulting telescope will be provided to the Space Force for evaluation under normal operations.

PHASE III DUAL USE APPLICATIONS: The contractor will demonstrate the scalability of the technology/techniques to a twenty-inch mirror with wavelength/10 figure.
For dual use potential: Recently there has been a shortage of commercial, hobbyist telescopes due to supply issues from non-indigenous manufacturers. This capability could relieve this shortage.

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1. https://3dprint.com/238521/nanofabrica-micron-resolution-3d-printing-platform/
2. https://www.energy.gov/science/bes/articles/how-3d-print-nanoscale
3. https://onlinelibrary.wiley.com/doi/abs/10.1002/adma.202001675?af=R

4. https://www.researchgate.net/publication/341454859_3D_Printing_of_Micrometer-Sized_Transparent_Ceramics_with_On-Demand_Optical-Gain_Properties

KEYWORDS: Additive Manufacturing; Telescope Mirrors; 3D Printing; Astronomical Mirrors; Nanometer scale

AF22A-T003 TITLE: Distributed Satellite Autonomy and Multi-perspective Data Fusion

TECH FOCUS AREAS: Autonomy

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: Research and develop algorithms applied distributed satellite autonomy for clustered satellite systems as well as leveraging multi-perspective observations and measurements.

DESCRIPTION: Academic circles have investigated the topic of distributed collaborative control and autonomy for decades and recent applications to UAV's, warehouse servicers, ground robotics and more are increasingly available. More specifically, the topic of distributed collaborative autonomy applies to the situation where a group of agents share their information to achieve a common task.

However, there exist numerous challenges of applying this work to the space domain that may not be seen in terrestrial domains, in particular, communication networks between satellites and/or ground stations are dynamic and are, in general, low bandwidth and throughput, contain significant latencies. Limited computational hardware requires lightweight algorithms to compute correct collaboration tasks, manage scalability and fuse agents' sensor measurements.

Moreover, space is growing increasingly congested and contested, for which the resiliency of the space domain must be assured. The objective of this STTR is to address the resiliency of the space domain through autonomous mission distribution of satellite systems. More specifically, the Offeror will research, develop and test lightweight distributed satellite autonomy of heterogeneous sensors and consider the impact of multi-perspective sensor fusion into the autonomous architecture. The capabilities of this software and algorithm-based approach will enhance the future of the space domain architecture. Offerors are encouraged to work with prime contractors to facilitate technology transition. Offerors should clearly indicate in their proposals what Government furnished property or information are required to conduct this effort.

PHASE I: Conduct a comprehensive comparative assessment and trade-off study of distributed autonomy architectures, algorithms and techniques that are computationally efficient and with low communication throughput requirements.

PHASE II: Design, implement, integrate and test the most promising and effective instantiation of the distributed autonomy algorithms in an AFRL/RV Laboratory Environment. Conduct analysis and simulations to demonstrate the effectiveness and resilience of the algorithms. Assess the implementation overhead of the candidate techniques and conduct through trade-off studies.

PHASE III DUAL USE APPLICATIONS: Develop flight ready software for implementation into future AFRL or other Government flight missions and laboratory experiments.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any

proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR Help Desk: usaf.team@afsbirsttr.us

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2. D. Selva, A. Golkar, O. Korobova, I. L. i Cruz, P. Collopy, and O. L. de Weck, “Distributed Earth Satellite Systems: What Is Needed to Move Forward?” Journal of Aerospace Information Systems 14:8, 412-438 2017;
3. S. A. Szklany, J. L. Crassidis and S.S. Blackman, "Centralized and Decentralized Space Object Estimation and Data Association with Pattern Recognition", John L. Junkins Symposium, College Station, TX, May 2018.

KEYWORDS: Distributed Satellite Autonomy; Autonomy; Sensor-Fusion

AF22A-T004 TITLE: Satellite Fault Identification

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: Currently, for USSF satellites there is a team of >5 SMEs furiously monitoring the state of a satellite's health. Fault classification software plus already existing fault detection software would remove the need for constant monitoring. This would not only allow the operators to focus on the congested and contested manner of space but also mitigate faults in a satellite quickly and effectively.

DESCRIPTION: For an operator to mitigate a satellite fault quickly and effectively, the fault's cause must be understood. This requirement is due to the fact many faults have similar effects on the satellite but completely different causes. For instance, a solar Coronal Mass Ejection (CME) looks similar to a developer’s bug in the software and various types of cyber-attacks. All of these faults might require completely different mitigation steps. For a CME, one way to fix the satellite is a restart after the event, the developer’s code fix should be uploaded, and the cyber-attack could require a variety of responses depending on the attacker and the severity of the attack. These events also might not exist in the same dataset if they exist at all [1,2]. Therefore, this classification must also work for unknown unknown events so that it can be prepared to interact with the dynamic environment of space.

This topic's objective is to develop algorithms and code classifying a detected fault. The contractor will be given different satellite datasets either simulated or real on which to train. A separate dataset will be provided to prove out the algorithm.

PHASE I: In Phase I, selected companies will conduct a comprehensive comparative assessment with trade-offs of various classification algorithms and approaches. Implementation complexity of candidate techniques and conduct trade-offs will be assessed with respect to impact on SWAP-C and operational suitability. Deliverables of this should include a trade study and appropriate analysis reporting.

PHASE II: If selected for Phase II, companies will design, implement, integrate, and test the most promising and effective algorithm with ground software to classify detected satellite faults in near real time. Deliverables will include any relevant reporting analysis and software developed where appropriate.

PHASE III DUAL USE APPLICATIONS: In cooperative efforts with one or more satellite software manufacturers and military satellite system developers, Phase III efforts would integrate the proposed algorithms with satellite software; demonstrate the algorithm running on board a satellite; and evaluate transition opportunities for utilization in approved Government civilian applications.

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section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR Help Desk: usaf.team@afsbirsttr.us

REFERENCES:
1. Trevor Hastie, Robert Tibshirani, and Jerome Friedman. The Elements of Statistical Learning.Springer, New York, NY, 2001.;
2. D. T. Magill. Optimal adaptive estimation of sampled stochastic processes. IEEE Transactions on Systems, Man and Cybernetics, AC-10:434–439, October 1965.

KEYWORDS: Satellite Faults; fault classification

AF22A-T005 TITLE: Characterization of Store Trajectory Dynamics Released from Internal Cavities Using Machine Learning, Artificial Intelligence and Other Advanced Data Analysis Techniques

TECH FOCUS AREAS: Artificial Intelligence/Machine Learning

TECHNOLOGY AREAS: Information Systems; Air Platform

OBJECTIVE: This topic's objective is to develop analysis techniques via application of machine learning, artificial intelligence and/or other advanced data analysis techniques to evaluate and characterize large amounts of trajectory data generated for stores released from an internal cavity weapons bay. The goal would be to utilize such techniques to identify and subsequently exploit potential linkages between flow conditions in the cavity at and after the time of release with the disparity of the store trajectories observed due to variation in release time.

DESCRIPTION: A large dataset consisting of approximately 100 cases is currently being generated via high-fidelity CFD simulating the trajectories of small, light-weight stores being released from internal weapons bays (cavities) at high speeds. The simulation in this dataset primarily consists of the store configuration being held in carriage for some period of time and then released using a prescribed ejector profile, with the release time being the only variation in the simulations. It has been shown that the time of release of the store has a significant impact on its subsequent trajectory due to the unsteady flow-field in the cavity. The existing CFD dataset consists of high-frequency integrated force/moment components acting on the store, two-dimensional flow-field representations at various spanwise locations and heights in the cavity, and pressure time histories at various positions on the cavity walls/ceiling and the store prior to release as well as during the trajectory.

Additional data could also be collected during subsequent simulations as needed to develop appropriate analysis techniques. This rich data set will be provided as a training set in order to use various AI/ML or other analysis techniques to attempt to determine if there is some predictable cavity flow-field and/or force/moment state either 1) at the time of release and/or 2) after release while the store is traversing the cavity, shear layer and/or free-stream that leads to specific trajectory states. Of particular interest are the states associated with “bad” releases, defined as the distance between the store center of gravity and aircraft hardware not monotonically increasing or the store entering the free stream with high rates of pitch and/or yaw.

PHASE I: Phase I efforts will determine the scientific and technical merit and feasibility of application of AI, ML and/or advanced analysis techniques to determine root causes for a specified store to reach a particular state when released from an internal store configuration. High-fidelity, unsteady CFD of 6DOF trajectories generated for a particular store released at various times will be provided as GFE.

Tangible outcomes for the Phase I effort would be the demonstration of a practical process to relate particular states of the cavity to specific trajectory behaviors. The envisioned main deliverable for Phase I would be a report documenting the process with sufficient detail to allow evaluation by the government and example(s) of its application on the dataset provided. Identification of the overall plan to mature the concepts into a useable tool along with plans to generate additional data needed to support development/expansion of method to additional configurations should also be reported.

PHASE II: Further develop the approach to demonstrate its ability to identify conditions in the cavity (including the shear layer) related to trajectories. This identification should be probabilistic in nature, where certain flow features and/or force/moment states produce, bad trajectories are observed to exist in some statistically significant number of cases.

Extension of approach to data from other stores and/or other cavity configurations would be encouraged. Tangible outcomes and expected deliverables for the Phase II effort would include stand-alone software that would take in high-fidelity unsteady CFD data and produce output that could identify release points or flow states/flow-field features associated with problematic trajectories. A stretch goal would be the inclusion of surrogate modeling of key cavity environmental features that would permit reduced order evaluation of configurations beyond the training data set.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will focus on transitioning the developed technology to a working commercial or warfighter software/processes. Solutions developed will be immediately relevant to precision airdrop, cargo and weapons release, among a whole range of commercial and military applications. If a viable approach to identify conditions associated with bad trajectories are identified, this would allow potential flow-control solutions to be investigated to "fix" these conditions and diminish problematic releases. They would be in a position to supply future software/processes to the Air Force, and other DoD components to facilitate future weapons bay designs that would improve separation characteristics.

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REFERENCES:

1. Brunton, S. L., Noack, B. and Koumoutsakos, P., "Machine Learning for Fluid Mechanics", Annual Review of Fluid Mechanics, Vol. 52, pp 477-508, 2020 (doi:10.1146/annurev-fluid-010719-060214);
2. Sun et al., "Resolvent Analysis of Compressible Laminar and Turbulent Cavity Flow", AIAA Journal, Vol .58, No. 3, pp. 1046-1055,(doi:10.251.4/J058663)

KEYWORDS: Artifical Intelligence; Machine Learning; Store Separation; Cavity; Computational Fluid Dynamics; Six-Degree-of-Freedom Trajectories

AF22A-T006 TITLE: Development of Integrated Infrared Focal Plane Arrays on Si, Requiring No Hybridization

TECH FOCUS AREAS: Microelectronics

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This topic seeks to develop infrared focal plane arrays (FPAs) directly onto silicon readout integrated circuitry without hybridization, operating at 2 um or longer, and using GeSn or GeSiSn absorbing layers.

DESCRIPTION: Conventional short- and mid-wave infrared (SWIR and MWIR) detectors based on III-V (i.e., GaInSb) or II-VI (i.e., HgCdTe) materials are relatively expensive and incompatible with silicon-based readout integrated circuitry (ROIC), requiring hybridization (typically in bump bonding) which is very expensive. Technologies based on Si and SiGe are pervasive for electronic applications, but indirect energy gaps prevent their use as the active elements in optoelectronic devices. Recent progress in the material system of Group-IV alloys containing Sn (GeSiSn and GeSn) and the potential of a direct energy gap for certain compositions promises significant optical performance which is compatible with and will allow for direct integration with Si complementary metal-oxide-semiconductor (CMOS) device processing. Extremely high-quality thin films and initial proof-of-concept emitters and detectors have been demonstrated on Ge substrates but corresponding films on Si substrates suffer from high defect levels due to the lattice mismatch of high Sn content GeSiSn and GeSn alloys necessary for direct energy gap devices. The use of one or more buffer layers (e.g., a Ge virtual substrate alone or with GeSn overlayers) on Si have been used to reduce such defects but impede device integration. Therefore, development of easily integrated emitters and detectors on Si substrates are critical for mass production of optoelectronic devices using standard CMOS production equipment and large diameter Si wafers. A number of patterned deposition techniques have been developed for other heteroepitaxy systems (e.g. GaN on SiC or Al2O3 substrates), including nanopillars, template growth, epitaxial overgrowth, and planarization to reduce structural defects such as dislocations. Therefore, it should be feasible to use similar approaches or develop novel ones to synthesize high quality GeSiSn or GeSn films directly on Si ROICs without the need for hybridization. Such layers could be used to fabricate integrated FPAs operating in the SWIR or MWIR spectral regions. Thus, if successful, this technology could be rapidly scaled and industrialized to produce low cost, large format imagers.

PHASE I: Demonstrate the feasibility of novel techniques for growth of GeSiSn and/or GeSn films directly on Si substrates. Design device structures incorporating barriers for dark current reduction, including single and complementary barrier architectures that minimize optical and electrical crosstalk between devices. All devices should be vertical to facilitate mating to either a commercially available readout integrated circuit (ROIC) or a fanout for testing purposes. Provide experimental evidence for improved material performance of device quality epitaxial films grown on Si substrates, improved infrared absorption, and narrower X-ray rocking curves compared to typical films synthesized on traditional vacuum deposited buffer layers. Deliver a GeSiSn or GeSn film on 2" silicon wafer or larger with a minimum of 500 nm thickness for material characterization, as well as a processed variable area device die for photodetector testing.

PHASE II: Companies selected for Phase II will fabricate and characterize integrated focal plane array (FPA) detectors operating within the spectral range of 2 - 5 um on Si readout intectrated circuits (ROICs). The external quantum efficiency (EQE) of the devices should be greater than 20% from 1.1 to more than 2.0 um and the dark current density should be less than 1 uA per sq. cm at temperatures of 200 K or greater. Deliver a silicon fanout (minimum 32 x 32, <50 um pitch) using direct deposition to verify dark current density and EQE. Deliver full FPAs for array level testing.

PHASE III DUAL USE APPLICATIONS: In Phase III, the device quality GeSiSn and/or GeSn films will be used to make infrared device structures as required by military and commercial customers including those who manufacture integrated circuits and IR optical detectors.

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1. C.-H. Tsai, K.-C. Lin, C.-Y. Cheng, K.-C. Lee, H. H. Cheng, G.-E. Chang, “GeSn lateral p-i-n waveguide photodetectors for mid-infrared integrated photonics”, Opt. Lett. 46, 864 (2021);
2. H. Kumar and R. Basu, “Effects of Defects on the Performance of Si-Based GeSn/Ge Mid-Infrared Phototransistors”, IEEE Sensors J. 21, 5975 (2021);
3. H. Tran, T. Pham, J. Margetis, Y. Zhou, W. Dou, P. C. Grant, J. M. Grant, S. Al-Kabi, G. Sun, R. A. Soref, J. Tolle, Y.-H. Zhang, W. Du, B. Li, M. Mortazavi, S.-Q. Yu, “Si-Based GeSn Photodetectors toward Mid-Infrared Imaging Applications”, ACS Photonics 6, 2807 (2019);
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6. R. Roucka, J. Mathews, C. Weng, R. Beeler, J. Tolle, J. Menendez, and J. Kouvetakis, “High-performance near-IR photodiodes: a novel chemistry-based approach to Ge and Ge–Sn devices integrated on silicon,” IEEE J. Quantum Electronics 47, 213 (2011);
7. J. Taraci, S. Zollner, M. R. McCartney, J. Menendez, M. A. Santana-Aranda, D. J. Smith, A. Haaland, A.V. Tutukin, G. Gundersen, G. Wolf, and J. Kouvetakis, “Synthesis of silicon-based infrared semiconductors in the Ge-Sn system using molecular chemistry methods,” J. Am. Chem. Soc. 123, 10980 (2001)

KEYWORDS: GeSiSn; GeSn; silicon; germanium; silicon-germanium-tin; Buffer layers; Molecular Beam Epitaxy; MBE; CVD; chemical vapor deposition; epitaxial lateral overgrowth (ELO); detectors; Group IV photonics; silicon photonics; optoelectronic devices; device fabrication; growth;

heterostructures; radiative recombination; quantum efficiency; semiconductor characterization; infrared; focal plane arrays (FPA)

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY (NGA)
22.A Small Technology Transfer (STTR) Phase I
Proposal Submission Instructions

INTRODUCTION

The National Geospatial-Intelligence Agency (NGA) has a responsibility to provide the products and services that decision makers, warfighters, and first responders need, when they need it most. As a member of the Intelligence Community and the Department of Defense, NGA supports a unique mission set. We are committed to acquiring, developing and maintaining the proper technology, people and processes that will enable overall mission success.

Geospatial intelligence, or GEOINT, is the exploitation and analysis of imagery and geospatial information to describe, assess and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence and geospatial information.

With our unique mission set, NGA pursues research that will help guarantee the information edge over potential adversaries. Additional information pertaining to the National Geospatial-Intelligence Agency's mission can be obtained by viewing the website at http://www.nga.mil/.

Proposers responding to a topic in this BAA must follow all general instructions provided in the Department of Defense (DoD) STTR Program BAA. NGA requirements in addition to or deviating from the DoD Program BAA are provided in the instructions below.

Specific questions pertaining to the administration of the STTR Program and these proposal preparation instructions should be directed to:

National Geospatial-Intelligence Agency
Attn: STTR Program Manager, RA, MS: S75-RA
7500 GEOINT Dr., Springfield, VA 22150-7500
Email: SBIR@nga.mil

PHASE I PROPOSAL GUIDELINES

The Defense SBIR/STTR Innovation Portal (DSIP) is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Detailed instructions regarding registration and proposal submission via DSIP are provided in the DoD STTR Program BAA.

Technical Volume (Volume 2)

The technical volume is not to exceed 20 pages and must follow the formatting requirements provided in the DoD STTR Program BAA. The Government will not consider pages in excess of the page count limitations. Number all pages of your proposal consecutively.

Content of the Technical Volume

Refer to the DoD SBIR Program BAA for detailed instructions on the content of the technical volume.

Cost Volume (Volume 3)

The Phase I Base amount must not exceed $100,000 over a period of performance not exceeding 9 months.

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD STTR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by NGA during proposal evaluations.

Supporting Documents (Volume 5)
In addition to the Volume 5 requirements listed in the DoD SBIR Program BAA, the vendor may submit supporting documents (Volume 5) but that material WILL NOT be reviewed by the evaluation team as part of the proposal evaluation. Items that may go into, not all inclusive, are additional cost proposal information, advocacy letters, etc.

PHASE II PROPOSAL GUIDELINES
Phase II proposals may only be submitted by Phase I awardees. Phase II is the demonstration of the technology found feasible in Phase I. All NGA STTR Phase I awardees from this BAA will be allowed to submit a Phase II proposal for evaluation and possible selection. To minimize the gap between the Phase I and Phase II, it is suggested that the vendor submit their proposal during month 7 of the Phase I award.

The NGA STTR Program is committed to minimizing the funding gap between Phase I and Phase II activities. Phase I awardees may submit a Phase II proposal without invitation; However, it is strongly encouraged that an UNCLASSIFIED Phase II proposal not be submitted until sufficient Phase I progress can be evaluated and assessed based on results of the Phase I proof-of-concept/feasibility study Work Plan. Therefore, it is highly recommended to submit your UNCLASSIFIED proposal 60 days prior to the end date of their Phase I contract in order to be considered for funding. All NGA STTR Phase II proposals will receive a timely review.

Due to limited funding, the NGA SBIR Program reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

NGA typically provides a firm fixed price payable milestone contract as a Phase II award. The type of contract is at the discretion of the Contracting Officer.

Initial Phase II proposals shall be limited to $1,000,000 over a two-year period with a Period of Performance not exceeding 24 months.

Small businesses submitting a Phase II Proposal must use the DoD STTR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheets, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR/STTR Help Desk at DoDSBIRSupport@reisystems.com.

The Phase II Technical Volume has a 40-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any attachments. Do not include blank pages, duplicate the electronically generated Cover Sheets or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 40-page limit.

- **Proposal Cover Sheet (Volume 1):** The Cover Sheet must include a brief technical abstract of no more than 200 words that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. Do not include proprietary or classified

information in the Proposal Cover Sheet. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released.

- **Format of Technical Volume (Volume 2)**: The Technical Volume must be a single Portable Document Format (PDF) file, including graphics. Perform a virus check before uploading the Technical Volume file. If a virus is detected, it may cause rejection of the proposal. Do not lock or encrypt the uploaded file. Do not include or embed active graphics such as videos, moving pictures, or other similar media in the document. The length of each part of the technical volume is limited to 40 pages. The Government will not consider pages in excess of the page count limitations. Number all pages of your proposal consecutively. Font size should not be smaller than 12 pitch Times New Roman font, with at least a one-inch margin on top, bottom, and sides, on 8½" by 11" paper. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by DSIP when the Cover Sheet was created. The header may be included in the one-inch margin.
    - (1) Significance of the Problem. Define the specific technical problem or opportunity addressed and its importance.
    - (2) Phase II Technical Objectives. Enumerate the specific objectives of the Phase II work, and describe the technical approach and methods to be used in meeting these objectives.
    - (3) Phase II Statement of Work. The statement of work should provide an explicit, detailed description of the Phase II approach, indicate what is planned, how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal. Include how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail.
    - (4) Section 508 Compliance: The contractor shall ensure that all systems, hardware, software, software engineering, and information technology associated with this effort is made in a manner that is accessible for people with the standards for people with disabilities as directed in the NGA Instruction 8400.4 and Section 508 of the Rehabilitation Act of 1973 as amended in 1998 (Section 508). Specifically, all Information and Communications Technology (ICT) associated with this contract, may use the Web Content Accessibility Guidelines (WCAG) 2.1 to comply with the Section 508 or use alternative designs or technologies which result in substantially equivalent or greater access to and use of the product for people with disabilities. Furthermore, the contractor shall pursue human centered design and usability guidelines in order to ensure that all services associated with this Topic Area are accessible by as many users as possible and as a means to drive modernization, innovation, and enhance mission support. **As part of the vendor's proposal, the vendor should include an outline specifically how Section 508 compliance will be achieved in the design of the ICT product. The proposal for Phase 2 should provide an explicit, detailed description of the approach, indicate what is planned, how and where the work will be carried out, a schedule of major events, how the solution will be Section 508 Compliant, and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail. If a determination is made that a Section 508 exception request is justified, the rationale for the exception request must be made and submitted as a part of the proposal.**
    - (5) Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the Principle Investigator (PI), the proposer, consultants or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state of the art in the specific topic. Describe previous work

not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number) and (3) date of completion.

- (6) Relationship with Future Research or Research and Development. State the anticipated results of the proposed approach if the project is successful. ii. Discuss the significance of the Phase II effort in providing a foundation for Phase III research and development or commercialization effort.
- (7) Key Personnel. Identify key personnel who will be involved in the Phase II effort including information on directly related education and experience. A concise resume of the PI, including a list of relevant publications (if any), must be included. All resumes count toward the page limitation.
- (8) Foreign Citizens. Identify any foreign nationals you expect to be involved on this project.
- (9) Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in the cost proposal) shall be justified under this section. If proposing to perform classified activities during the period of performance you need to provide the following: 1) Will the information include controlled unclassified information (CUI) and; 2) What unclassified IT systems will be required.
- (10) Subcontractors/Consultants. Involvement of a university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be identified and described according to the Cost Breakdown Guidance. Please refer to section 4.2 of this BAA for detailed eligibility requirements as it pertains to the use of subcontractors/consultants.
- (11) Prior, Current or Pending Support of Similar Proposals or Awards. If a proposal submitted in response to this is substantially the same as another proposal that was funded, is now being funded, or is pending with another Federal Agency, or another or the same DoD Component, you must reveal this on the Proposal Cover Sheet and provide the following information: a) Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received. b) Date of proposal submission or date of award. c) Title of proposal. d) Name and title of the PI for each proposal submitted or award received. e) Title, number, and date of BAA(s) or solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received. f) If award was received, state contract number. g) Specify the applicable topics for each proposal submitted or award received. Note: If this does not apply, state in the proposal "No prior, current, or pending support for proposed work."
- (12) Commercialization Strategy. NGA is equally interested in dual use commercialization of SBIR/STTR projects that result in products sold to the U.S. military, the private sector market, or both. NGA expects explicit discussion of key activities to achieve this result in the commercialization strategy part of the proposal. The Technical Volume of each Direct to Phase I proposal must include a commercialization strategy section. The Phase I commercialization strategy shall not exceed 5 pages. The commercialization strategy should include the following elements:
    - a) Problem or Need Statement. Briefly describe what you know of the problem, need, or requirement, and its significance relevant to a Department of Defense application and/or a private sector application that the SBIR/STTR project results would address.
    - b) Description of Product(s) and/or System Application(s). Identify the commercial product(s) and/or DoD system(s), or system(s) under development,

or potential new system(s). Identify the potential DoD end users, Federal customers, and/or private sector customers who would likely use the technology.

- c) Business Model(s)/Procurement Mechanism(s). Discuss your current business model hypothesis for bringing the technology to market. Describe plans to license, partner, or self-produce your product. How do you plan to generate revenue? Understanding NGA's goal of creating and sustaining a U.S. military advantage, describe how you intend to develop your product and supply chains to enable this differentiation.
- d) Target Market. Describe the market and customer sets you propose to target, their size, their growth rate, and their key reasons they would consider procuring the technology. Describe competing technologies existent today on the market as well as those being developed in the lab.
- e) Funding Requirements. Describe your company's funding history. How much external financing have you raised? Describe your plans for future funding sources (internal, loan, angel, venture capital, etc.).
- f) Commercialization Risks. Describe the major technology, market and team risks associated with achieving successful transition of the NGA funded technology. NGA is not afraid to take risks but we want to ensure that our awardees clearly understand the risks in front of them.
- g) Expertise/Qualifications of Team/Company Readiness. Describe the expertise and qualifications of your management, marketing/business development and technical team that will support the transition of the technology from the prototype to the commercial market and into government operational environments. Has this team previously taken similar products/services to market? If the present team does not have this needed expertise, how do you intend to obtain it? What is the financial history and health of your company (e.g., availability of cash, profitability, revenue growth, etc.)?

- **Format of Cost Volume (Volume 3):** The Cost Volume (and supporting documentation) DOES NOT count toward the page limit of the Technical Volume. Some items in the Cost Breakdown Guidance below may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. ALL proposed costs should be accompanied by documentation to substantiate how the cost was derived. For example, if you proposed travel cost to attend a project-related meeting or conference, and used a travel website to compare flight costs, include a screen shot of the comparison. Similarly, if you proposed to purchase materials or equipment, and used the internet to search for the best source, include your market research for those items. You do not necessarily have to propose the cheapest item or supplier, but you should explain your decision to choose one item or supplier over another. It's important to provide enough information to allow contracting personnel to understand how the proposer plans to use the requested funds. If selected for award, failure to include the documentation with your proposal will delay contract negotiation, and the proposer will be asked to submit the necessary documentation to the Contracting Officer to substantiate costs (e.g., cost estimates for equipment, materials, and consultants or subcontractors). It is important to respond as quickly as possible to the Contracting Officer's request for documentation. Cost Breakdown Guidance:
    - List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
    - Special tooling and test equipment and material cost may be included. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative

instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with NGA; unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by NGA.
    - Cost for travel funds must be justified and related to the needs of the project.
    - Cost sharing is permitted for proposals under this announcement; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.
    - All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal. The Supporting Documents Volume (Volume 5) may be used if additional space is needed. For more information about cost proposals and accounting standards, see the DCAA publication titled "Audit Process Overview – Information for Contractors" available at: http://www.dcaa.mil.
- **Company Commercialization Report (Volume 4):** See DoD STTR Instructions on Company Commercialization Report. This material WILL NOT be reviewed by the evaluation team as part of the proposal evaluation.
- **Supporting Documents (Volume 5):** The vendor may submit supporting documents (Volume 5) but that material WILL NOT be reviewed by the evaluation team as part of the proposal evaluation. Items that may go into, not all inclusive, are additional cost proposal information, Completed Form SF326, advocacy letters, etc.
- **Fraud, Waste and Abuse Training (Volume 6):** See DoD STTR Instructions on Fraud, Waste and Abuse Training. This material WILL NOT be reviewed by the evaluation team as part of the proposal evaluation.

Selection of Phase II proposals will be in accordance with the evaluation procedures and criteria discussed in this BAA (refer to Section 6.0 of the BAA). As part of subfactor c in the evaluation criteria, the vendor will be evaluated on how it addresses the following five questions on the overall commercialization strategy:

(1) What is the first product that this technology will go into?
(2) Who will be the customers, and what is the estimated market size?
(3) How much money will be needed to bring the technology to market, and how will that money be raised?
(4) Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
(5) Who are the proposing firm's competitors, and what is the price and/or quality advantage over those competitors?

A work breakdown structure that shows the number of hours and labor category broken out by task and subtask, as well as the start and end dates for each task and subtask, shall be included.

Phase II contracts shall include a requirement to produce a monthly status and financial reports, an interim report not later than 12 months after contract award, a prototype demonstration not later than 23 months after contract award and a final report not later than 24 months after contract award. These reports shall include the following sections:

- A summary of the results of the Phase II research to date
- A summary of the Phase II tasks not yet completed with an estimate of the completion date for each task
- A statement of potential applications and benefits of the research.

- A summary of any risks or issues

The interim and final report shall be prepared single spaced in 12 pitch Times New Roman font, with at least a one-inch margin on top, bottom, and sides, on 8½" by 11" paper. The pages shall be numbered.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)
NGA will not provide any TABA.

EVALUATION AND SELECTION
All proposals will be evaluated in accordance with the evaluation criteria listed in the DoD STTR Program BAA. Selection of Phase I proposals will be in accordance with the evaluation procedures and criteria discussed in this BAA. As part of subfactor c in the evaluation criteria, the vendor will be evaluated on how it addresses the following five questions on the overall commercialization strategy:

(1) What is the first product that this technology will go into?
(2) Who will be the customers, and what is the estimated market size?
(3) How much money will be needed to bring the technology to market, and how will that money be raised?
(4) Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
(5) Who are the proposing firm's competitors, and what is the price and/or quality advantage over those competitors?

Proposals not conforming to the terms of this BAA, and unsolicited proposals, will not be considered. Awards are subject to the availability of funding and successful completion of contract negotiations.

The NGA STTR Program reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality in the judgment of the technical evaluation team will be funded. The offeror must be responsive to the topic requirements, as solicited.

Proposing firms will be notified of selection or non-selection status for a Phase I award within 90 days of the closing date of the BAA. The individual named as the Corporate Official on the Proposal Cover Sheet will receive an email for each proposal submitted from the Government Contracting Officer/Specialist with their official notification of proposal selection or non-selection. The notices will be binned into 3 categories: (1) proposals selected for award, (2) proposals selected for award, if additional funding becomes available, and (3) proposals not selected for award. Proposals with the award designation of 'Award if Additional Funding Becomes Available' will receive consideration for award 12 months from the BAA close date. An unsuccessful offeror has 3 days after notification that its proposal was not selected to submit a written request for a debriefing to the Contracting Officer (CO). Those offerors who get their written request in within the allotted timeframe above will be provided a debriefing.

Refer to the DoD STTR Program BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Viphalac Dickover at Viphalac.C.Dickover@nga.mil.

AWARD AND CONTRACT INFORMATION
Federally Funded Research and Development Contractors (FFRDC) and other government contractors, whom have signed Non-Disclosures Agreements, may be used in the evaluation of your proposal.
NGA typically provides a firm fixed price payable milestone contract for Phase I awards. The type of contract is at the discretion of the Contracting Officer.

Phase I contracts will include a requirement to produce monthly status reports, a more detailed interim report not later than 7 months after award, a final report no later than 9 months after award and any software/algorithms/documentation from items developed in Phase I. These reports shall include the following sections:

- A summary of the results of the Phase I research to date
- A summary of the Phase I tasks not yet completed, with an estimated completion date for each task
- A statement of potential applications and benefits of the research.
- A summary of any risks or issues

The interim report (draft final report) and final report shall be prepared single spaced in 12 pitch Times New Roman font, with at least a one-inch margin on top, bottom, and sides, on 8½" by 11" paper. The pages shall be numbered.

ADDITIONAL INFORMATION

USE OF FOREIGN NATIONALS

Due to the nature of our business, only US Nationals are permitted to work on NGA topics, unless the vendor proposes the work as Fundamental Research and indicates it as such in the proposal. The use of non-US National on a NGA contract is PROHIBITTED, unless the work is scoped as Fundamental Research. If the effort is Fundamental Research, the PI must be a US National. ALL offerors proposing to use non-US Nationals (which has not been determined as Fundamental Research) on the effort will be ineligible for award. This includes the use at universities or any other subcontractor. In the event it is determined to be Fundamental Research, non-US Nationals will be ineligible to receive controlled unclassified information as described below.

CONTROLLED UNCLASSIFIED INFORMATION (CUI)

Controlled Unclassified Information (CUI) is information that requires safeguarding or dissemination controls pursuant to and consistent with applicable law, regulations, and government-wide policies but is not classified under Executive Order 13526 or the Atomic Energy Act, as amended.

Executive Order 13556 "Controlled Unclassified Information" (the Order), establishes a program for managing CUI across the Executive branch and designates the National Archives and Records Administration (NARA) as Executive Agent to implement the Order and oversee agency actions to ensure compliance. The Archivist of the United States delegated these responsibilities to the Information Security Oversight Office (ISOO).

32 CFR Part 2002 "Controlled Unclassified Information" was issued by ISOO to establish policy for agencies on designating, safeguarding, disseminating, marking, decontrolling, and disposing of CUI, self-inspection and oversight requirements, and other facets of the Program. The rule affects Federal executive branch agencies that handle CUI and all organizations (sources) that handle, possess, use, share, or receive CUI—or which operate, use, or have access to Federal information and information systems on behalf of an agency.

During performance of this contract, if the government provides the vendor a dataset that is not publicly released, the vendor must be CUI Compliant to receive it. For more information on this compliance please see DFARS Clause 252.204-7012, NIST Special Publication SP 800-171 and the National Archives and Records Administration (NARA) website (https://www.archives.gov/cui/about).

CERTICATE PERTAINING TO FOREIGN INTERESTS
Offers must submit a SF-328 in Volume 5 in order to be considered for award. If after review of the form, the offeror may be found ineligible for award if the offerors foreign interest are found to be unacceptable. The form can be found at https://www.gsa.gov/forms-library/certificate-pertaining-foreign-interests.

DISCLOSURE OF INFORMATION
(a) The Contractor shall not release to anyone outside the Contractor's organization any unclassified information, regardless of medium (e.g., film, tape, document), pertaining to any part of this contract or any program related to this contract, unless-

(1) The Contracting Officer has given prior written approval;
(2) The information is otherwise in the public domain before the date of release; or
(3) The information results from or arises during the performance of a project that involves no covered defense information (as defined in the clause at DFARS 252.204-7012, Safeguarding Covered Defense Information and Cyber Incident Reporting) and **has been scoped and negotiated by the contracting activity with the contractor and research performer and determined in writing by the contracting officer to be fundamental research* (which by definition cannot involve any covered defense information)**, in accordance with National Security Decision Directive 189, National Policy on the Transfer of Scientific, Technical and Engineering Information, in effect on the date of contract award and the Under Secretary of Defense (Acquisition, Technology, and Logistics) memoranda on Fundamental Research, dated May 24, 2010, and on Contracted Fundamental Research, dated June 26, 2008 (available at DFARS PGI 204.4).

(b) Requests for approval under paragraph (a)(1) shall identify the specific information to be released, the medium to be used, and the purpose for the release. The Contractor shall submit its request to the Contracting Officer at least 10 business days before the proposed date for release.

(c) The Contractor agrees to include a similar requirement, including this paragraph (c), in each subcontract under this contract. Subcontractors shall submit requests for authorization to release through the prime contractor to the Contracting Officer.

***Note: This has to be negotiated prior to award of the contract. A request for determination after award will not be entertained and will result in the clause being pushed down to all subcontracts. Non-performance could result in cancelation of contract.**

5X252.204-7000-90 PUBLIC RELEASE OF INFORMATION

(a) Except as provided in paragraph (b) of this clause, information pertaining to this contract shall not be released to the public unless authorized by the Contracting Officer in accordance with DFARS 252.204-7000, Disclosure of Information. Requests for approval to release information pertaining to this contract shall be submitted to the Contracting Officer by means of NGA Form 5230-1, National Geospatial-Intelligence Agency Request for Clearance for Public Release.

(b) The contractor may provide past performance information regarding this contract, without Contracting Officer approval, to the Office of the Director of National Intelligence (ODNI), the Central Intelligence Agency (CIA), the National Reconnaissance Office (NRO), the National Security Agency (NSA), the Defense Intelligence Agency (DIA), and NGA to support source selections at those agencies. The contractor is responsible for the proper classification and handling of such information and shall provide a copy of the information provided to the Contracting Officer.

5X52.227-9000 UNAUTHORIZED USE OF NGA NAME, SEAL AND INITIALS

(a) As provided in 10 U.S.C. Section 425, no person may, except with the written permission of the Director, National Geospatial-Intelligence Agency, knowingly use the words “National Geospatial-Intelligence Agency”, National Imagery and Mapping Agency” or “Defense Mapping Agency”, the initials “NGA”, “NIMA” or “DMA”, the seal of the National Geospatial-Intelligence Agency, National Imagery and Mapping Agency or the Defense Mapping Agency, or any colorable imitation of such words, initials, or seal in connection with any merchandise, retail product, impersonation, solicitation, or commercial activity in a manner reasonably calculated to convey the impression that such is approved, endorsed, or authorized by the Director, NGA.

(b) Whenever it appears to the U.S. Attorney General that any person is engaged or about to engage in an act or practice which constitutes or will constitute conduct prohibited by paragraph (a), the Attorney General may initiate a civil proceeding in a district court of the United States to enjoin such act or practice. Such court shall proceed as soon as practicable to hearing and determination of such action and may, at any time before such final determination, enter such restraining orders or prohibition, or take such other action as is warranted, to prevent injury to the United States, or to any person or class of persons whose protection the action is brought.

NGA STTR 22.A Phase I Topic Index

OSD22A-001 TITLE: Multi-Scale Representation Learning

OUSD (R&E) MODERNIZATION PRIORITY: Artificial intelligence/machine learning

TECHNOLOGY AREA(S): Information systems, modeling and simulation technology

OBJECTIVE: Develop a single neural network that learns representations at multiple spatial and semantic scales and that may be applied to different geospatial tasks, such as land cover segmentation, object detection, key-point matching, and few-shot/fine-grained/long-tailed classification.

DESCRIPTION: NGA is interested in a single, hierarchical network that learns representations at multiple spatial and semantic scales and can improve the performance of all aspects common to differing geospatial computer vision pipelines.

Existing representation learning techniques are often tailored to a specific task such as semantic segmentation, classification, object detection, or key-point matching. As a result, the trained feature extractors are focused on learning global image-level features, object-level features, or local interest-point features but do not work well at extracting all such feature types at varying scales. This problem is compounded when introducing data that differs fundamentally in format, such as images with more or fewer bands than the data that the feature extractor was trained on.

Recent advancements in representation learning and generalizability show promise that such a one-network solution may be on the horizon. CNN feature extractors for object detection have used feature pyramid networks for several years, which are architected to extract features at different scales [1]. Self-supervised learning has now matched, or exceeded, the transferability of supervised techniques and has demonstrated promising performance on diverse downstream tasks requiring learning different feature types and scales [2, 3]. Transformers, which have earned the state-of-the-art (SoTA) in a variety of vision benchmarks, have shown ability to work across mid-sized and small image scales when pre-trained on large datasets, show parity with SoTA in self-supervised vision tasks, and have been successfully applied to remote sensing [4, 5, 6]. Moreover, the attention layers in a Pre-Trained Frozen Transformer are generalizable across a wide variety of data types and tasks—for example, from language to vision [7].

PHASE I: Develop a neural network architecture that learns representations at multiple spatial and semantic scales and a pre-training methodology on publicly available satellite imagery and/or Government furnished WorldView-3 imagery. Self-supervised pre-training is preferred. Using the same pre-trained network backbone, demonstrate near-parity with SoTA on two different satellite imagery computer vision benchmark tasks requiring either different resolution imagery or different feature scales. Proposers are expected to identify which benchmarks they will target in the proposal.

PHASE II: Extend Phase I results to 4+ computer vision benchmarks using 3+ different image resolutions and/or feature scales. Develop techniques to use the same pre-trained backbone with 4-16 band imagery and demonstrate parity with SoTA on at least two associated benchmarks. Collaborate with NGA's SAFFIRE program for testing and evaluation on classified imagery, and provide code and support for integration.

Deliverables include a comprehensive report on the architecture, training scheme, and benchmark performance delivered to NGA at the conclusion of Phase I, Phase II midpoint, and Phase II conclusion; at least two papers submitted to academic journals or conferences by the conclusion of Phase II; all data procured, curated, and/or labeled during the period of performance; and delivery without restriction (or open-sourcing) of code. Proposing teams are expected to have a strong and ongoing academic publication track record on related research topics.

PHASE III DUAL USE APPLICATIONS: A single neural network that learns representations at multiple spatial and semantic scales has the potential to apply broadly to diverse machine learning tasks across Government and industry. For example, such technology could improve performance in all aspects of geospatial computer vision, as well as diverse fields such as facial recognition, self-driving cars, and robotics.

REFERENCES:

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4. Dosovitskiy A., et al. "An image is worth 16x16 words: Transformers for image recognition at scale," 9th International Conference on Learning Representations, ICLR 2021, Virtual Event, Austria, 3-7 May 2021. OpenReview.net 2021.
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6. Bazi Y., et al. "Vision transformers for remote sensing image classification," Remote Sens. 2021, 13(3), 516; https://doi.org/10.3390/rs13030516.
7. Lu, K., Grover, A., Abbeel, P., Mordatch, I., "Pretrained transformers as universal computation engines," arXiv preprint, arXiv:2103.05247.
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9. Yurun, T., et al. "HyNet: Learning local descriptor with hybrid similarity measure and triplet loss." arXiv preprint, arXiv:2006.10202 (2020).
10. Zhuoqian, Y., Dan, T., and Yang, Y. "Multi-temporal remote sensing image registration using deep convolutional features." IEEE Access 6 (2018): 38544-38555.

KEYWORDS: Artificial intelligence, deep learning, machine learning, representation learning, computer vision, remote sensing

OSD22A-002 TITLE: Environmental Security Risk Forecasting

OUSD (R&E) MODERNIZATION PRIORITY: Artificial intelligence/machine learning, statistical forecasting

TECHNOLOGY AREA(S): Information systems, modeling and simulation technology

OBJECTIVE: Develop computer models to forecast risk to US critical infrastructure from a range of potential climate futures. During Phase I, research will be restricted to modeling past and forecasting future wildfire potential in a chosen area containing critical infrastructure.

DESCRIPTION: NGA provides GEOINT to support national policy makers and other federal and local agencies on matters of environmental security such as humanitarian and disaster relief efforts. Much of this GEOINT provides tactical intelligence, such as complementing the picture on the ground with near real time GEOINT to build a comprehensive awareness of the operating environment (e.g., [1]). Because of the increasing incidence and severity of natural disasters correlated with climate change [2], NGA requires the capability to forecast such events, particularly in areas where critical infrastructure is present, which would allow decision makers time to implement mitigation strategies beforehand.

Currently, fire intelligence analysts compile climate and drought forecasts, regional fuel conditions, and satellite and mapping imagery into short-term and seasonal forecasts for broad regions [3]. However, these existing forecasting methods are unable to make fine-grained distinctions in at-risk areas based on small-scale variations in land use, land use change, vegetation, and, moreover, proximity to critical infrastructure.

In recent years, both the volume and resolution of commercial and publicly available satellite imagery relevant to wildfire forecasting has massively increased. Together with recent improvements in machine learning, this imagery may be used to produce high-resolution GEOINT products relevant to wildfire conditions; for example, land use change, soil moisture, and normalized difference vegetation index [4,5]. Alternative phenomenologies such as SAR and lidar may be applied to monitor conditions and changes in forest health. Additionally, new applications of machine learning have produced much more robust risk assessment modeling in a variety of fields, including fire risk [6].

PHASE I: Identify two geographic areas containing US critical infrastructure, one of which that has experienced wildfire-related damage or destruction. Complete a forensic analysis of wildfire risk based on historical remote sensing data from these areas to identify predictive variables. Suggest potential mitigation strategies that would decrease risk. Using identified predictive variables, develop a computer model that forecasts wildfire risks monthly and/or seasonally and suggests mitigation strategies. The forensic analysis and methodology used to model and forecast shall be provided to NGA and (optionally) submitted to an academic journal or conference.

PHASE II: Extend Phase I results to at least two other natural disaster types relating to environmental security of critical infrastructure (e.g., flooding, permafrost melting). Extend analysis to 6+ geographic areas per natural disaster type containing US critical infrastructure on at least two different continents. Extend duration of forecasting capability (seasonal+) and compute statistically valid uncertainty and error estimates.

PHASE III DUAL USE APPLICATIONS: Accurately forecasting environmental security risks and suggesting mitigations would have immense and broad applications. Analysts across a variety of Government and commercial sectors could utilize these forecasts to improve risk understanding and suggest mitigation strategies that could potentially prevent costly repercussions of natural disasters.

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