DEPARTMENT OF DEFENSE
SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAM
STTR 23.A Program Broad Agency Announcement (BAA)

January 11, 2023: DoD BAA issued for pre-release
February 08, 2023: DoD begins accepting proposals
March 08, 2023: Deadline for receipt of proposals no later than **12:00 p.m. ET**

Participating DoD Components:

- Department of the Navy (Navy)
- Department of Air Force (Air Force)
- Defense Logistics Agency (DLA)

IMPORTANT

Deadline for Receipt: Complete proposals must be certified and submitted in DSIP no later than **12:00 PM** ET on **March 08, 2023.** Proposals submitted after 12:00 p.m. 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. Proposing Small Business Concerns 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 (BAA). The DoD SBIR/STTR Programs follow the policies and practices of the SBA SBIR/STTR Policy Directive [updated 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 HERE.

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.

On April 4, 2022, the DUNS Number was replaced by the Unique Entity ID (SAM) to identify organizations doing business with the Government. If the proposing small business concern has an entity registration in SAM.gov (even if the registration has expired), a UEI (SAM) has already been assigned. **For proposing small business concerns with established DSIP accounts, update the proposing small business concern profile with the UEI (SAM) as soon as possible.** See section 4.15 for more information.

Questions: Please refer to the DSIP Customer Support Document for general information regarding the DoD SBIR/STTR process in DSIP. For additional assistance with the DSIP application, please visit the Learning & Support section of the DSIP at https://www.dodsbirsttr.mil/submissions/learning-support/. Email DSIP Support at DoDSBIRSupport@reisystems.com only for further assistance with issues pertaining directly to the DSIP application. Questions submitted to DSIP Support 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 4.14 for further information on where to direct questions regarding instructions and topics in this BAA**.

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ATTACHMENTS

1.0 INTRODUCTION

Navy, Air Force and DLA, hereafter referred to as DoD Components, invite proposing small business concerns and research institutions to jointly submit proposals under this BAA for the Small Business Technology Transfer (STTR) Program. Proposing Small Business Concerns 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 proposing small business concerns that receive a Phase I award originating from this BAA will be eligible to participate in Phase 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 proposing small business concern 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 proposing small business concern 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.

OUSD(R&E) Critical Technology Areas

Focus Area	Description
FutureG	FutureG is a suite of emerging wireless network technologies enabled by DoD and commercial industry cooperation to enable military operations and ensure a free and open internet. As Fifth Generation (5G) wireless technology is adopted and provides building blocks for capability, the DoD will also look to FutureG for leap-ahead technologies to lead in creating future standards. The Department will invest in FutureG technology development to lay the groundwork for continued United States

	leadership in information technology, which is vital for maintaining our economic and national security.
Trusted AI and Autonomy	Artificial Intelligence (Al) is the software engineering discipline of expanding capabilities of software applications to perform tasks that currently require human intelligence. Machine learning is an engineering subfield of AI that trains software models using example data, simulations, or real-world experiences rather than by direct programming or coding. Autonomy is the engineering discipline that expands robots' abilities to perform tasks while limiting the need for human interaction. AI holds tremendous promise to improve the ability and function of nearly all systems and operations. Trusted AI with trusted autonomous systems are imperative to dominate future conflicts. As AI, machine learning, and autonomous operations continue to mature, the DoD will focus on evidence-based AI-assurance and enabling operational effectiveness.
Biotechnology	Biotechnology is an emerging engineering discipline that uses living systems to produce a wide range of technologies and capabilities. From fighting global pandemics and avoiding surprises to reducing logistics and sustainment costs and increasing energy efficiency, biotechnology can help change the way the Department conducts missions, performs in contested logistics environments, and adapts to major global changes.
Advanced Computing and Software	Advanced computing and software technologies include supercomputing, cloud computing, data storage, computing architectures, and data processing. Software is ubiquitous throughout the Department, but the speed at which software develops outpaces the Department's ability to stay up to date. The Department must rapidly modernize its legacy software systems with resilient, affordable, and assured new software that has been designed, developed, and tested using processes that establish confidence in its performance. The Department must migrate to a Development-Security-Operations (DevSecOps) approach in its software development and evolve to a model of continuous development, continuous test, and continuous delivery. The Department must leverage modular open system architecture approaches to isolate hardware from software and enable rapid upgrades to secure processors.
Integrated Sensing and Cyber	To provide advantage for the joint force in highly contested environments, the Department must develop wideband sensors to operate at the intersection of cyber space, electronic warfare, radar, and communications. Sensors must be able to counter advanced threats and can no longer be stove-piped and single function.
Directed Energy (DE)	Directed Energy Weapons utilize lasers, high power microwaves, and high energy particle beams to produce precision disruption, damage, or destruction of military targets at range. Directed energy systems will allow the Department to counter a wide variety of current and emerging threats with rapid responses and engagement at the speed of light. High-power lasers and high-power microwave technologies both offer new ways to counter diverse sets of threats.
Hypersonics	Hypersonic systems fly within the atmosphere for significant portions of their flight at or above 5 times the speed of sound, or approximately 3700 miles per hour. Hypersonics dramatically shorten the timeline to strike a target and increase unpredictability. While strategic competitors are pursuing and rapidly fielding advanced hypersonic missiles, the DoD will develop leap-ahead and cost-effective technologies for our air, land, and sea operational forces.

Microelectronics	Microelectronics are circuits and components that serve as the "brain" to human-made electronic functional systems. Virtually every military and commercial system relies on microelectronics. Diminishing microelectronics manufacturing in the United States and supply chain concerns have highlighted national economic and security risks. Working closely with industry, academia, and across the Government, the Department is addressing the need for secure microelectronics sources and will leverage state-of-the-art commercial development and production for defense microelectronic solutions.
Integrated Network Systems-of-Systems	Integrated Network Systems-of-Systems technology encompasses the capability to communicate, provide real-time dissemination of information across the Department, and effective command and control in a contested electromagnetic environment. Integrated Network Systems-of-Systems capability must enable engagements by any sensor and shooter, with the ability to integrate disparate systems. An interoperable network that leverages emerging capabilities across the electromagnetic spectrum such as 5G, software defined networking and radios, and modern information exchange techniques will allow the Department to better integrate many diverse mission systems and provide fully networked command, control, and communication that is capable, resilient, and secure.
Quantum Science	Quantum Science is the study of physical properties at small, even atomic, scales. Defense applications include atomic clocks, quantum sensors, quantum computing, and quantum networks. Quantum science promises to enable leap-ahead capabilities. Quantum computing can provide unprecedented computational speeds and help solve the Department's hardest analytical problems. Quantum sensors promise the ability to provide unprecedented accuracy in position, navigation, and timing. From more accurate information to faster decision making, to significantly stronger encryption capabilities, quantum science has the promise to deliver cutting-edge technology.
Space Technology	Space technologies include space flight, Space communication and other technologies needed to maintain space operations. With rising threats and increasing dependence on space-based systems, the Department's space strategy must shift away from exquisite satellites to a more robust and proliferated architecture. Novel space technologies are necessary to enable resilient cross-domain operations. The space strategy must incorporate technologies that enhance the Department's adaptive and reconfigurable capabilities in space situational awareness, space control, communication path diversity, on-orbit processing, and autonomy.
Renewable Energy Generation and Storage	Renewable energy generation and storage includes solar wind, bio-based and geothermal technologies, advanced energy storage, electronic engines, and power grid integration. Renewable energy generation and storage promises to decrease warfighter vulnerability and deliver new operational capabilities for the Department. From more efficient batteries to diversifying energy sources and reduced fuel transportation risks, renewable energy generation and storage will add resilience and flexibility in a contested logistics environment.
Human-Machine Interfaces	Human-Machine Interface refers to technologies related to human-machine teaming and augmented and virtual reality. Rapid advancements in this technology will have a multitude of benefits for our service members. Highly immersive realistic training environments provide real-time feedback to enhance warfighter performance. Intuitive 5 interactive human-machine interfaces enable rapid mission planning and mission command by providing a common operational picture to geographically distributed operations.

Advanced Materials	Advanced materials explore innovative new materials and novel manufacturing techniques that can dramatically improve many of the Department's capabilities. Materials that have higher strength, lighter weight, higher efficiency, and can handle more extreme temperatures will have the potential to better protect our service members and enhance their ability to accomplish their mission.

2.2 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. Proposing small business concerns 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 proposing small business concerns 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 SBIR/STTR Policy Directive, the Federal Acquisition Regulation (FAR), and other cited regulations 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

Research and development conducted jointly by a small business concern and a research institution. For purposes of the STTR Program, 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. For purposes of the SBIR Program,

this refers to work conducted by a research institution as a subcontractor to the small business concern. At least two-thirds of the research and/or analytical work in Phase I must be conducted by the proposing small business concern.

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 proposing 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 concern 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 proposing small business concern 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. Proposing small business concerns 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 small business concern has the capability to implement the technical approach, i.e., has or can obtain people and equipment suitable to the task.

4.2 Proposing Small Business Concern Eligibility and Performance Requirements

a. Each proposing small business concern must qualify as a small business concern as defined by 13 CFR §§ 701-705 at time of award and certify to this in the Cover Sheet section 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). Proposing small business concern 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 measured by both direct and indirect costs. Deviations from these STTR requirements are not allowed, as the performance of work requirements are specified in statute at 15 USC 638(e). For more information on the percentage of work calculation during proposal submission, refer to section 5.3.
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**. Proposing small business concern 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 proposing small business concern 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 proposing small business concerns with greater than 15 Phase II awards over the last ten fiscal years excluding the last two years, the proposing small business concern 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 proposing small business concern's eligibility for new Phase I awards, a proposing small business concern 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 proposing small business concern 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. Proposing small business concern must disclose joint ventures with existing (or planned) relationships/partnerships with any foreign entity or any foreign government-controlled companies.

A small business joint venture offeror must submit, with its offer, the representation required in paragraph (c) of FAR solicitation provision 52.212-3, Offeror Representations and Certifications-Commercial Products and Commercial Services, and paragraph (c) of FAR solicitation provision 52.219-1, Small

Business Program Representations, in accordance with 52.204-8(d) and 52.212-3(b) for the following categories:

(A) Small business;
(B) Service-disabled veteran-owned small business;
(C) Women-owned small business (WOSB) under the WOSB Program;
(D) Economically disadvantaged women-owned small business under the WOSB Program; or
(E) Historically underutilized business zone small business.

These representations can be found as Attachment 3 to this BAA and must be uploaded to Volume 5, Supporting Documents of the proposal submission, if applicable.

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

Unless otherwise noted in the participating Component instructions, proposing small business concerns 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 proposing small business concern 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 proposing small business concern, whether such equity stake is directly or indirectly held. The proposing small business concern 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 proposing small business concern 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, proposing small business concerns are required to identify and disclose all facts relevant to potential OCIs involving the proposing small business concern's organization and any proposed team member (sub-awardee, consultant). Under this Section, the proposing small business concern is responsible for providing this disclosure with each proposal submitted to the BAA. The disclosure must include the proposing small business concern's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposing small business concern has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposing small business concern's judgment and to prevent the proposing small business concern 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 proposing small business concern must affirm whether the proposing small business concern 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 proposing small business concerns to provide additional information to assist the Government in evaluating the proposing small business concern'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 small business concern 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 Federal-wide 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. proposing small business concerns 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 in accordance with the procedures in FAR Subpart 33.1.

Pre-award agency protests related to the terms of this BAA must be served to:

Ms. Tara Randolph
Contracting Officer
tara.j.randolph.civ@us.navy.mil & osd.ncr.ousd-r-e.mbx.SBIR-STTR-Protest@mail.mil

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 proposing small business concern may also be made to the Small Business Administration.

4.13 Phase I Award Information

All Phase I proposals will be evaluated and judged on a competitive basis in terms of technical capability and technical value. Proposals will be initially screened to determine responsiveness to the topic objective. Proposals passing this initial screening will be technically evaluated by engineers or scientists to determine the most promising technical and scientific approaches. As a common statement of work does not exist, each proposal will be assessed on the merit of the approach in achieving the technical objectives established in the topic. 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 proposing small business concerns 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 small business concerns to review Component-specific instructions regarding award size.

d. **Timing**. Proposing small business concerns will be notified of selection or non-selection status for a Phase I 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 Questions/Information**.

(1) **DSIP Support**:
Email DSIP Support at DoDSBIRSupport@reisystems.com only for assistance with using the DSIP application. Questions regarding DSIP can be emailed to DSIP Support 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). Please include information on your small business concern, a proposal number (if applicable), and screenshots of any pertinent errors or issues encountered.

DSIP Support 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. Proposing small business concerns 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://www.defensesbirsttr.mil/, which provides the following resources:

- Customer Support Information
- 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.** Questions pertaining to a particular DoD Component or the Component-specific BAA instructions should be submitted in accordance with the instructions given at the beginning of that Component's topics.

c. **Direct Contact with Topic Authors**. From **January 11, 2023 – February 8, 2023,** 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 small business concerns 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 small business concerns 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 **February 8, 2023**, no further direct contact between proposing small business concerns and topic authors is allowed unless the Topic Author is responding to a question submitted during the pre-release period. However, proposing small business concerns 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 small business concerns 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 **January 11, 2023**, and closes to new questions on **February 22, 2023**, **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 small business concerns are advised to monitor Topic Q&A during the BAA period for questions and answers. Proposing small business concerns should also frequently monitor DSIP for updates and amendments to the topics.

4.15 Registrations and Certifications

Individuals from proposing small business concerns must be registered in the Defense SBIR/STTR Innovation Portal (DSIP) in order to prepare and submit proposals. **The DSIP application is only accessible from within the United States, which is defined as 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.** All users are required to have an individual user account to access DSIP. As DSIP user accounts are authenticated by Login.gov, all users, who do not already have a Login.gov account, will be required to create one. 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, can be accessed here: https://www.dodsbirsttr.mil/submissions/learning-support/training-materials.

Be advised that the sharing of accounts and passwords is a violation of the Terms of Use for Login.gov and DoD policy.

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.

Users should complete their account registrations as soon as possible to avoid any delays in proposal submissions.

Before the DoD Components can award a contract, proposing small business concerns must be registered in the System for Award Management (SAM). SAM allows proposing small business concerns 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. Proposing small business concerns should login to SAM and ensure the small business concern's registration is active and representations and certifications are up-to-date to avoid delay in award.

On April 4, 2022, the DUNS Number was replaced by the Unique Entity ID (SAM). The Federal Government will use the UEI (SAM) to identify organizations doing business with the Government. The DUNS number will no longer be a valid identifier. If the proposing small business concern has an entity registration in SAM.gov (even if the registration has expired), a UEI (SAM) has already been assigned. This can be found by signing into SAM.gov and selecting the Entity Management widget in the Workspace or by signing in and searching entity information. **For proposing small business concerns with established Defense SBIR/STTR Innovation Portal (DSIP) accounts, update the small business concern profile with the UEI (SAM) as soon as possible.**

For new proposing small business concern registrations, follow instructions during SAM registration on how to obtain a Commercial and Government Entry (CAGE) code and be assigned the UEI (SAM). Once a CAGE code and UEI (SAM) are obtained, update the proposing small business concern's profile on the 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 proposing small business concerns at time of award and during the award life cycle. Each proposing small business concern 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 https://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 proposing small business concerns 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 business concerns 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 not 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,

proposing small business concerns 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. Proposing small business concerns are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposing small business concerns submitting through this site for the first time will be asked to register. It is recommended that proposing small business concerns register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process.

This information in this section is applicable to Phase I proposals only. If the Component is participating in the **Direct to Phase II Program**, refer to the Component-specific Direct to Phase II instructions for more information on proposal preparation.

Guidance on allowable proposal content may vary by Component. A completed proposal submission in DSIP does NOT indicate that each proposal volume has been completed in accordance with the Component-specific instructions. Accordingly, it is the proposing small business concern's responsibility to consult the Component-specific instructions for detailed guidance, including required proposal documentation and structure, 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
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 proposing small business concerns must complete the following:

- Volume 4: Company Commercialization Report (upload of CCR from SBIR.gov to DSIP is required for proposing small business concerns 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 (Proposing small business concerns 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 proposing small business concern 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 proposing small business concern for signatures at the time of award.

5.2 Marking Proprietary Proposal Information

Proposing small business concerns 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 proposing small business concern 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.

Effective January 2023, the amounts listed in the Percentage of Work (POW) certification question on the Proposal Cover Sheet are derived from information entered by the proposing small business concern in the Cost Volume (Volume 3). Details on the calculation can be viewed in DSIP during proposal submission.

If the POW calculations fall below eligibility requirements, the small business concern will not be able to proceed with proposal submission. Deviations from the POW minimum requirements for STTR proposals are not allowed.

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 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.**

(2) **Length**: It is the proposing small business concern'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 proposing small business concern 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 in the order given below:

(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). **Small Business Concerns 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 small business concern, 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 proposing small business concern'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 proposing small business concern'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 proposing small business concern 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. Proposing small business concerns 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, proposing small business concerns 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 to the same level of detail as the prime contractor costs. 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 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 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 small business concern 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 proposing small business concern 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 proposing small business concern 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 small business concern 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 proposing small business concern. 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 small business concern 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 small business concerns will have to recertify and resubmit such proposals. If a proposing small business concern does not recertify or resubmit such proposals, they will not be considered fully submitted and will not be evaluated.

b. If the proposing small business concern 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 proposing small business concern 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 proposing small business concern 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 small business concern 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 small business concern will select NO. The CCR section of the proposal will be marked complete.

While all proposing small business concerns 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 proposing small business concerns to submit additional documentation to support the Coversheet (Volume 1), Technical Volume (Volume 2), and the Cost Volume (Volume 3).

All proposing small business concerns 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) (Proposing small business concerns 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 proposing small business concern's authorized proposing small business concern representative. The DFARS provisions and clause may be found in BAA Attachment 1. **These certifications must be signed by the authorized proposing small business concern 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 proposing small business concern and for any contractors that may be proposed as a part of the submission including research partners and suppliers. Therefore, proposing small business concerns 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**

Proposing small business concerns must review Attachment 2: Foreign Ownership or Control Disclosure to determine applicability. If applicable, an authorized proposing small business concern 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 small business concern. 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 proposing small business concern.

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 a determination of the overall technical value of each proposal and an evaluation of the cost volume, with the appropriate method of analysis given the contract type to be awarded, in order for selection of the proposal(s) most advantageous 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 proposals 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 proposing small business concern 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 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 proposing small business concern 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 solicitation for SBIR may transition in Phase II to STTR and vice versa. A proposing small business concern 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 proposing small business concern contain marketing expertise and, if not, how will that expertise be brought into the small business concern?
(5) Who are the proposing small business concern'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 proposing small business concern 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 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 proposing small business concern 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 established 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 DoD SBIR/STTR Program has 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

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, regardless of medium (e.g., film, tape, document), pertaining to any part of this contract or any program related to this contract except within and between the Contractor and any subcontractors, of unclassified 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 22.2803.
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. To learn about cybersecurity resources for your SBIR/STTR contract visit the Blue Cyber webpage: https://www.safcn.af.mil/CISO/Small-Business-Cybersecurity-Information/.

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 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 (NOV 2021)

(a) **Definitions.** As used in this clause -

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

(2) *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 websites) or simple transactional information, such as necessary to process payments.

(3) *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).

(4) *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).

(5) *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 products or commercial services, 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.

(End of clause)

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

DFARS 252.225-7055, Representation Regarding Business Operations with the Maduro Regime, is incorporated into this solicitation. In accordance with section 890 of the National Defense Authorization Act for Fiscal Year 2020 (Pub. L. 116-92), DoD is prohibited from 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 the person has a valid license to operate in Venezuela issued by the Office of Foreign Assets Control of the Department of the Treasury.

8.4 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.

8.5 Patents

Proposing small business concerns 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.

8.6 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 twenty 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 Class Deviation 2020-O0007. Upon expiration of the twenty-year restrictive license, the Government has Government Purpose 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 Class Deviation 2020-O0007 "Rights in Noncommercial Technical Data and Computer Software – Small Business Innovation Research (SBIR) Program." NOTE: Although Class Deviation 2020-O0007 only specifies applicability to SBIR, as required in the Small Business Act [15 USC 638 (p)(2)(B)(v)] and further prescribed by the SBA SBIR/STTR Policy Directive [section 8(b)(2)], this language also applies to STTR.

If a proposing small business concern plans to submit assertions in accordance with DFARS 252.227-7017 Class Deviation 2020-O0007, 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.

8.7 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.

8.8 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 are available 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 proposing small business concern in its Phase II proposal to report Phase I progress may also be used in the final report.

(2) For each unclassified report, the proposing small business concern 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 Program Office."

Note: Data developed under a STTR contract is subject to STTR Data Rights which allow for protection under DFARS 252.227-7018 Class Deviation 2020-O0007 (see Section 8.5, Technical Data Rights). The sponsoring DoD activity, after reviewing the proposing small business concern'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 Class Deviation 2020-O0007.

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	
Small Business Concern 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)

ATTACHMENT 3

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

Verification of Eligibility of Small Business Joint Ventures

A small business joint venture offeror must submit, with its offer, the representation required in paragraph (c) of FAR solicitation provision 52.212-3, Offeror Representations and Certifications-Commercial Products and Commercial Services, and paragraph (c) of FAR solicitation provision 52.219-1, Small Business Program Representations, in accordance with 52.204-8(d) and 52.212-3(b) for the following categories:

(A) Small business;
(B) Service-disabled veteran-owned small business;
(C) Women-owned small business (WOSB) under the WOSB Program;
(D) Economically disadvantaged women-owned small business under the WOSB Program; or
(E) Historically underutilized business zone small business

Contractor's Name	
Small Business Concern Name	
Office Tel #	
Mobile #	
Email	

Name of person authorized to sign: _____

Signature of person authorized: _____

Date: _____

FAR Provision Incorporated in Full Text:

52.219-1 Small Business Program Representations (Oct 2022)

(a) *Definitions*. As used in this provision-

Economically disadvantaged women-owned small business (EDWOSB) concern means a small business concern that is at least 51 percent directly and unconditionally owned by, and the management

and daily business operations of which are controlled by, one or more women who are citizens of the United States and who are economically disadvantaged in accordance with 13 CFR part 127, and the concern is certified by SBA or an approved third-party certifier in accordance with 13 CFR 127.300. It automatically qualifies as a women-owned small business concern eligible under the WOSB Program.

Service-disabled veteran-owned small business concern-

(1) Means a small business concern-

(i) Not less than 51 percent of which is owned by one or more service-disabled veterans or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more service-disabled veterans; and

(ii) The management and daily business operations of which are controlled by one or more service-disabled veterans or, in the case of a service-disabled veteran with permanent and severe disability, the spouse or permanent caregiver of such veteran.

(2) "Service-disabled veteran" means a veteran, as defined in 38 U.S.C.101(2), with a disability that is service-connected, as defined in 38 U.S.C.101(16).

Small business concern—

(1) Means a concern, including its affiliates, that is independently owned and operated, not dominant in its field of operation, and qualified as a small business under the criteria in 13 CFR part 121 and the size standard in paragraph (b) of this provision.

(2) *Affiliates*, as used in this definition, means business concerns, one of whom directly or indirectly controls or has the power to control the others, or a third party or parties control or have the power to control the others. In determining whether affiliation exists, consideration is given to all appropriate factors including common ownership, common management, and contractual relationships. SBA determines affiliation based on the factors set forth at 13 CFR 121.103.

Small disadvantaged business concern, consistent with 13 CFR 124.1002, means a small business concern under the size standard applicable to the acquisition, that-

(1) Is at least 51 percent unconditionally and directly owned (as defined at 13 CFR 124.105) by-

(i) One or more socially disadvantaged (as defined at 13 CFR 124.103) and economically disadvantaged (as defined at 13 CFR 124.104) individuals who are citizens of the United States, and

(ii) Each individual claiming economic disadvantage has a net worth not exceeding $750,000 after taking into account the applicable exclusions set forth at 13 CFR 124.104(c)(2); and

(2) The management and daily business operations of which are controlled (as defined at 13 CFR 124.106) by individuals who meet the criteria in paragraphs (1)(i) and (ii) of this definition.

Veteran-owned small business concern means a small business concern-

(1) Not less than 51 percent of which is owned by one or more veterans (as defined at 38 U.S.C.101(2)) or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more veterans; and

(2) The management and daily business operations of which are controlled by one or more veterans.

Women-owned small business concern means a small business concern-

(1) That is at least 51 percent owned by one or more women; or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women; and

(2) Whose management and daily business operations are controlled by one or more women.

Women-owned small business (WOSB) concern eligible under the WOSB Program (in accordance with 13 CFR part 127) means a small business concern that is at least 51 percent directly and unconditionally owned by, and the management and daily business operations of which are controlled by, one or more women who are citizens of the United States, and the concern is certified by SBA or an approved third-party certifier in accordance with 13 CFR 127.300.

(b) (1) The North American Industry Classification System (NAICS) code for this acquisition is _____ *[insert NAICS code]*.

(2) The small business size standard is _____ *[insert size standard]*.

(3) The small business size standard for a concern that submits an offer, other than on a construction or service acquisition, but proposes to furnish an end item that it did not itself manufacture, process, or produce (*i.e.*, nonmanufacturer), is 500 employees if the acquisition—

(i) Is set aside for small business and has a value above the simplified acquisition threshold;

(ii) Uses the HUBZone price evaluation preference regardless of dollar value, unless the offeror waives the price evaluation preference; or

(iii) Is an 8(a), HUBZone, service-disabled veteran-owned, economically disadvantaged women-owned, or women-owned small business set-aside or sole-source award regardless of dollar value.

(c) *Representations.*

(1) The offeror represents as part of its offer that—

(i) it ☐is, ☐ is not a small business concern; or

(ii) It ☐is, ☐is not a small business joint venture that complies with the requirements of 13 CFR 121.103(h) and 13 CFR 125.8(a) and (b). [*The offeror shall enter the name and unique entity identifier of each party to the joint venture:* __.]

(2) [*Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.*] The offeror represents that it ☐is, ☐ is not, a small disadvantaged business concern as defined in 13 CFR 124.1002.

(3) [*Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.]* The offeror represents as part of its offer that it ☐ is, ☐ is not a women-owned small business concern.

(4) *Women-owned small business (WOSB) joint venture eligible under the WOSB Program.* The offeror represents as part of its offer that it ☐ is, ☐ is not a joint venture that complies with the requirements of 13 CFR 127.506(a) through (c). [*The offeror shall enter the name and unique entity identifier of each party to the joint venture: __.*]

(5) *Economically disadvantaged women-owned small business (EDWOSB) joint venture.* The offeror represents as part of its offer that it ☐ is, ☐ is not a joint venture that complies with the requirements of 13 CFR 127.506(a) through (c). [*The offeror shall enter the name and unique entity identifier of each party to the joint venture: __.*]

(6) [*Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.*] The offeror represents as part of its offer that it ☐ is, ☐ is not a veteran-owned small business concern.

(7) [*Complete only if the offeror represented itself as a veteran-owned small business concern in paragraph (c)(6) of this provision.*] The offeror represents as part of its offer that

(i) It ☐ is, ☐ is not a service-disabled veteran-owned small business concern; or

(ii) It ☐ is, ☐ is not a service-disabled veteran-owned joint venture that complies with the requirements of 13 CFR 125.18(b)(1) and (2). [*The offeror shall enter the name and unique entity identifier of each party to the joint venture: __.*] Each service-disabled veteran-owned small business concern participating in the joint venture shall provide representation of its service-disabled veteran-owned small business concern status.

(8) [*Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.*] The offeror represents, as part of its offer, that-

(i) It ☐ is, ☐ is not a HUBZone small business concern listed, on the date of this representation, as having been certified by SBA as a HUBZone small business concern in the Dynamic Small Business Search and SAM, and will attempt to maintain an employment rate of HUBZone residents of 35 percent of its employees during performance of a HUBZone contract (see 13 CFR 126.200(e)(1)); and

(ii) It ☐ is, ☐□ is not a HUBZone joint venture that complies with the requirements of 13 CFR 126.616(a) through (c). [*The offeror shall enter the name and unique entity identifier of each party to the joint venture: __.*] Each HUBZone small business concern participating in the HUBZone joint venture shall provide representation of its HUBZone status.

(d) *Notice.* Under 15 U.S.C.645(d), any person who misrepresents a firm's status as a business concern that is small, HUBZone small, small disadvantaged, service-disabled veteran-owned small, economically disadvantaged women-owned small, or women-owned small eligible under the WOSB Program in order to obtain a contract to be awarded under the preference programs established pursuant to section 8, 9, 15, 31, and 36 of the Small Business Act or any other provision of Federal law that specifically references section 8(d) for a definition of program eligibility, shall-

(1) Be punished by imposition of fine, imprisonment, or both;

(2) Be subject to administrative remedies, including suspension and debarment; and

(3) Be ineligible for participation in programs conducted under the authority of the Act.

(End of provision)

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

IMPORTANT

- **The following instructions apply to STTR topics only:**
  - **N23A-T001 through N23A-T029**
- **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	DSIP Support via email at dodsbirsupport@reisystems.com
Navy-specific BAA instructions and forms	Always	Navy SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil

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

Topic Numbers	Point of Contact	SYSCOM	Email
N23A-T001 to N23A-T008	Ms. Kristi Wiegman	Naval Air Systems Command (NAVAIR)	navair.sbir@navy.mil
N23A-T009 to N23A-T014	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N23A-T015 to N23A-T029	Mr. Steve Sullivan	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

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

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

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

Proposal Volumes. The following six volumes are required.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR Program BAA.
- **Technical Proposal (Volume 2)**

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

- **Cost Volume (Volume 3).**

- Cost Volume (Volume 3) must meet the following requirements or the proposal will be REJECTED:
  - The Phase I Base amount must not exceed $140,000.
  - Phase I Option amount must not exceed $100,000.
  - Costs for the Base and Option must be separated and clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3.
  - For Phase I a minimum of 40% of the work is performed by the proposing small business concern, and a minimum of 30% of the work is performed by the single research institution. The percentage of work is measured by both direct and indirect costs. To calculate the minimum percentage of effort for the proposing small business concern the sum of all direct and indirect costs attributable to the proposing small business concern represent the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) is the denominator. The single research institution percentage is calculated by taking the sum of all costs attributable to the single research institution (identified as Total Subcontractor Costs (TSC) 1 in DSIP Cost Volume) as the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) as the denominator.
    - Proposing Small Business Concern Costs (included in numerator for calculation of the small business concern):
      - Total Direct Labor (TDL)
      - Total Direct Material Costs (TDM)
      - Total Direct Supplies Costs (TDS)
      - Total Direct Equipment Costs (TDE)
      - Total Direct Travel Costs (TDT)
      - Total Other Direct Costs (TODC)
      - General & Administrative Cost (G&A)

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

- Research Institution (numerator for Research Institution calculation):
  - Total Subcontractor Costs (TSC) 1
- Total Cost (denominator for either calculation)

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

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

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

  All proposing small business concerns must review and submit the following items, as applicable:
  - **Telecommunications Equipment Certification.** Required for all proposing small business concerns. The DoD must comply with Section 889(a)(1)(B) of the FY2019 National Defense Authorization Act (NDAA) and is working to reduce or eliminate contracts, or extending or renewing a contract with an entity that uses any equipment, system, or service that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As such, all proposing small business concerns must include as a part of their submission a written certification in response to the clauses (DFAR clauses 252.204-7016, 252.204-7018, and subpart 204.21). The written certification can be found in Attachment 1 of the DoD SBIR/STTR Program BAA. This certification must be signed by the authorized company representative and is to be uploaded as a separate PDF file in Volume 5. Failure to submit the required certification as a part of the proposal submission process will be cause for rejection of the proposal submission without evaluation. Please refer to the instructions provided in the Phase I Proposal section of the DoD SBIR/STTR Program BAA.
  - **Disclosure of Offeror's Ownership or Control by a Foreign Government.** All proposing small business concerns must review to determine applicability. In accordance with DFARS provision 252.209-7002, a proposing small business concern is required to disclose any interest a foreign government has in the proposing small business concern when that interest constitutes control by foreign government. All proposing small business concerns must review the Foreign Ownership or Control Disclosure information to determine applicability. If applicable, an authorized representative of the small business

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

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

PHASE I EVALUATION AND SELECTION

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

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

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

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

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

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

- **Cost Volume (Volume 3).** The Cost Volume (Volume 3) will not be considered in the selection process and will only undergo a compliance review to verify the proposing small business concern has met the following requirements or the proposal will be REJECTED:
  - Must not exceed values for the Base ($140,000) and Option ($100,000).
  - Must meet minimum percentage of work; 40% of the work is performed by the proposing small business concern, and a minimum of 30% of the work is performed by the single research institution.
- **Company Commercialization Report (Volume 4).** The CCR (Volume 4) will not be evaluated by the Navy nor will it be considered in the Navy's award decision. However, all proposing small business concerns must refer to the DoD SBIR/STTR Program BAA to ensure compliance with DSIP Volume 4 requirements.

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

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

ADDITIONAL SUBMISSION CONSIDERATIONS

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

Discretionary Technical and Business Assistance (TABA). The SBIR and STTR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Proposing small business concerns may request, in their Phase I Cost Volume (Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award. The TABA amount, of up to $25,000, is to be included as part of the award amount and is limited by the established

award values for Phase II by the SYSCOM (i.e. within the $1,800,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee by the proposing small business concern and must be inclusive of all applicable indirect costs. TABA cannot be used in the calculation of general and administrative expenses (G&A) for the SBIR proposing small business concern. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project. A small business concern receiving TABA will be required to submit a report detailing the results and benefits of the service received. This TABA report will be due at the time of submission of the final report.

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

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

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

TABA must NOT:

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

TABA requests must be included in the proposal as follows:

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

Proposed values for TABA must NOT exceed:

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

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

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

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

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

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

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

Human Subjects, Animal Testing, and Recombinant DNA. Due to the short timeframe associated with Phase I of the SBIR/STTR process, the DON does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I goal for time-to-award. Before the DON makes any award that involves an IRB or similar approval requirement, the proposing small business

concerns must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact the DON's evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within two months of notification of selection, the decision to award may be terminated. If the use of human, animal, and recombinant DNA is included under a Phase I or Phase II proposal, please carefully review the requirements at: https://www.nre.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

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

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

SELECTION, AWARD, AND POST-AWARD INFORMATION

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

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

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

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

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

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

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

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per small business concern per topic. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $1,800,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $1,800,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

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

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

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

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

PHASE II GUIDELINES

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

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

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

PHASE III GUIDELINES

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

Navy STTR 23.A Topic Index

N23A-T019	Electrochemical Machining of Turbine Engine Components
N23A-T020	Scalable Production of Carbon-Based Composites from Sequestered Environmental Carbon
N23A-T021	Autonomous, Long-Duration, Directional Ambient Sound Sensor
N23A-T022	Lightweight Mirrors for Microsatellites and Small Satellites
N23A-T023	Integrated Optical Imaging of the Environment on Underwater Autonomous Vehicles
N23A-T024	Compact Condensers Enabled by Additive Manufacturing
N23A-T025	Cloud Nowcasting Data/Model Fusion
N23A-T026	Development of Finite-Rate Ablation Toolset for Hypersonic Vehicles
N23A-T027	Digital Sidekick for Submarine Watchstander Augmentation
N23A-T028	Broadband, High Power, Low Loss N-polar GaN Radio Frequency (RF) Switches
N23A-T029	Non-Intrusive Aerodynamic State Sensing for Hypersonic Flight Control

N23A-T001 TITLE: DIGITAL ENGINEERING - Toolkit to Produce Common Adaptive Mesh for Virtual Reality-based Multidisciplinary Interactive Design of Naval Aircraft

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

OBJECTIVE: Develop an innovative tool that can autonomously generate a common mesh from Computer-Aided Design (CAD) geometry with adaptive global and local refinement capabilities for coupled aero-thermal-structural analysis and optimization to enable Virtual Reality (VR)-based real-time interactive designs.

DESCRIPTION: Digital engineering for aircraft development can be accelerated by multidisciplinary design, analysis, and optimization (MDAO). The core component of MDAO for hypersonic aircraft is the multi-physics simulations involving the interplay between high-speed aerodynamics, structural dynamics, and thermodynamics. Aero-structure-thermal simulations could dramatically reduce the ground-based and in-flight tests as more capable high-performance computing (HPC) hardware can afford higher resolutions of geometrical and physical complexities — i.e., if a 10 cm accuracy in the 1980s for an aircraft was the standard, 1 mm for the geometry and 1 μm in the boundary layer resolution is now commonplace.

However, these increasing geometrical accuracy requirements and physical complexities pose grand challenges in mesh generation [Refs 1–2]. According to the NASA CFD Vision 2030 [Ref 3], mesh generation and adaptivity persist as significant bottlenecks in computational fluid dynamics (CFD) workflow. On the one hand, autonomous and geometry-aware mesh generation techniques are still lacking. Generating high-quality meshes by existing approaches [Refs 4–7] from complex CAD models of aircraft still involves time-consuming human intervention, and the resulting meshes do not retain the parameterization of the geometry. The geometric discrepancy can lead to significant errors in the prediction of critical physics, such as shock-boundary layer interaction and fatigue/damage in structures. On the other hand, mesh adaption can substantially save CPU time, memory requirement, and storage space. However, controlling the error and generating the optimal mesh for a given accuracy is challenging [Ref 9]. Automatic mesh adaption with local and global refinements in critical regions without prior knowledge of the problem is also a difficult task [Ref 1]. Resolving these challenges, which have been hampering automatic and adaptive mesh generation for complex geometries, will dramatically facilitate simulation-based aircraft design and optimization and have a far-reaching impact on Navy's missions. An adaptive, common mesh generation tool is needed to facilitate the MDAO to accelerate aircraft development. The effectiveness of the tool is measured by reducing the time, and therefore cost, required to develop the multi-physics meshes. The tool should enable autonomously-generated geometry-aware mesh generation and adaption, which can be integrated into the simulation tools of aircrafts involving CFD (e.g., hypersonic flows), fluid-structure interaction (FSI), fatigue/damage, and thermodynamics. The developed tool should be flexible, i.e., able to handle various air vehicle geometries. The tool should allow automatic mesh adaption with no or minimal dependence on prior knowledge in multi-physics simulations for critical quantities at critical locations, such as shock and turbulence in the fluid domain, as well as mechanical and thermal variables in the structural domain. The mesh generation and adaption tool should have quantification metrics, control strategies, and error estimates to assist the user in obtaining reliable simulation results with the first mesh. It should also address both body-fitted meshes and nonbody-fitted meshes, as the latter meshes are essential for the feasibility, as well as efficiency of MDAO problems where the geometry undergoes large shape and/or topological changes, and the multidisciplinary simulations involve large structural displacements, rotations and/or deformations [Ref 10]. The toolkit should enhance the user's experience with virtual reality by improving visual understanding of the mesh with respect to the geometry through the interaction of the various physics.

PHASE I: Demonstrate the capability of the mesh generation tool and its integration with a prototype simulation toolkit design. Illustrate a workflow for a multidisciplinary analysis along with the local-global

coupling for a representative aircraft structural component subjected to a given operational profile. Demonstrate the effectiveness and cost saving in design iteration in comparison with a conventional approach. Show the autonomous capability of meshing complex CAD models and adaption upon mesh generation, capturing critical features such as shocks or stress concentrations. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, demonstrate, and validate the prototype design from Phase I. Fully integrate the mesh generation technique with multi-physics simulation tools of aero-structure-thermal analysis for aircraft development. Quality metrics for the fully functional software product should include the automatic meshing adaptivity to capture the local physics and meshing transformation between different physical problem descriptions. Incorporate virtual reality to enhance the user's understanding of the mesh and how it relates to the geometry. The virtual reality should also enhance understanding of the solution and the interactions of various physics. Show the applicability of the tool using commercially available or open literature CAD data for the original design and specifications. Demonstrate its advantages in terms of cost, accuracy, and robustness in the context of MDAO to reach an optimized design under fluid-thermal-mechanical loading.

PHASE III DUAL USE APPLICATIONS: Demonstrate capability to model a flight test event with inclusion of fluid-thermal-mechanical loading and show it provides risk reduction for the test event. The use of multidisciplinary simulations is becoming more common for commercial products. Beyond the natural need of the commercial aerospace industry, many other industries are interested in multi-physics simulations. Civil engineering needs to consider fluid-structures interactions. Fluid-thermal interactions are critical for electronics. The automotive industry is interested in fluid-thermal-structural analysis, with rapid turnaround. These industries will benefit from more capable and quicker multidisciplinary mesh generation.

REFERENCES:

1. Alauzet, F., & Loseille, A. (2016). A decade of progress on anisotropic mesh adaptation for computational fluid dynamics. Computer-Aided Design, 72, 13-39. https://doi.org/10.1016/j.cad.2015.09.005
2. Karman, S. L., Wyman, N., & Steinbrenner, J. P. (2017). Mesh generation challenges: A commercial software perspective. In 23rd AIAA Computational Fluid Dynamics Conference (p. 3790). https://doi.org/10.2514/6.2017-3790
3. Slotnick, J. P., Khodadoust, A., Alonso, J., Darmofal, D., Gropp, W., Lurie, E. and Mavriplis, D. J. (2014). CFD vision 2030 study: a path to revolutionary computational aerosciences. https://ntrs.nasa.gov/citations/20140003093
4. Aftosmis, M., Berger, M., & Murman, S. (2004, May). Applications of space-filling-curves to cartesian methods for cfd. In 42nd AIAA Aerospace Sciences Meeting and Exhibit (p. 1232). https://doi.org/10.2514/6.2004-1232
5. Löhner, R., & Parikh, P. (1988). Generation of three-dimensional unstructured grids by the advancing-front method. International Journal for Numerical Methods in Fluids, 8(10), 1135-1149. https://doi.org/10.1002/fld.1650081003
6. Weatherill, N. P., & Hassan, O. (1994). Efficient three-dimensional Delaunay triangulation with automatic point creation and imposed boundary constraints. International journal for numerical methods in engineering, 37(12), 2005-2039. https://doi.org/10.1002/nme.1620371203
7. Yerry, M. A., & Shephard, M. S. (1984). Automatic three-dimensional mesh generation by the modified-octree technique. International Journal for Numerical Methods in Engineering, 20(11), 1965-1990. https://doi.org/10.1002/nme.1620201103
8. Hughes, T. J., Cottrell, J. A., & Bazilevs, Y. (2005). Isogeometric analysis: CAD, finite elements, NURBS, exact geometry and mesh refinement. Computer methods in applied mechanics and engineering, 194(39-41), 4135-4195. https://doi.org/10.1016/j.cma.2004.10.008

9. Park, M. A., Kleb, W. L., Jones, W. T., Krakos, J. A., Michal, T. R., Loseille, A., Haimes, R., & Dannenhoffer, J. (2019). Geometry modeling for unstructured mesh adaptation. In AIAA Aviation 2019 Forum (p. 2946). https://doi.org/10.2514/6.2019-2946
10. Ho, J. B., & Farhat, C. (2021). Aerodynamic shape optimization using an embedded boundary method with smoothness guarantees. In AIAA Scitech 2021 Forum (p. 0280). https://doi.org/10.2514/6.2021-0280

KEYWORDS: Mesh Generation; Adaptive Meshing; Global-local modeling; Multidisciplinary Analysis; multi-disciplinary design, analysis, and optimization; virtual reality

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N23A-T002 TITLE: DIGITAL ENGINEERING - Integration of Fiber Optics Systems Design, Supportability, and Maintainability

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

OBJECTIVE: Develop modeling approach for designing, maintaining, and supporting air and sea platform digital and analog fiber optic communications technology.

DESCRIPTION: The use of optical fiber on air, surface ship, and undersea platforms is pervasive, and is an enabling technology. Current military electronics, electro-optic, communications, radar, and electronic warfare systems require ever-increasing bandwidths, while simultaneously demanding reductions in space, weight, and power (SWaP). The effectiveness of these systems hinges on optical communication components that realize sufficient link budget, dynamic range, and compatibility with military surface ship, undersea platform, and aircraft maintenance environments [Refs 1-5]. Future digital and analog/radio frequency (RF) signal transmission rates and frequencies have increased to the point where fiber optics is the only medium with the capacity and low loss for maintaining communications signal integrity. Maintainability and supportability are well-known operational availability drivers for fiber optics technology deployment on military platforms [Ref 6]. Key systems engineering design considerations include architecture (openness, modularity, scalability, and upgradeability), reliability, maintainability, and supportability. Supportability infrastructure is difficult to add on after the design is established, and therefore should be included in the systems engineering design process.

Key fiber optics systems engineering design considerations include architecture, reliability, maintainability, and supportability. Integrating the disparate interfaces associated with digital and analog/RF fiber optic systems, and a model-based engineering approach, requires significant digital engineering research and innovation. Although the Navy has complete knowledge of the required connections and interfaces for digital and analog/RF fiber optics, there is no model-based approach to selecting components (connectors, cable, termini, transmitters, receivers), support equipment (maintenance sets), training, and the required supportability and maintainability concepts. MIL-HDBK-217 requires modernization for fiber optics reliability engineering [Ref 7]. This digital engineering research effort should develop models that include all of the platform components, support equipment, associated fleet maintainer training, reliability data, and digital and analog/RF fiber optic system design engineering principles. Digital engineering research should capture approaches to minimize the number and diversity of parts and interfaces, and be applicable to aircraft, surface ship, and undersea platform specific model-based system-engineering models. Digital engineering research is also required to understand how to best utilize the existing CAMEO Systems Modeler tool [Ref 8] and Systems Modeling Language (SysML) [Ref 9] for ship and aircraft fiber optics hardware integration, relevant use cases, use of existing standards, digital and analog/RF link design principles, and use of existing and emerging components.

Fiber optics supportability cuts across reliability, maintainability, and the supply chain to facilitate detection, isolation, and timely repair/replacement of system anomalies. Typical supportability features include prognostics, diagnostics, skill levels, support equipment footprint, training, maintenance data collection, compatibility, packaging and handling, and other factors that contribute to an optimum environment for sustaining a fiber optic system. The ability to sustain the operation of a fiber optic system on a surface ship, undersea platform or aircraft, is established by the inherent supportability of the system and the processes used to sustain the functions and capabilities of the system in the context of the end user. The focus of sustainment planning is to influence the inherent supportability of the system and to plan the sustainment capabilities and processes used to sustain system operations. Sustainment influence requires an understanding of the system missions and mission profiles and to provide rationale for

functional and performance priorities. Understanding the rationale paves the way for decisions about necessary tradeoffs between system performance, with impact on the cost effectiveness of system operation, maintenance, and logistics support. There is no single list of sustainment considerations or a specific way of grouping system operation, maintenance, and logistics support, as they are highly inter-related. They include compatibility, transportability, the actual maintenance environment, diagnostics and prognostics (including real-time maintenance data collection and built-in test), and corrosion protection and mitigation.

Fiber optics maintainability considerations encompass modularity, interoperability, physical accessibility, training, testing, and human systems integration. Maintainability generally requires balancing the maintenance requirement over the life cycle with minimal user workload. The emphasis on maintainability is to reduce the maintenance burden and supply chain by reducing time, personnel, tools, test equipment, training, facilities, and cost to maintain the system. Maintainability engineering includes the activities, methods, and practice to design minimal system maintenance requirements and associated costs for preventative and corrective maintenance, as well as servicing and calibration activities. Maintainability should be a designed-in capability and not an add-on option, because good maintenance procedures cannot overcome poor system and equipment maintainability design. The primary objective is to reduce the time and complexity for a properly trained maintainer to detect, isolate and repair a failure.

PHASE I: Collect research data on fiber optic components, link-loss power budget methodologies, system design concepts, maintenance concepts, support equipment concepts, and overall maintainability and supportability. Using SysML, create handoff between reliability, maintainability, and supportability within the bounds of the military platform fiber optic systems engineering process. Identify key risk areas for tracing lower level fiber optic system designs to higher level supportability and maintainability considerations to realize desired life cycle performance, and mitigate these risks using digital engineering research concepts and modeling tools. Demonstrate operational suitability trade-offs of model-based system engineering approaches to fiber optic system design and support. The Phase I effort shall include plans to be developed under Phase II.

PHASE II: Develop digital engineering-based prototype software to enable modeling of fiber optics integration in the context of supportability and maintainability. Optimize the model designs using representative cases from ships and aircraft. Build and test support equipment prototypes based on results from the models. Determine the efficacy of the entire support concept. Deliver the SysML model and digital engineering software.

PHASE III DUAL USE APPLICATIONS: Finalize the application. Verify and validate the application in model-based systems engineering environments that are applicable to aerospace, surface ship, and undersea platforms. Transition to applicable naval platforms.

Commercial sector telecommunication systems, fiber optic networks, and data centers could benefit from the development of this application.

REFERENCES:

1. Binh, L. N. (2017, July 26) Advanced digital optical communications (2nd ed.). CRC Press. https://www.worldcat.org/title/advanced-digital-optical-communications/oclc/1053852857?referer=br&ht=edition
2. Urick, V. J., Williams, K. J. & McKinney, J. D. (2015). Fundamentals of microwave photonics. John Wiley & Sons. https://www.worldcat.org/title/fundamentals-of-microwave-photonics/oclc/895388531&referer=brief_results

3. AS-3 Fiber Optics and Applied Photonics Committee. (2018, January 23). AS5603A Digital Fiber Optic Link Loss Budget Methodology for Aerospace Platforms. Warrendale: SAE. https://www.sae.org/standards/content/as5603a/
4. AS-3 Fiber Optics and Applied Photonics Committee. (2018, January 23). AS5750A Loss Budget Specification for Fiber Optic Links. Warrendale: SAE. https://www.sae.org/standards/content/as5750a/
5. Naval Sea Systems Command. (1997, October 10). MIL-STD-2052A: Department of Defense design criteria standard: fiber optic systems design. Department of Defense. http://everyspec.com/MIL-STD/MIL-STD-2000-2999/MIL-STD-2052A_9141/
6. Department of Defense. (1991, December 2). MIL-HDBK-217F: Military Handbook: Reliability prediction of electronic equipment. Department of Defense. http://everyspec.com/MIL-HDBK/MIL-HDBK-0200-0299/MIL-HDBK-217F_14591/
7. CATIA. (n.d.). Cameo systems modeler. 3DS.com. Retrieved August 25, 2021, from https://www.nomagic.com/products/cameo-systems-modeler
8. Defense Supply Center Columbus. (2010, May 28). MIL-STD-1678/1: Department of Defense standard practice: Fiber optic cabling systems requirements and measurements (Part 1: Design, installation and maintenance requirements). Department of Defense. http://everyspec.com/MIL-STD/MIL-STD-1600-1699/MIL-STD-1678-1_20346/
9. The Object Management Group. (n.d.). What is SYSML? OMG Systems Modeling Language. Retrieved August 25, 2021, from https://www.omgsysml.org/what-is-sysml.htm

KEYWORDS: Fiber optics; system design; supportability; maintainability; model-based systems engineering; digital engineering

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N23A-T003 TITLE: DIGITAL ENGINEERING - Improved Physics Modeling for Sand Particulate Tracking and Deposition in Gas Turbine Engines

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software
OBJECTIVE: Improve time-varying modeling and simulation capabilities to couple representative reactive sand particulates with modern propulsion systems, including inlet and turbomachinery.

DESCRIPTION: Naval aircraft powered by gas turbine engines experience safety, performance, and reliability concerns when operating in degraded visual environments with significant concentrations of reactive dust and sand. Sand particulates—including sand, salt, dust, and volcanic ash that aren't filtered or separated by an existing inlet or engine mounted filtration system—are ingested into the gas turbine engine.

Improved modeling and simulation tools will help better characterize the sand particulate impact on turbomachinery within aircraft propulsion systems. Current systems can have safety impacts when operating in sand and dust related to sand deposition within the turbine leading to engine surge and potential loss of aircraft. Engine reliability is heavily impacted by sand ingestion, which can lead to faster engine deterioration with significant life cycle cost. Improved understanding of the impacts and design changes using modeling tools would have a positive impact on capability, performance, and cost.

Ingested particles can degrade compressor performance via surface erosion, deform leading and trailing edges of blade airfoils, and open rotor tip-clearances [Ref 4]. Sand particulates that make it through to the combustor are elevated to high temperatures and can deposit on turbine airfoil surfaces—shrinking throat clearances—or deposit on turbine shroud and degrade turbine tip clearances. Sand particulates can also enter cooling passages and create deposits that block cooling flows resulting in exceedance of airfoil material temperature limits. This can affect both military and commercial aircraft and rotorcraft. Sand ingestion and deposition can be further impacted by relevant sand properties (geology, chemical composition, size distribution, shape, concentration) [Ref 3].

Airflow restrictions can occur rapidly on wing, and result in sand related operability impacts that can cause safety issues with undesired engine surge and stall events. Additionally, performance loss from significant turbine airfoil damage typically cannot be recovered entirely via engine wash or other maintenance procedures. This can lead to more frequent engine replacements and an overall reliability concern for the propulsion system. Complex propulsion systems of interest include inlets, inertial separators, hot and cold rotating turbomachinery with and without secondary cooling air flow, as well as the coupling of multiple of these components.

Current state-of-the-art modeling and simulation tools typically couple steady-state Reynold's averaged navier stokes (RANS) computational fluid dynamics (CFD) solvers to a discrete particle tracking tool. This method has several disadvantages, including inaccurate inclusion or modeling of turbulent particle dispersion, limited particle-to-particle collisions and interaction, simplified particle shapes that affect drag estimates and wall-impacts/rebounds, one-way coupled particles that don't affect gas aerodynamics, and deposition predictions that use frozen geometry shapes and wall properties that can't change in time as the deposit size increases. Unsteady Large Eddy Simulation (LES) typically include more rich physics-based models that incorporate more of the above RANS deficiencies; however, they can also be computationally expensive and too long to impact design iterations or active acquisition programs. Additionally, the vast amount of data available from a resolved simulation with millions of particulates is frequently difficult to post-process and analyze efficiently. Efficient algorithms and post-processing methodologies to cumulatively understand time-accurate statistical measures of the ingested sand particulates are required. Modeling and simulation tools need to be improved to be able to accurately predict time-varying particle trajectories, wall-impacts, surface erosion, and surface deposition within inlet systems and engine

turbomachinery [Ref 5]. Improvements to accuracy and confidence of modeling methodologies, as well as significant improvements to computational cost and efficiency to be able to impact a typical design cycle, are desired. The proposed approach's accuracy and applicability to relevant, complex propulsion systems should be demonstrated via comparisons against available (published), acquired experimental data, or government-provided test data.

A focus on robust, parallel, highly efficient software improvements that can be utilized for complex geometries (such as inertial separators and rotating turbomachinery with secondary and cooling flows) with relevant sand particle constituents, size distributions, and cloud concentrations [Ref 1], is required. Although not required, it is highly recommended that the proposer work in coordination with the original equipment manufacturer (OEM) to ensure proper design and to facilitate transition of the final technology.

PHASE I: Demonstrate understanding of relevant sand properties, including those of reactive sand and dust (geology, chemical composition, size distribution, shape, concentration). Demonstrate and validate the use of a commercially available CFD solver that has been coupled to incorporate sand particulates. Validate selected aerodynamic software on relevant turbomachinery geometry. Define the approach to be used in Phase II for improved physics modeling and robust, efficient solver development that can be applied to complex propulsion systems. Provide risk mitigation information. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate the prototype improved sand and dust modeling capability. Show efficient integration of reactive capability with existing, commercially available CFD software. Evaluate and report on the tool improvements impact on accuracy against available (published), acquired experimental data, or government-provided test data. Provide clear documentation of the theory, applied models and methods, assumptions, limitations, and instructions for use of the coupled aerodynamic and sand predictive tool. Demonstrate computational efficiency and robustness on DoD High Performance Computing assets.

PHASE III DUAL USE APPLICATIONS: Transition developed tool and capability to government for implementation on fleet aircraft. Modify tools based on feedback from use within a DoD acquisition program. Support the application of advanced, mature, robust tools on aircraft engine and inlet analysis and redesign.

Commercial aircraft engines experience sand and dust deterioration over long-time exposures. This can also impact performance and reliability of commercial engines. Improved modeling and simulation for better understanding and design methodologies will also impact aircraft engines for rotary- and fixed-wing commercial aircraft.

REFERENCES:

1. Cowherd, C. (2007). MRI project no. 110565: Sandblaster 2 support of see-through technologies for particulate brownout. Midwest Research Institute. https://apps.dtic.mil/sti/pdfs/ADA504965.pdf
2. Guha, A. (2008). Transport and deposition of particles in turbulent and laminar flow. Annu. Rev. Fluid Mech., 40, 311-341. https://doi.org/10.1146/annurev.fluid.40.111406.102220
3. Walock, M. J., Barnett, B. D., Ghoshal, A., Murugan, M., Swab, J. J., Pepi, M. S., Hopkins, P. D., Gazonas, G., Rowe, C., & Kerner, K. (2017). Micro-scale sand particles within the hot section of a gas turbine engine. Mechanical Properties and Performance of Engineering Ceramics and Composites XI, 606, 159. https://doi.org/10.1002/9781119320104.ch14
4. Hamed, A., Tabakoff, W. C. and Wenglarz, R. V. “Erosion and deposition in turbomachinery. Journal of propulsion and power, 22(2), 350-360. https://doi.org/10.2514/1.18462

5. Jain, N., Le Moine, A., Chaussonnet, G., Flatau, A., Bravo, L., Ghoshal, A., Walock, M. J., Murugan, M., & Khare, P. (2021). A critical review of physical models in high temperature multiphase fluid dynamics: turbulent transport and particle-wall interactions. Applied Mechanics Reviews. https://doi.org/10.1115/1.4051503
6. DoD High Performance Computing Modernization Program (DoD HPCMP). https://centers.hpc.mil/systems/hardware.html

KEYWORDS: Gas Turbine Engines; Degraded Visual Environments; Sand and Dust Ingestion; Computational-Fluid Dynamics; High Performance Computing; Sand Deposition

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N23A-T004 TITLE: DIGITAL ENGINEERING - Digital Twin-based Machine Control for Adaptive Additive Manufacturing Processing of Metallic Aerospace Components

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

OBJECTIVE: Develop a digital twin (DT)-based system that can autonomously tailor local microstructure, heal defects, and minimize residual stresses and surface roughness in near real-time to assure repeatable, reliable, and optimal fatigue performance for additive manufactured (AM) metallic aerospace components.

DESCRIPTION: Additive manufacturing (AM) has attained significant popularity in research and application fields such as aerospace, automobile, maritime, biomedical, and other industrial sectors. AM processes are capable of depositing near-net-shape complex geometries; but major drawbacks of the AM materials remain, including anisotropy, surface irregularities, residual stresses, and defects (such as porosity, microcracks, inclusions, dislocations, etc.). These drawbacks significantly influence the static and dynamic mechanical properties of a material. As a result, the AM parts still lack quality consistency and repeatability. While post-processing such as Hot Isotropic Pressing (HIP) could enhance performance for some alloys, it could lead to additional cost and production time.

The various defects in AM processing can arise due to many causes, and significant attention has been given to different strategies to ameliorate these defects. Two significant types of defects observed from AM processing are lack-of-fusion (LOF) defects and gas porosity. LOF occurs when an insufficient amount of energy is applied to melt a specific location of a powderbed. This is directly influenced by site-specific processing parameters, such as laser power, hatch spacing, and scan speed. A rescanning strategy in the region with the LOF may eliminate the LOF defects. Gas porosity is often spherical due to gas trapped in the raw metal powder particles or trapped inert gas during the AM processing. It has been shown that gas porosity can be minimized with increasing scan speed and appropriate power level. Another challenge that causes build failures and poor part quality is large residual stresses due to the high cooling rates in AM processing. However, recent research has found that rescanning the top layer reduces residual stresses near that surface. In order to enable in-situ controlling the quality of the build, a monitoring and control system is necessary.

There are several in-situ monitoring methods that have been demonstrated. For example, in order to capture the porosity, a high-speed camera and a photodiode were used to measure the dimensions of the melt pool condition and the mean emitted radiation. A two-color pyrometer was used to relate the consolidation phenomena with the surface temperature and to understand the solidification process of the molten powder. However, the collected data could be enormous (~0.5 Terabytes per build) requiring a large amount of storage and fast computational algorithms. Furthermore, the level of accuracy to detect and classify defects/anomalies still needs significant improvement, especially minimizing false positives and negatives.

Once the undesirable state of the deposit is monitored and sensed, near real-time healing and tailoring of the deposit are needed. A close-loop feedback laser system, such as a laser with shaped beam profiles, may be used for in-situ treatment of the deposit, as well as preventing material spattering and defects. For example, it was reported that equiaxed grains occupied a larger area fraction, and texture was reduced in parts built using an elliptical beam, compared to those built using a Gaussian beam. Laser power and wavelength control could also tailor the cooling rate to prevent cracking and improve the mechanical properties of the part. The use of ring distributed power in welding can result in a decrease of laser penetration depth, along with huge spatter reduction observed on the deposited bead and surrounding area. However, a near real-time close-loop feedback system also requires robust reduced-order/surrogate modeling coupled with Artificial Intelligence (AI)/Machine Learning (ML) that link powders, process

parameters, microstructure, and site-specific properties at the component level, including the effects of build orientation, laser-material interaction, and specific part geometry. These are the key elements of a DT-based system.

The Navy requires an integrated DT-based system that can provide near real-time machine control for fully autonomous adaptive AM processing of metallic aerospace components. The system should be able to: (a) locally re-scan and re-melt; (b) autonomously adjust and control deposited energy density including laser power/intensity, spot size, and beam shape/profile, (de)focusing, scanning speed and pattern, hatch spacing, layer thickness, and interlayer delay time; and (c) build time of a complete part should not exceed by more than 20% compared to the traditional fixed parameter pre-set method. It is envisioned that such an in-situ tailoring/healing system will not only significantly improve the fatigue life performance comparable to wrought alloys, but also assure the repeatability and reliability of AM structural parts.

PHASE I: Demonstrate feasibility of a feedback control concept that integrates with a beam shaping laser system, sensors, ML-enabled monitoring and control methodologies, and reduced-order modeling (ROM) for Laser Powder Bed Fusion (LPBF) system. Demonstrate the feasibility of healing and tailoring the AM deposit. A detailed plan should be laid out to perform the validation of the effectiveness of the concept with implementation for a metallic alloy such as AlSi10Mg aluminum. The concept should have the potential to be developed into a full-scale, near real-time, in-situ monitoring and control system of an AM process to improve fatigue properties in Phase II. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, demonstrate, and validate the prototype system developed in Phase I. Fully develop and validate the ML-enabled monitoring and control system with reduced-order modeling for a laser-based AM process to efficiently and robustly heal and tailor the AM deposited material properties, based on the optimized AM process parameters for additional selected materials, such as Ti6Al4V, SS316L, and aluminum alloys. Demonstrate its capability of manufacturing aircraft components with complex geometry and tailored performance.

PHASE III DUAL USE APPLICATIONS: Fully develop the advanced monitoring and control system coupled with reduced order models for various laser-based AM processes to fabricate naval aircraft components that can be integrated into the fleet. Conduct final component-level testing to achieve the geometry and material property of AM components meeting the Navy’s needs.

The monitoring and control system will be directly applicable to a wide range of AM process methods and machines due to the high amount of usage of AM parts in the commercial aerospace and medical industries. The oil and gas, automotive, and shipping industries could also benefit from this developed technology.

REFERENCES:

1. Liu, M., Fang, S., Dong, H., & Xu, C. (2021). Review of digital twin about concepts, technologies, and industrial applications. Journal of Manufacturing Systems, 58, 346-361. https://doi.org/10.1016/j.jmsy.2020.06.017
2. Gunasegaram, D. R., Murphy, A. B., Matthews, M. J., & DebRoy, T. (2021). The case for digital twins in metal additive manufacturing. Journal of Physics: Materials, 4(4), 040401. https://iopscience.iop.org/article/10.1088/2515-7639/ac09fb
3. Mukherjee, T., & DebRoy, T. (2019). A digital twin for rapid qualification of 3D printed metallic components. Applied Materials Today, 14, 59-65. https://doi.org/10.1016/j.apmt.2018.11.003

4. Kim, F. H., & Moylan, S. P. (2018, May). NIST advanced manufacturing series 100-16: Literature review of metal additive manufacturing defects. U.S. Department of Commerce. https://doi.org/10.6028/NIST.AMS.100-16
5. Roehling, T. T., Shi, R., Khairallah, S. A., Roehling, J. D., Guss, G. M., McKeown, J. T., & Matthews, M. J. (2020). Controlling grain nucleation and morphology by laser beam shaping in metal additive manufacturing. Materials & Design, 195, 109071. https://doi.org/10.1016/j.matdes.2020.109071
6. Kim, J., Ji, S., Yun, Y. S., & Yeo, J. S. (2018). A review: melt pool analysis for selective laser melting with continuous wave and pulse width modulated lasers. Applied Science and Convergence Technology, 27(6), 113-119. https://doi.org/10.5757/ASCT.2018.27.6.113
7. Gunasegaram, D. R., Murphy, A. B., Barnard, A., DebRoy, T., Matthews, M. J., Ladani, L., & Gu, D. (2021). Towards developing multiscale-multiphysics models and their surrogates for digital twins of metal additive manufacturing. Additive Manufacturing, 102089. https://doi.org/10.1016/j.addma.2021.102089
8. Yadav, P., Rigo, O., Arvieu, C., Le Guen, E., & Lacoste, E. (2020). In situ monitoring systems of the SLM process: On the need to develop machine learning models for data processing. Crystals, 10(6), 524. https://doi.org/10.3390/cryst10060524
9. Adnan, M., Lu, Y., Jones, A., Cheng, F.-T., & Yeung, H. (2020). A new architectural approach to monitoring and controlling AM processes. Applied Sciences, 10(18), 6616. https://doi.org/10.3390/app10186616
10. Liu, C., Le Roux, L., Ji, Z., Kerfriden, P., Lacan, F., & Bigot, S. (2020). Machine Learning-enabled feedback loops for metal powder bed fusion additive manufacturing. Procedia Computer Science, 176, 2586-2595. https://doi.org/10.1016/j.procs.2020.09.314
11. Vandone, A., Baraldo, S., & Valente, A. (2018). Multisensor data fusion for additive manufacturing process control. IEEE Robotics and Automation Letters, 3(4), 3279-3284. https://doi.org/10.1109/LRA.2018.2851792
12. Zhu, Q., Liu, Z., & Yan, J. (2021). Machine learning for metal additive manufacturing: predicting temperature and melt pool fluid dynamics using physics-informed neural networks. Computational Mechanics, 1-17. https://doi.org/10.1007/s00466-020-01952-9
13. McCann, R., Obeidi, M. A., Hughes, C., McCarthy, É., Egan, D. S., Vijayaraghavan, R. K., Joshi, A. M., Acinas Garzon, V., Dowling, D. P., McNally, P. J., & Brabazon, D. (2021). In-situ sensing, process monitoring and machine control in Laser Powder Bed Fusion: A review. Additive Manufacturing, 102058. https://doi.org/10.1016/j.addma.2021.102058
14. Du, Y., Mukherjee, T., & DebRoy, T. (2021). Physics-informed machine learning and mechanistic modeling of additive manufacturing to reduce defects. Applied Materials Today, 24, 101123. https://doi.org/10.1016/j.apmt.2021.101123
15. Pandita, P., Ghosh, S., Gupta, V. K., Meshkov, A., & Wang, L. (2021). Application of deep transfer learning and uncertainty quantification for process identification in powder bed fusion. ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering, 8(1), 011106. https://doi.org/10.1115/1.4051748

KEYWORDS: Additive Manufacturing; Digital Twin; In-situ Monitoring; Closed-Loop Feedback Control; Artificial Intelligence/Machine Learning; Reduced-Order Modeling

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N23A-T005 TITLE: Sensor System for Time-Resolved Temperature Measurements in High-Temperature/High-Velocity Exhaust Plumes

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

OBJECTIVE: Develop a time-resolved sensor system for measuring gas dynamic and compositional characteristics of high-temperature/high-velocity engine exhaust plumes.

DESCRIPTION: Time-resolved measurements in high-temperature and high-velocity exhaust plumes are necessary to better understand transient phenomena including startup/shut down, combustion instabilities, and flow nonuniformity. Measurement parameters of interest in exhaust plumes include temperature, pressure, velocity, combustion efficiency, and gas composition.

High-temperature, high-velocity exhaust plumes present a uniquely challenging measurement environment. Wetted sensors, such as thermocouples and pressure transducers, degrade rapidly in reactive, particle-laden, high-temperature, high-velocity plume flows, emphasizing a need for noninvasive measurement approaches. Similarly, noninvasive optical techniques are hampered by low-transmission, large-density gradients, and high-thermal, spontaneous emission in hot, fast, particle-laden flows. An innovative sensor system is desired for measurements in high-temperature and high-velocity exhaust plumes. Extending existing measurement technologies to full-scale engines requires improved strategies in sensor survivability, overcoming poor signal-to-noise ratio, and the extreme acoustic and vibratory environment in close proximity to the exhaust plume.

Key sensor system parameters should include, but not be limited to the following:

1. Measuring temperature is of primary interest. Additional measurement parameters of interest include pressure, velocity, combustion efficiency, and gas composition. Desired speciation of composition measurements include unburned fuel components, intermediate fuel-cracking products, and final products (CO, CO2, H2O, NO, NO2).
2. Temperature measurement accuracy must be better than +/- 5%.
3. Sensor must provide, spatially-resolved point or line-averaged measurements to a resolution of at least 1 mm or smaller. Two-dimensional maps of measurement parameters are also of interest.
4. Minimum sensor bandwidth must exceed 1 kHz. Increased bandwidth up to 100 kHz is preferred.
5. The operational envelope for the sensor must span temperatures from 500–3,000 K (227–2727 °C).
6. Optical sensors are of interest to provide noninvasive measurements that do not perturb plume characteristics. Optical sensors must be capable of performing measurements in particle-laden, highly emissive flows.
7. Sensor lifetime for high-temperature, high-velocity exhaust plume measurements must exceed 1,000 hr.

PHASE I: Develop a concept and determine the feasibility of a sensor system for time-resolved measurements in high-temperature, high-velocity exhaust plumes with the ideal goal of providing greater than 1 kHz measurement bandwidth. Ensure that the concept sensor provides point- or line-averaged measurements of temperature over the range of 500 to 3,000 K (227–2727 °C).

Additional measurement parameters—including pressure, velocity, combustion efficiency, and composition—are of interest, but not required, in Phase I. Noninvasive optical measurement approaches are desirable, but must be able to operate in flows with high-particulate loads (low transmission) and high emission. Phase I should include (a) benchtop testing and validation of sensor concept and accuracy in

controlled high-temperature gas environment, (b) designs for construction of field-deployable sensor prototype, and (c) detailed prototype plans to be developed under Phase II.

PHASE II: Develop, demonstrate, and validate a prototype sensor. Improve upon the performance, reliability, and usability of the sensor. Perform field demonstrations, which will guide sensor improvements. Desired improvements include (a) measurement bandwidth in excess of 10 kHz, (b) temperature measurement accuracy better than +/- 5%, (c) measurements at multiple locations within a plume, including close proximity to the nozzle exhaust, and (d) increased capability to handle all relevant engine operating conditions. Include the extension of the sensor prototype to include additional measurement parameters such as pressure, velocity, combustion efficiency, and/or composition. Include (a) revision of the sensor design to improve performance, reliability, and usability; (b) successful demonstration of temperature measurements using the second-generation prototype in high-temperature/velocity exhaust plume; (c) successful demonstration of additional measurement parameters using the second-generation prototype in high-temperature, high-velocity exhaust plume; and (d) delivery and initial testing of the sensor prototype.

PHASE III DUAL USE APPLICATIONS: Complete final testing and transition the technology for Navy use. Accurate time-resolved measurements of aircraft engine, rocket, and other plumes could steer development of commercial propulsion systems and modeling tools used in their development.

REFERENCES:

1. Peng, W. Y., Cassady, S., Strand, C. L., Goldenstein, C. S., Spearrin, R. M., Brophy, C. M., Jeffries, J. B., & Hanson, R. K. (2019). Single-ended mid-infrared laser-absorption sensor for time-resolved measurements of water concentration and temperature within the annulus of a rotating detonation engine. Proceedings of the Combustion Institute, 37(2) 1435-1443. Elsevier. https://doi.org/10.1016/j.proci.2018.05.021
2. Goldenstein, C. S., Spearrin, R. M., Jeffries, J. B., & Hanson, R. K. (2017). Infrared laser-absorption sensing for combustion gases. Progress in Energy Combustion Science, 60, 132-176. https://doi.org/10.1016/j.pecs.2016.12.002
3. Goldenstein, C. S., Almodovar, C. A., Jeffries, J. B., Hanson, R. K., & Brophy, C. M. (2014). High-bandwidth scanned-wavelength-modulation spectroscopy sensors for temperature and H2O in a rotating detonation engine. Measurement Science and Technology, 25(10), 105104. https://doi.org/10.1088/0957-0233/25/10/105104
4. Sun, K., Sur, R., Chao, X., Jeffries, J. B., Hanson, R. K., Pummill, R. J., & Whitty, K. J. (2013). TDL absorption sensors for gas temperature and concentrations in a high-pressure entrained-flow coal gasifier. Proceedings of the Combustion Institute, 34(2), 3593-3601. https://doi.org/10.1016/j.proci.2012.05.018
5. Hanson, R. K. (2011). Applications of quantitative laser sensors to kinetics, propulsion and practical energy systems. Proceedings of the Combustion Institute, 33(1), 1-40. https://doi.org/10.1016/j.proci.2010.09.007
6. Schäfer, K., Heland, J., Lister, D. H., Wilson, C. W., Howes, R. J., Falk, R. S., Lindermeir, E., Birk, M., Wagner, G., Haschberger, P., Bernard, M., Legras, O., Wiesen, P., Kurtenbach, R., Brockmann, K. J., Kriesche, V., Hilton, M., Bishop, G., Clarke, R., … Vally, J. (2000). Nonintrusive optical measurements of aircraft engine exhaust emissions and comparison with standard intrusive techniques. Applied Optics, 39(3), 441-455. https://doi.org/10.1364/AO.39.000441
7. Ihme, M., 2017. Combustion and engine-core noise. Annual Review of Fluid Mechanics, 49, pp.277-310. https://www.annualreviews.org/doi/pdf/10.1146/annurev-fluid-122414-034542
8. Brès Guillaume A. and Lele Sanjiva K. 2019. Modelling of jet noise: a perspective from large-eddy simulations. Phil. Trans. R. Soc. A. http://doi.org/10.1098/rsta.2019.0081

9. Cavalieri, A. V. G., Jordan, P., and Lesshafft, L. (March 13, 2019). "Wave-Packet Models for Jet Dynamics and Sound Radiation." ASME. Appl. Mech. Rev. March 2019; 71(2): 020802. https://doi.org/10.1115/1.4042736

KEYWORDS: High Temperature Sensor; Temperature Measurement; Time-Resolved; Plume Measurements; Combustion Measurements; Gas Composition Measurement

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N23A-T006 TITLE: Microwave Curing Process Modeling for Continuous Carbon Fiber Reinforced Thermoset Composites

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

OBJECTIVE: Develop simulation models and visualization tools for microwave curing process of carbon fiber reinforced composites, and demonstrate the feasibility to manufacture high quality carbon fiber reinforced composites using microwave radiation.

DESCRIPTION: Autoclaves are widely utilized to process and manufacture high-performance aircraft composite materials. This conventional method provides laminate consolidation by application of elevated pressures and temperatures; however, the high costs and extensive process times associated with this technique have generated an interest in the implementation of out of autoclave curing methods. Microwave curing is gaining increasing attention as an alternative tool for composite industrialization, due to its potential for reduced cure times, low energy consumption, and mass production.

Microwave systems heat materials via electromagnetic field interaction. Electromagnetic fields are transferred to the material, and heat is generated through polarization. Microwave curing has been used for glass fiber composite processing, but there are significant challenges associated with microwave curing of carbon fiber composites. Efficient heating is difficult due to high dielectric loss and low depth of penetration associated with carbon fibers. Another major challenge is related to arcing of carbon fibers, which can result in very high-localized hot spots that damage the surrounding material. Laminate quality is highly dependent on the uniformity of the electromagnetic field in the material. The anisotropic dielectric properties of composite constituents disrupts the intended homogeneous volumetric cure, resulting in non-uniform heating. This heating behavior requires further investigation; highlighting the need for a tool that can model this phenomenon.

This STTR topic seeks to develop a multi-physics based model that simulates and optimizes the microwave curing process of thick fiber reinforced composites (up to 10 mm). The model should account for the interaction of electromagnetic, thermal, and chemical mechanisms induced during the curing process. The tool will be used to model aerospace-grade thermoset composite materials (such as IM7/8552) of varying lay-up thicknesses and fiber orientations, to predict curing behavior and material properties. The model predictions for microwave cured fiber reinforced composites will be validated by qualitative (such as porosity, defects, etc.), mechanical (such as tension, flexure, impact, etc.) and chemical (such as differential scanning calorimetry, dynamic mechanical analysis, etc.) coupon testing. The implementation of a microwave curing process would result in reduced cure times and reduced energy consumptions. The modeling tool would aid in the reduction of test runs required for composite part production. It would also give companies greater production scheduling freedom through process modeling of components. This would make production more adaptive and save scheduling time and costs.

PHASE I: Develop a modeling methodology based on the proposed concept of a multi-physics tool that can simulate and optimize the microwave curing process of fiber reinforced composite materials. Demonstrate feasibility of the methodology and investigate the effects of the microwave curing conditions, such as power, duration, composite orientation, composite thickness, etc., via simulations, that account for electromagnetic, thermal, and chemical mechanisms on the mechanical properties of the cured composite. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the proposed multi-physics tool to address microwave manufacturing of fiber reinforced composites of thicknesses up to 10 mm. Demonstrate and validate the tool by comparing

simulation predictions to the results of various qualitative, mechanical, and chemical tests of microwaved and autoclaved cured fiber reinforced composite coupons.

PHASE III DUAL USE APPLICATIONS: Enhance and demonstrate this tool with difficult to process parts, associated with autoclave curing, and with different material systems. Coordinate with the prime and sub-contractors producing composite parts to facilitate the transition and utilization of this tool. The product outcome of this topic has extensive applications for companies producing fiber- reinforced composite parts, in particular companies that utilize an autoclave process. This topic desires to provide a modeling tool to optimize the alternative microwave curing process for the production of quality parts at a lower cost (50% reduction) and quicker turnaround times (40% reduction).

REFERENCES:

1. Mishra, R. R., & Sharma, A. K. (2016). Microwave–material interaction phenomena: heating mechanisms, challenges and opportunities in material processing. Composites Part A: Applied Science and Manufacturing, 81, 78-97. https://doi.org/10.1016/j.compositesa.2015.10.035
2. Mgbemena, C. O., Li, D., Lin, M. -F., Liddel, P. D., Katnam, K. B., Thakur, V. K., & Nezhad, H. Y. (2018). Accelerated microwave curing of fibre-reinforced thermoset polymer composites for structural applications: A review of scientific challenges. Composites Part A: Applied Science and Manufacturing, 115, 88-103. https://doi.org/10.1016/j.compositesa.2018.09.012
3. Galos, J. (2021). Microwave processing of carbon fibre polymer composites: a review. Polymers and Polymer Composites, 29(3), 151-162. https://doi.org/10.1177/0967391120903894

KEYWORDS: Microwave curing; Manufacturing process; Physics-based modeling; Carbon fiber thermoset composites; Process optimization; Mechanical testing

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N23A-T007 TITLE: Ultra-Compact, Lightweight MWIR Zoom Imaging Optics Based on Flat Lens Technology

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

OBJECTIVE: Develop ultra-compact, lightweight Mid-wave infrared (MWIR) zoom imaging optics based on flat lens technology and with 7 times improvement in SWaP.

DESCRIPTION: MWIR imaging systems are essential to intelligence, surveillance, and reconnaissance (ISR) missions. Conventional IR optics are thick, heavy, costly, and often require bulky mechanical mounting system to keep their multiple optical elements stable and well-aligned. Current systems weigh 400 g or more, often necessitating heavy-duty gimbals for aiming. Heavy optics require tens of minutes to reach thermal equilibrium during takeoff and landing of air platforms such as unmanned aircraft systems (UASs), limiting ISR operations.

Flat lens technologies have the potential to provide extremely compact and lightweight imaging capability in the MWIR, including reduced costs and added functionality such as zoom or variable focus [Refs 1 & 2]. Microfabricated flat lens optics can be only 1 mm thick or less, reducing overall lens system length and supporting more compact imaging systems. Their extremely low mass allows them to reach thermal equilibrium in less than one minute in typical airborne scenarios. Two promising flat lens technologies are metasurface optics (or meta-optics) [Refs 3–5], and multilevel diffractive lenses (MLD) [Ref 6]. Both have challenges related to scalable fabrication and with chromatic aberration for broadband applications. The MLD approach has challenges associated with large numerical apertures (small f-numbers) and high throughput, especially for oblique angles of incidence, which gives rise to significant vignetting, that is, reduction of the image's brightness toward the sensor periphery compared to center. Meta-optics can achieve extremely low-aberration imaging, often reducing the number of optical elements required. As the design space and device function complexity of flat lenses scales up, limitations of the conventional human-driven forward design of meta-optics have necessitated a breakthrough in design philosophy. Recent work using inverse design with appropriate artificial intelligence (AI) tools positions this method to transform meta-optics design [Refs 7–9]. The inverse design approach explores the physics of nanophotonics using advanced mathematical tools, iterating until an optimal solution is achieved. Inverse design has significant advantages over conventional forward design: it does not need a priori knowledge of physics; it can be used for complex designs that have no analytical solution; and it can automatically balance the trade-offs among multiple device functions given the design constraints while minimizing crosstalk. Design robustness can also be considered using the inverse design techniques.

The development of a novel lightweight, low-aberration flat lens-based MWIR zoom optics must achieve certain minimum specifications in performance and size, weight, and power (SWaP) to accelerate its adoption for next-generation ISR missions. For example, the aperture size and f/# must be large enough to be useful for low-light imaging. For this effort, the target specifications include, but are not limited to, the follows:

(a) total weight, including housing, mount, and motorized control: 100 g or less
(b) axial length of lens elements: 2 cm or less (i.e., > 7 times improvement over conventional zoom lens),
(c) focal length range: f/2 for wide field of view (FoV), variable up to f/8 for narrow FoV,
(d) clear aperture: 2 cm or more, with a scalable fabrication process that can achieve larger sizes,
(e) spot size: within 20% of diffraction limit,
(f) in-band transmittance: 85% or better, including for all incident angles up to ±25°,
(g) electro-mechanical zoom time: 3s or less, and zoom range up to 5X.

The goal is to dramatically reduce size and weight versus comparable state-of-the-art conventional zoom lens systems, without reducing performance. Weight will be reduced to 25% or less, and axial length of the optical elements (excluding back focal length standoff distance) will be reduced to 15% or less than that of the conventional zoom lens set-up. The reduced weight and length should reduce time required for zoom adjustments. Initially, focal length tuning can be performed manually, but tuning speed should achieve the above target specification by the end of this effort. Longer-term goals include reduction of f/# (the f number which is a measure of the FoV of the lens set up) and increase in mechanical robustness to withstand vibrations, acceleration forces, and mechanical shocks associated with unmanned aerial system (UAS) takeoff and landing.

PHASE I: Determine the feasibility of, detail, model, and simulate an innovative approach for an ultra-compact lightweight, MWIR zoom imaging optic based on flat lens technology. Design, fabricate, and test in the laboratory a proof of concept to demonstrate the flat lens technology and its varifocal capability. Characterize performance based on the specifications outlined in the topic description. The proof of concept should have a clear aperture diameter of at least 4 mm, a zoom range of 5x, a wide FoV of f/2, in-band transmittance of 60% or better, and 96% polarization insensitivity. Design a compact MWIR zoom imaging optic to be fabricated and tested in Phase II. Use modeling and simulation to estimate its performance, including size, weight, and power. Develop a test plan and test procedures to be developed in Phase II. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the design of the prototype flat lens MWIR zoom optic based on the design from Phase I. Develop modifications that can improve performance and perform modeling and simulations. Design electro-mechanical lens housing and motorized control software for the zoom system. Fabricate the zoom optic and test it in the laboratory to demonstrate all the performance specification targets listed in the Description. Detail a scalable fabrication process that provides a roadmap toward cost-effective production and larger clear aperture systems. Study numerically the trade-offs of zoom optic performance between aperture size, numerical aperture (f/#), working bandwidth, transmittance, and FoV. Also investigate theoretically and experimentally the feasibility of extending the zoom range from 5X to 10X.

PHASE III DUAL USE APPLICATIONS: Transition the technology for U.S. Government use. Fully develop and transition the technology and methodology based on the research and development results developed for DoD applications in the various areas of anomaly detection, surveillance, and reconnaissance applications.

The commercial sector can also benefit from this innovative flat lens with very low SWaP in the areas of detection of toxic gases, environmental monitoring, and noninvasive structural materials monitoring and sensing.

REFERENCES:

1. Chen, W. T., Zhu, A. Y., Sanjeev, V., Khorasaninejad, M., Shi, Z., Lee, E., & Capasso, F. (2018). A broadband achromatic metalens for focusing and imaging in the visible. Nature nanotechnology, 13(3), 220-226. https://doi.org/10.1038/s41565-017-0034-6
2. Bosch, M., Shcherbakov, M. R., Won, K., Lee, H. S., Kim, Y., & Shvets, G. (2021). Electrically actuated varifocal lens based on liquid-crystal-embedded dielectric metasurfaces. Nano Letters, 21(9), 3849-3856. https://doi.org/10.1021/acs.nanolett.1c00356
3. Cotrufo, M., Guo, S., Overvig, A., & Alù, A. (2021, March). Nanostructured metasurfaces for optical wavefront manipulation. In Advanced Fabrication Technologies for Micro/Nano Optics and Photonics XIV (Vol. 11696, p. 1169609). International Society for Optics and Photonics. https://doi.org/10.1117/12.2584024
4. Presutti, F., & Monticone, F. (2020). Focusing on bandwidth: achromatic metalens limits. Optica, 7(6), 624-631. https://doi.org/10.1364/OPTICA.389404

5. Banerji, S., Meem, M., Majumder, A., Vasquez, F. G., Sensale-Rodriguez, B., & Menon, R. (2019). Imaging with flat optics: metalenses or diffractive lenses?. Optica, 6(6), 805-810. https://doi.org/10.1364/OPTICA.6.000805
6. Molesky, S., Lin, Z., Piggott, A. Y., Jin, W., Vuckovic, J., & Rodriguez, A. W. (2018). Inverse design in nanophotonics. Nature Photonics, 12(11), 659-670. https://doi.org/10.1038/s41566-018-0246-9
7. Li, Z., Lin, P., Huang, Y. W., Park, J. S., Chen, W. T., Shi, Z., Qui, C. –W., Cheng, J. –X., & Capasso, F. (2021). Meta-optics achieves RGB-achromatic focusing for virtual reality. Science Advances, 7(5), eabe4458. https://doi.org/10.1126/sciadv.abe4458
8. Shi, Z., Zhu, A. Y., Li, Z., Huang, Y. W., Chen, W. T., Qiu, C. W., & Capasso, F. (2020). Continuous angle-tunable birefringence with freeform metasurfaces for arbitrary polarization conversion. Science Advances, 6(23), eaba3367. https://doi.org/10.1126/sciadv.aba3367

KEYWORDS: Low-aberration; Imaging optics; Flat lens; Zoom capabilities; Mid-wave infrared; MWIR; Metamaterials

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N23A-T008 TITLE: Ultra-fast Full-Wave Photonic Simulation and Optimization

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

OBJECTIVE: Develop novel ultra-fast simulation technology capable of speeding up full-wave electrodynamic simulation by 1,000 times. This ultra-fast simulation technology will be used to develop long-wave infrared (LWIR) lens that are 100 times thinner and lighter than today's state-of-the-art LWIR optics and with fully customizable aperture sizes and focal length.

DESCRIPTION: Flat metamaterial optical devices provide a unique opportunity for producing compact and high-performance components for manipulation of light [Ref 1]. Such devices may be constructed through nanofabrication on a planar substrate, providing the possibility of replacing traditional diffractive components that are versatile for various defense and civilian applications [Ref 2]. Flat optics is particularly interesting in the long-wave infrared region because the lack of high-quality imaging optics. Traditional lenses are costly and bulky and possess limited aperture size in the infrared region. Developing integrated imaging optics in LWIR is of great interest especially for tactical surveillance and reconnaissance in this special range [Ref 3].

Metamaterial optical device is a 2D array of dielectric structures that is used to focus transmitted light to a single position directly in front of the device. Typically, these structures are emulated by simulating each dielectric unit cell individually to compute a phase and amplitude transmittance for each cell. While this approach makes for an approximation of the overall device performance, it would be useful to be able to simulate the entire device as a whole to capture the complete physical characteristics of the device structure. However, a simulation of this scale requires several hours or days to perform with a conventional CPU-based finite-difference time-domain (FDTD) method.

To get around the lack of sufficient computational power and to shorten the computation time, the typical compromising approach is to assume a constant phase and amplitude response from each cell [Ref 4], which are used to approximate electromagnetic fields in front of the device. This approximation leads to undesirably less accurate predictions [Ref 5], resulting in sub-optimal device performance. Various techniques, such as the optimization technique in Ref 6, have been attempted to correct for these errors and yet none have been completely successful.

Addressing the very time consuming computation and the accuracy of the modeling and simulation issues simultaneously for this type of complex optics is therefore paramount for designing and fabricating compact optics for LWIR imaging systems with stringent high-performance requirements. This topic seeks to exploit emerging computing hardware to develop ultra-fast computation algorithms to accelerate accurate simulation and uncompromising optimization of flat optics in the LWIR wavelength range. This topic seeks development of FDTD simulation that is at least 1,000 times faster than today's open source and commercially available FDTD solutions. The developed ultra-high-speed FDTD solution is then utilized to model and simulate metalenses that reduce the computation time—by up to 1,000 times—relative to conventional FDTD methods [Ref 8]. The simulation solution should be able to simulate metalenses of multiple centimeters in optical aperture with optimization of imaging figures of merit such as focusing efficiency and Strehl ratio with respect to the unit cell design parameters. The metalens' focusing efficiency should be higher than 95% over a broad wavelength range from 8–12 microns, and at least 100 times lighter and thinner than traditional state-of-the-art LWIR imaging optics [Ref 8]. Traditional FDTD [Ref 7] would take tens of hours to simulate the abovementioned structure. With the successful development of this algorithm, the same simulation should finish in about one minute.

PHASE I: Determine optimal hardware platform and computational resources required for centimeter-scale simulation of metamaterial lens. Identify both the starting device design based on material and geometry designs from previous experimental works, as well as the figures of merit to optimize and measure experimentally. Demonstrate feasibility and begin development of a working prototype of the software, to include demonstration of a near field calculation of 5 cm x 5 cm flat optics system with a simulation speed improvement of over 1,000 times when compared to CPU-based FDTD. Show consistency between these simulations and experimental demonstrations of the flat metamaterial optics in LWIR. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop, demonstrate, and validate the prototype. Incorporate adjoint-based optimization capabilities into the solver. Using adjoint-enabled gradient-based optimization, produce a prototype structure that maximizes the focusing efficiency over the spectral wavelength of interest using about 100 iterations. Demonstrate a significant improvement in device performance that surpasses that of conventional LWIR imaging systems.

PHASE III DUAL USE APPLICATIONS: Transition the technology for Government use. Further develop and refine the design of the simulation software and assist in adapting the simulation software for optimization designs of various photonic devices.

The commercial sectors such as the optics and camera industries can benefit from the reduction of the individual simulation time from several hours to seconds, meaning more parameters can be scanned and at greater resolution, allowing one to simulate structures at a larger scale, enabling full 3D modeling and simulation of an entire device instead of components, and running many jobs simultaneously in the cloud.

REFERENCES:

1. Yu, N., & Capasso, F. (2014). Flat optics with designer metasurfaces. Nature materials, 13(2), 139-150. https://doi.org/10.1038/nmat3839
2. Khorasaninejad, M., & Capasso, F. (2017). Metalenses: Versatile multifunctional photonic components. Science, 358(6367). https://doi.org/10.1126/science.aam8100
3. Zuo, H., Choi, D. -Y., Gai, X., Ma, P., Xu, L., Neshev, D. N., Zhang, B., & Luther-Davies, B. (2017). High-efficiency all-dielectric metalenses for mid-infrared imaging. Advanced Optical Materials, 5(23), 1700585. https://doi.org/10.1102/adom.201800585
4. Shrestha, S., Overvig, A. C., Lu, M., Stein, A., & Yu, N. (2018). Broadband achromatic dielectric metalenses. Light: Science & Applications, 7(1), 1-11. https://doi.org/10.1038/s41377-018-0078-x
5. Chung, H., & Miller, O. D. (2020). High-NA achromatic metalenses by inverse design. Optics express, 28(5), 6945-6965. https://doi.org/10.1364/OE.385440
6. Lin, Z., & Johnson, S. G. (2019). Overlapping domains for topology optimization of large-area metasurfaces. Optics express, 27(22), 32445-32453. https://www.osapublishing.org/DirectPDFAccess/58EECB62-F0FB-4B4F-89A74FA8011960D9_422568/oe-27-22-32445.pdf?da=1&id=422568&seq=0&mobile=no
7. Warren, C., Giannopoulos, A., Gray, A., Giannakis, I., Patterson, A., Wetter, L., & Hamrah, A. (2019). A CUDA-based GPU engine for gprMax: Open source FDTD electromagnetic simulation software. Computer Physics Communications, 237, 208-218. https://doi.org/10.1016/j.cpc.2018.11.007
8. Hughes, T. W., Minkov, M., Williamson, I. A., & Fan, S. (2018). Adjoint method and inverse design for nonlinear nanophotonic devices. ACS Photonics, 5(12), 4781-4787. https://pubs.acs.org/doi/pdf/10.1021/acsphotonics.8b01522#

KEYWORDS: Full-wave photonic simulation; Design optimization; Computational speed improvement; Metalens; Metamaterials; Lens

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N23A-T009 TITLE: DIGITAL ENGINEERING - Generalizable Tactical Software AI/ML-informed Debloating

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy; Integrated Sensing and Cyber
OBJECTIVE: Develop capability that leverages artificial intelligence and machine learning (AI/ML) technologies to debloat tactical software to reduce support costs, improve run-time stability, and reduce cybersecurity vulnerability.

DESCRIPTION: Much modern software suffers from "bloat" that negatively impacts its maintenance costs, performance, and security. Commercial software tries to address wide audiences and focuses on programmer productivity, resulting in software with many indirections, libraries, and layers of abstraction. Government entities have not historically incentivized industry to produce minimal code bases, sometimes even basing funding on the number of source lines of code (SLOCs). Compounding this state of affairs, Naval Control Systems (NCSs) are built and upgraded over extended periods of time, resulting in systems containing tens of millions of SLOCs.

Exploratory research at the Naval Undersea Warfare Center has determined that significant bloat can be removed from these complex control systems. One impact of this bloat is cost associated with supporting excessive binary executable sizes. A more troubling consequence of software bloat is instability in the run-time tactical system. The presence of exploitable attack surfaces in the bloat within code is a third problem. Finally, excessive bloat has a commensurate impact on cost and time to perform system testing. As testing rarely exercises the total system, excessive SLOCs and binary executable sizes increase the likelihood of "escaped bugs," software problems that are not seen until after system fielding. Escaped bugs require heroic measures to fix.

State-of-the-art research studies by subject matter experts in academia outline the approaches that can be taken to de-bloat and harden software systems. Yet there are few, if any, commercial programs to automatically de-bloat and harden software systems, due to commercial emphasis on productivity and software reuse.

The Naval Undersea Warfare Center (NUWC) has experimented with debloating tactical code, demonstrating the utility of such an effort. However, the exploratory debloating process conducted by NUWC was labor-intensive and tailored, making this sort of debloating cumbersome and unaffordable in the context of envisioned Continuous Integration/Continuous Delivery (CICD) capability fielding. The NUWC manual-intensive process seems amenable to being automated by use of AI/ML. Based on NUWC's success, the Navy seeks a solution to develop a generalizable tactical software debloating capability informed by AI/ML.

There are multiple metrics for software debloating. The first metric is the number of SLOCs reduced or decreased in binary file size, as there can be some benefit to sheer reduction in the total system size. However, it has been shown that this quantity is misleading because debloat tools that perform hardening are often expected to increase the overall file sizes by including additional protections for cyber-resiliency. The second metric is the quality of bloat removal, where the bloat that has been removed substantially improves system stability and reduces cybersecurity vulnerabilities. For example, past research has used as a metric "code reuse gadget count reduction", which measures the difficulty for an attacker to mount a gadget-based code reuse exploit such as return-oriented programming (ROP). However, realistic debloating scenarios have shown that even high gadget count reduction rates can fail to limit an attacker's ability to construct an exploit and may even introduce new quality gadgets [Ref 2]. Thus, the quality of debloat metric should use "functional gadget set expressivity" and "special purpose gadget availability" to assess the utility of the gadgets available to the attacker rather than the quantity, as

calculated using the Gadget Set Analyzer (GSA). The technology sought would have a threshold requirement of decreased functional gadget set expressivity and special purpose gadget availability by 10% relative to the untouched tactical system. The security metrics would identify the reduction in unique attack surfaces associated with bloat. Finally, the performance metric would characterize the improved performance associated with debloating as a modification to tactical computational time and memory usage. Similar metrics are expected to be derived for container, Linux kernel, and firmware debloat.

PHASE I: Develop a concept for a generalizable debloating capability powered by AI/ML. The concept must demonstrate feasibility to reduce the bloats in code, with potential to reduce attack surfaces and improve software quality according to the parameters in the Description. Feasibility will be demonstrated through analysis and modeling. The Phase I effort can be demonstrated on unclassified software the company feels is analogous to the complexity level of the target USW systems. 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 generalizable debloating capability powered by AI/ML for testing and evaluation based on the results of Phase I. Demonstrate that the prototype meets the parameters in the Description. The technology will be assessed over the course of Phase II by Navy software subject matter experts (SMEs) knowledgeable about the investigative effort to debloat Navy software.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. The final product will consist of a capability to debloat tactical software that leverages AI/ML to minimize the tailoring and labor that can be associated with a manual debloating approach.

The resultant technology will be used during system integration and production by the prime contractors producing Undersea Warfare Systems such as AN/SQQ-89A(V)15 and AN/UYQ-100. The generalized technology developed could also be used for debloating any complex software system, such as information technology systems, and critical infrastructure systems such as power generation, water purification, and healthcare delivery.

REFERENCES:

1. Alhanahnah, M., Jain, R., Rastogi, V., Jha, S., & Reps, T. (2021). Lightweight, Multi-Stage, Compiler-Assisted Application Specialization. arXiv preprint arXiv:2109.02775. Online: https://doi.org/10.48550/arXiv.2109.02775
2. Brown, Michael D. and Santosh Pande. “Is Less Really More? Towards Better Metrics for Measuring Security Improvements Realized Through Software Debloating.” arXiv:1902.10880v3. https://doi.org/10.48550/arXiv.1902.10880
3. Bruce, B. R., Zhang, T., Arora, J., Xu, G. H., & Kim, M. (2020, November). Jshrink: In-depth investigation into debloating modern java applications. In Proceedings of the 28th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering (pp. 135-146). Online: https://dl.acm.org/doi/abs/10.1145/3368089.3409738
4. Casinghino, C., Paasch, J.T., Roux, C., Altidor, J., Dixon, M., & Jamner, D. (2019, May 28). Using Binary Analysis Frameworks: The Case for BAP and angr. NASA Formal Methods https://doi.org/10.1007/978-3-030-20652-9_8
5. Christensen, J., Anghel, I. M., Taglang, R., Chiroiu, M., & Sion, R. (2020). DECAF: Automatic, Adaptive De-bloating and Hardening of COTS Firmware. Proceedings of the 29th USENIX Security Symposium (pp. 1713-1730). Virtual: USENIX. doi:978-1-939133-17-5. Online: https://www.usenix.org/conference/usenixsecurity20/presentation/christensen

KEYWORDS: Continuous Integration/Continuous Delivery; CICD; source lines of code; SLOCs; software debloating; cybersecurity vulnerabilities; instability in the run-time tactical system; artificial intelligence and machine learning; AI/ML

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N23A-T010 TITLE: DIGITAL ENGINEERING - Sonar Dome Anti-Fouling Tracking and Prediction Tool

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Intergated Network Systems-of-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

REFERENCES:

1. Omae, Iwao. (2003). “Organotin Antifouling Paints and Their Alternatives.” Applied Organometallic Chemistry, Vol. 17, n2 (200302), . 81 - 105. https://www.worldcat.org/title/organotin-antifouling-paints-and-their-alternatives/oclc/4633838388
2. Donnelly, Bradley et al. (2019) “Effects of Various Antifouling Coatings and Fouling on Marine Sonar Performance. Polymers.” Polymers Vol. 11, Issue 4, 663. https://www.mdpi.com/2073-4360/11/4/663
3. "AN/SQQ-89(V) Undersea Warfare / Anti-Submarine Warfare Combat System." United States Navy Fact File, 24 March 2021. https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166784/ansqq-89v-undersea-warfare-anti-submarine-warfare-combat-system/

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

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N23A-T011 TITLE: Innovative Optics for Wide Field of View Infrared Sensors

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

OBJECTIVE: Develop innovative and affordable wide aperture optics technology for imaging sensors operating in the mid-wave infrared (MWIR) and short-wave infrared (SWIR) bands.

DESCRIPTION: Electro-optic and infrared (EO/IR) video imaging sensors (cameras) are widely used for situational awareness, surveillance, and targeting. The Navy is deploying such cameras in multiple spectral bands, covering both wide and narrow fields of view (FOV). Wide field of view (WFOV) cameras are particularly expensive as they employ large focal plane array (FPA) sensors and, to gather sufficient light, these cameras must have large aperture optics (lenses). In the infrared (IR), these lenses are especially costly, not benefitting from large commercial economies of scale as exists for camera lenses in the visible spectrum. Furthermore, because of the shallow depth of field inherent in such large aperture lenses, the optical elements (and the FPA) must be aligned to extremely tight tolerances in order to maintain the high resolution required. Tolerances for axial alignment on the single-micron level are not uncommon. In addition, the optical assembly must be rugged enough for shipboard deployment, maintaining its alignment in spite of operational shock, vibration, and extremes of temperature. Consequently, not only are the optical elements (lens elements) expensive, but the optical housing (lens barrel) is expensive as well. Finally, the precision assembly processes required to achieve such tight optical alignment are labor intensive and the labor is highly skilled in nature. The result is that such cameras are excessively costly.

The Navy needs an innovative technology for focusing IR light onto FPA sensors with high optical resolution. The goal is to dramatically reduce cost without compromising performance. A nominal cost reduction of 5:1 is desired for the optical assembly (based on the current state-of-the-art for conventional optics), which, for this purpose, does not include the material cost of the FPA but does include the optical elements, the optical assembly, and alignment of the optics with the FPA. A solution applicable to both the MWIR and the SWIR is desired. However, the technology may be demonstrated in either band, at the discretion of the proposer. A maximum effective aperture of f1.0 is desired with a 90° FOV and coverage sufficient for a 2k X 2k pixel FPA with 10 µm pitch. The light fall-off from FPA center to the corner of the FPA shall not exceed a factor of 2.0. The depth of field shall be sufficient to resolve single pixel targets. Note that all requirements apply at full aperture. Optical aberrations are acceptable provided they can be compensated for in post processing and provided that they are not so severe as to inhibit resolution of a single pixel target lying anywhere in the imaged field.

In demonstrating a solution, and in order to reduce cost, a large format FPA meeting the dimensions given above need not be included in the prototype. A smaller FPA (or multiple FPAs) may be used provided it can be shown that the required image quality defined above is achieved over the extent of the large format FPA. This effort anticipates a hardware solution for a single large format FPA that yields high image quality (resolution, dynamic range, noise, etc.) video capture in real time. Image capture shall accommodate a video frame rate of 30 frames per second. Solutions that attempt to re-construct images or combine images from multiple FPAs are undesirable. Predominantly software-based solutions – that is solutions based on extensive post processing of the captured image data will not be considered. Solutions incorporating electro-mechanical compensation of optical elements are permitted providing the compensation mechanism does not reduce the integration time available to the FPA. Any electro-mechanical components included in the solution must also be shown to have a (maintenance-free) life expectancy comparable to the FPA.

At the end of the effort the prototype shall be delivered to Naval Surface Warfare Center (NSWC) Crane Division. Included in the prototype will be the FPA (or FPAs) used to demonstrate the image quality

obtained by the solution, and any controllers, power supplies, housings, coolers, output interfaces, special processing hardware, custom software, fixtures, and specialized tools necessary to replicate testing of the prototype. A cost estimate for production and integration of the solution will be performed to assess the reduction in cost associated with the technology. The cost assessment shall be benchmarked to the cost of a conventional optical design.

PHASE I: Develop a concept for a large aperture optical system that meets the objectives stated in the Description. Demonstrate the feasibility of the concept in meeting the Navy's need. Analyze the effect on image quality and predict the benefits for cost reduction. Feasibility shall be demonstrated by a combination of analysis, modeling, and simulation. The Phase I Option, if exercised, will include an initial sensor specification, test specification, and capabilities description necessary to build and evaluate prototype hardware in Phase II.

PHASE II: Develop and demonstrate a prototype large aperture optical system for imaging IR sensors based on the concept, analysis, preliminary design, and specifications resulting from Phase I. Demonstration of the large aperture optics technology shall be accomplished through test of a prototype in a laboratory or sheltered outdoor environment. At the conclusion of Phase II, prototype hardware shall be delivered to NSWC Crane along with complete test data, installation and operation instructions, and any auxiliary software and special hardware necessary to operate the prototype.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for Government use. Develop specific optical designs for Navy sensor systems. Establish hardware configuration baselines, produce support documentation, production processes, and assist the Government in the integration of the optical technology into existing and future WFOV imaging sensor systems.

The technology resulting from this effort is anticipated to have broad military application. In addition, there are law enforcement and security applications. Scientific applications include satellite and aerial imagery.

REFERENCES:

1. Driggers, Ronald G., et al. Introduction to Infrared and Electro-Optical Systems, Second Edition. Boston: Artech House, 2012.
2. Gibson, Daniel, et al. "Diffusion-based gradient index optics for infrared imaging." Optical Engineering 59 (2020): 112604-1-22. https://www.spiedigitallibrary.org/journals/optical-engineering/volume-59/issue-11/112604/Diffusion-based-gradient-index-optics-for-infrared-imaging/10.1117/1.OE.59.11.112604.full?SSO=1

KEYWORDS: Video Imaging; Imaging Sensors; Wide Field of View Cameras; FOV; Large Aperture Optics; Depth of Field; Optical Resolution

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N23A-T012 TITLE: Atmospheric Aerosol Model and Data Collection Over the Marine Boundary Layer for Imaging/Radiofrequency (RF) and Laser Beam Propagation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE)
OBJECTIVE: Develop a periscope imaging, electronic warfare, and High Energy Laser (HEL) beam propagation model over the marine aerosol boundary layer for the integration of propagation modeling software into a system that will investigate absorption and scattering properties of marine aerosols, the interplay between aerosols and turbulence, and the impact on imaging and electronic warfare (EW).

DESCRIPTION: The Navy seeks technologies that are oriented toward a deeper experimental and theoretical understanding of maritime turbulence and laser beam propagation in the marine boundary layer (MABL). Ocean evaporation is occurring within a very thin molecular layer at the surface. However, there are indications that instantaneous turbulent structures in the ocean and marine atmospheric mixing layers play a critical role in determining the water vapor flux and near surface particulate (aerosol) concentrations. The Navy is looking for a greater understanding of the marine aerosols and their impact on turbulence on periscope imaging, EW, and HEL beam propagation. Aerosol properties will be studied using available instruments such as particle counters, sun photometers, Short Wave Infrared (SWIR) cameras, Delayed Tilt Anisoplanatism (DELTA) camera, RAMAN scattering instrument, and instruments for aerosol absorption quantification. This proposed study will help improve the current atmospheric models for submarine imaging/ EW and HEL horizontal beam propagation within the MABL. Recent efforts have been aimed at characterizing the turbulence in the marine wave layer and surface layer marine boundary layer. The aerosol and turbulence models developed through experimental measurements will be used to model nonlinear effects such as thermal blooming in a marine environment on both continuous and pulsed lasers. Additionally, image contrast reduction due to marine aerosols will be studied and the prospect of determining aerosol loading from degraded images will be investigated. In this proposed study and model, we are looking for an innovative instrument development to understand the nonlinearity of the atmosphere like thermal blooming and RAMAN scattering. The model developed shall include atmospheric nonlinearity and its effects on a complete model of Imaging and HEL beam propagation that includes turbulence and aerosol effects. The model will be extremely useful for development of adaptive optics and beam control systems to maximize power in the bucket in case of horizontal propagations.

In this STTR topic the proposer shall explore the use of a small Unmanned Aircraft System (sUAS) and develop and execute sUAS flight profiles for marine Sea-Air turbulence and aerosol interface research. Marine boundary layer profiling at different heights shall be used to enhance the multi-target capability of a customer's imaging and on HEL as well as the HEL subsystem's including laser range finders (LRFs), and beacon and tracker illuminator lasers. Additionally, such profiling in combination with radiative transfer and Imaging and HEL propagation models such as the Laser Environmental Effects Definition and Reference (LEEDR) and High Energy Laser End to End Operational Simulation (HELEEOS) codes shall enhance post-engagement HEL forensic analysis such as target effects in the marine boundary layer. Current measurement techniques, such as Laser Doppler Velocimetry (LDV), are limited to resolutions of 0.5 meters or greater and fall short of the required millimeter level resolution. A new type of spectral imaging modality and instrumentation is required that will increase our understanding of ocean evaporation and lead to better tools for measuring and modeling the near-marine boundary layer for optical and radio frequency Naval applications. This generalized understanding will significantly enhance beam optic directors, adaptive optics, and other turbulence mitigating techniques to enhance the reach and effectiveness of communication as well as defensive and offensive high energy laser engagement in the marine aerosol boundary layer.

PHASE I: Provide a concept to solve the Navy's problem, and demonstrate the feasibility of that concept. Develop the general model concept and instrumentation setup over MABL to collect data for the

prediction atmospheric non linearity and its effects such as marine thermal blooming and other marine non linear effects due to image degradation and HEL horizontal beam propagation through the MABL < 60 ft above marine surface. Develop clear model concepts and non-linear MABL data acquisition setup to remotely measure temperature, pressure, and marine aerosol for the acquisition MABL model validation and verification. Phase I Option, if exercised, will include the initial model and capabilities description to build a prototype model and validation of the proposed model by data collection over marine surface in Phase II.

PHASE II: Develop the marine aerosol on image degradation and HEL Beam propagation model and data collection analysis software which shall be delivered to Navy. The MABL model shall be used for submarine imaging system and target detection and tracking, HEL target lethality improvement and integration with submarine HEL beam control software for evaluating HEL horizontal beam propagation and image degradation through marine aerosol environment. The model shall be used for system performance evaluation based on the results of Phase I concepts. Describe how evaluation can be accomplished through modeling or non-linear analytical methods to demonstrate that the technology does have the potential to meet Navy imaging, such as image degradation, target detection, target identification, and HEL performance goals such as remotely profile horizontal turbulence profile mapping, temperature, and pressure profile mapping.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy submarine platforms as a metrological tool for marine wave boundary data collection.

The non-liner marine aerosol effects on Submarine Imaging and HEL beam propagation model and innovative data analysis technology such as Fourier Optical analysis have both commercial and DoD applications. This technology can improve a commercial ship’s localized weather prediction and update the weather software for safe operation. Additionally, improved LIDAR detection for range at day, night, and all-weather conditions is beneficial for both commercial and DoD applications. The nonlinear marine aerosol metrology model system could also find applications in trace gas and pollution monitoring.

REFERENCES:

1. Wasiczko Thomas, Linda M., Moore, Christopher I., Burris, Harris R., Suite, Michele, Smith Jr., Walter Reed, and Rabinovich, William. “NRL's Research at the Lasercomm Test Facility: Characterization of the Maritime Atmosphere and Initial Results in Analog AM Lasercomm”, Proc. SPIE, 6951, Atmospheric Propagation V, 69510S (April 18, 2008). https://doi.org/10.1117/12.783791
2. David N. Whiteman, "Examination of the traditional RAMAN lidar technique. I. Evaluating the temperature-dependent lidar equations," Appl. Opt. 42, 2571-2592 (2003) https://doi.org/10.1364/AO.42.002571
3. David N. Whiteman, "Examination of the traditional RAMAN lidar technique. II. Evaluating the ratios for water vapor and aerosols," Appl. Opt. 42, 2593-2608 (2003) https://doi.org/10.1364/AO.42.002593
4. Chunhua Deng , Sarah D. Brooks , German Vidaurre & Daniel C. O. Thornton (2014) Using RAMAN Microspectroscopy to Determine Chemical Composition and Mixing State of Airborne Marine Aerosols over the Pacific Ocean, Aerosol Science and Technology, 48:2, 193-206, DOI: 10.1080/02786826.2013.867297 https://www.tandfonline.com/doi/full/10.1080/02786826.2013.867297

KEYWORDS: RAMAN; Laser Beam Propagation; Marine Aerosol Environment; Marine turbulent boundary Layer; MABL; Thermal blooming; Laser Environmental Effects Definition and Reference; LEEDR

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N23A-T013 TITLE: Unmanned Underwater Vehicle (UUV) Sensor Data Transformation Tool

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy
OBJECTIVE: Develop a software tool to transform and create synthetic sensor data from information received by a different sensor.

DESCRIPTION: Modern platforms may contain a variety of sensors such as sonars of varying frequencies, cameras, and magnetic sensors. Often times, target information is collected by one or more sensors, but not by all of the sensors. This can lead to an increased number of test runs against targets to ensure each sensor, and associated algorithms, have an opportunity to collect target information in a variety of environmental conditions. The Navy seeks an innovative tool to transform sensor and metadata from a given system or frequency into realistic synthetic data from another sensor. For example, the transformation tool should be capable of transforming real data collected by a side scan sonar (SSS) into synthetic data representative of other sensor modalities, such as an SSS of a different frequency, a forward-looking sonar (FLS), or an electro-optical camera. In addition, this tool would be able to reconstruct a synthetic target in different orientations, with varied degrees of burial, and with adjacent imagery in varying bottom types (e.g., complex, noncomplex).

The information created with this synthetic data generation tool will be used to develop and train automatic target recognition (ATR) algorithms. Sensor data to be generated should use complex physics-based models and represent objects in the subsea environments including mine-like objects. Providing realistic synthetic data will improve ATR, operator responses, reduce operator uncertainty, and improve decision-making. Machine Learning (ML) synthesis tools can enable development of realistic synthetic sonar for use with simulations. ML approaches are being leveraged for image and video processing applications, but a limiting factor is the availability of training data. High-quality synthesis approaches that utilize ML can also provide an alternate means to creating the large volumes of training data that are needed to ‘teach’ a deep learning algorithm.

Sensors of interest include acoustic, optical, and magnetic sensors. Solutions must also be compatible with, and easily applied within Navy Expeditionary user displays and interfaces for conducting in-situ mission monitoring and post mission analysis.

The proposer will analyze sensors and data formats, and develop data transformation solutions capable of incorporation onto Nvidia Graphic Processing Units (GPUs), ensuring compatibility with user interfaces employed in legacy Navy Expeditionary UUV systems.

Synthetically generated images and data should be quantifiably similar to real data produced by the target sensor in terms of acoustic and optical reflectivity, and magnetic moment. That is, synthetic data scored as 'similar' should have ATR outcomes representative of real sensor data. ATR performance will be measured in Phase II. Methodologies and metrics for similarity scoring are encouraged as components of validity test proposals.

PHASE I: Develop a concept for an innovative software solution capable of generating synthetic sensory data and metadata. During the Phase I base effort, the Government will provide a list of commercial sensor type, representative calibration targets and display/meta-data for sensors of interest to enable analysis of data structures and determination of data transformation feasibility and limits. Demonstrate the feasibility of the concept to successfully confirm that data from a real data set is transformed into synthetic data as if collected by other sensor modalities to include different sonar frequencies and types (e.g., FLS, Gap-filling sonar (GFS), Real Aperture Sonar (RAS), and Synthetic Aperture Sonar (SAS)), Magnetometer, and Optical Sensors. The Phase I Option, if exercised, will include initial design specifications and a capabilities description to build a prototype in Phase II.

PHASE II: Develop, demonstrate, and deliver a software prototype system capable of creating synthetic sensor data and metadata from sensors identified in Phase I efforts for testing and evaluation; the prototype system will be compatible with and suited to future integration as a module of the Common Operator Interface, Navy (COIN)/NEXUS user interface. Develop the prototype sensor transformation tool. Synthetic data generated using this tool will be evaluated against baseline ATR algorithms it to determine if it meets Navy performance goals described in the Phase II SOW. Use operationally representative data for the demonstration. Identify performance and technical requirements to be met during evaluation. Prepare a Phase III development plan to transition the technology for Navy and other potential commercial use.

In Phase II, develop and demonstrate performance of a prototype software module, incorporating their technical solution for synthetic data generation for sonar, optical and magnetic moment data. The transformed data set build time threshold is 3:1 with an objective of 24 hours or less, for distribution to fleet operators or other programs.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the successfully matured technology as a software module of the Common Operator Interface, Navy (COIN)/NEXUS user interface as a component of Navy Expeditionary UUV systems. Technical support to further troubleshoot, further refine and better adapt the Phase II prototype deliverable will be provided by the contractor as the Navy conducts the full range of testing and evaluation of the module as a software upgrade to the UUV systems. Navy testing and evaluation will be included comparative analysis of real-world data sets collected by the Navy where actual representative targets have been added, with synthetically generated data sets which add the targets to the environment. ATR algorithms will be run on both data sets to verify effectiveness of the synthetic data generation tool. Refinements by the contractor during Phase III may include, but are not limited to, software certification for cyber security compliance, and an addition or improvement of features and attributes to enhance user interfaces.

Application of the product may reasonably be expected to extend to commercial contexts such as automated object recognition for autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs) engaged in maritime salvage and field inspection for the oil and gas industry.

REFERENCES:

1. Brad Walls (Mar 23 2021). Using the Unreal Engine as a High Fidelity Simulation for Data Creation, The Fifth Annual Workshop on Naval Applications of Machine Learning, Underline Science Inc. https://underline.io/lecture/14817-using-the-unreal-engine-as-a-high-fidelity-simulation-for-data-creation
2. Ilisescu, Corneliu et al. “Responsive Action-based Video Synthesis.” Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, May 06-11, 2017, pp. 6569 6580. https://arxiv.org/pdf/1705.07273.pdf
3. Wang, Ting-Chun et al. “Video to Video Synthesis.” NIPS Proceedings, 2018. https://arxiv.org/abs/1808.06601
4. You, Xinge et al. “Kernel Learning for Dynamic Texture Synthesis.” IEEE Transactions on Image Processing, Vol.. 25, No. 10, OCTOBER 2016. Kernel-Learning-for-Dynamic-Texture-Synthesis.pdf
5. Dosovitskiy, Alexey and Brox, T. “Generating images with perceptual similarity metrics based on deep networks.” NIPS Proceedings, 2016. https://papers.nips.cc/paper/6158-generating-images-with-perceptual-similarity-metrics-based-on-deep-networks

KEYWORDS: Mine Countermeasures; MCM; Synthetic Data; Software; Unmanned Undersea Vehicles; Mines; Navy Expeditionary; Collection of target information on UUVs

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N23A-T014 TITLE: DIGITAL ENGINEERING - Automated Knowledge Base Extraction and Student Assessment

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy
OBJECTIVE: Develop an automated capability to generate exams with answer keys using Artificial Intelligence or Machine Learning (AI/ML)-powered data mining for Undersea Warfare (USW).

DESCRIPTION: When systems are updated, development of training materials for the updated system can be labor-intensive and can take significant time to prepare. Meanwhile, students are being taught using potentially deprecated information. This is particularly true when the system is complex. The problem is compounded when updates occur frequently. USW system operation is a skill that is highly perishable, increasing the importance of accurate, updated training products. The importance of USW to national security necessitates system updates on a frequent basis. This makes developing current, up-to-date training materials for the updated capabilities key to harnessing the power of these systems.

Today, over 450 sailors graduate annually from Surface Combat Systems Training Command San Diego (SCSTC-SD). To stay current with the ongoing efforts to continually update USW related course materials, exams are currently still manually produced, administered, and graded by hand, which consumes numerous man-hours that could be better spent providing course instruction and running tactical scenarios in high fidelity virtual trainers. Creating a Surface Force USW Knowledge Bank to augment Instructional Design, with up-to-date USW References, would significantly decrease this workload.

The Navy seeks a solution that can (1) mine documentation for existing capability associated with the SQQ-89 and UYQ-100, (2) autonomously develop a core USW training knowledge base with associated exam questions and answer keys, and (3) automatically identify deltas to the core knowledge base associated with approved capability improvements and appropriately adjust the core knowledge base to remove deprecated content.

AI/ML techniques such as natural language processing (NLP) and data mining have improved markedly in recent years. The Navy seeks a technology that automatically generates tests and answer keys from functional description documents (FDDs), concepts of employment (CONEMPs), and concepts of operation (CONOPs), and other USW References created during capability developments and deployment. The AI/ML technology will demonstrate capability at a complexity level that is analogous to the target USW systems but need not be a military system. The Government will provide data and specifications as needed to demonstrate the capability.

Utilizing various USW References including the FDD, CONEMPs, and CONOPs created during capability developments, this innovative tool would utilize AI/ML to search these references and generate an automated testing function. This tool would produce a test bank comprised of applicable and correct questions, generate an answer key, grade, and provide test score results as applicable. Automated exam generation capability, based on material(s) of interest, does not currently exist due to the complex and changing system requirements and reference updates. This tool will also appropriately adjust the core knowledge base to remove deprecated content.

There is currently no technology available that smartly mines data from selected materials to document, categorize, and interpret information then generate up-to-date exams, and subsequent administration. Furthermore, current technologies do not allow for the interpretation and evaluation logic to verify that sailors are fully understanding and experiencing the intended system improvements.
USW reference resources are drafted and finalized over time and not necessarily in a prescribed order as they are continuously updated. Vendors provide the FDD outlining the capability of the system, displays,

unique features, operating instructions, etc. However, the FDD does not explain how the updated system will function on deployment or how the sailor would employ the system specifically for anti-submarine warfare (ASW). The schoolhouse instructors manually translate the FDD into training material by creating a Modernization Training Team PowerPoint deck for training. AI/ML could be utilized to glean appropriate training materials from the FDD more efficiently, and effectively, than an instructor can manually.

The CONEMP provides a big picture look regarding how the sailor should use this updated system capability at a high level specifically, what is the employment and how this fits into the totality of tools at their disposal. The information in this document must also be included in the repertoire of training materials. As system engineers evaluate the system, they generate the CONOP which drills down into the details explicitly aimed at how to hunt for submarines. It describes exactly how the operator should use the system for this specific purpose. An AI/ML tool could be used to continuously mine for appropriate course material incorporating the operating requirements of the system related to the overall ASW process.

While AI/ML can be utilized to mine course materials from the FDD, CONEMP, CONOPs, and existing training PowerPoint documents, a more tailored and unique AI/ML capability would be necessary to evaluate the more subjective issue of whether sailors are understanding how to use the new system attributes specifically for ASW. AI/ML would need to be utilized to generate training materials and questions designed to analyze sailor understanding of the system nuances and how it works within the larger platform for ASW.

The School House gets the FDD with a copy of the code associated with the update/upgrade. They do not have CONEMP or CONOP immediately. As these documents and additional USW references, like Operator Employment Guides, become available over time, the instructors will need the flexibility to engage the AI/ML tool to include these materials in ongoing training course material updates. The new technology will be introduced in parallel with capability fielding and provide training personnel with the most current information to train students. This will increase the speed at which the Fleet can adopt transformational capabilities to maintain a warfighting edge. The threshold would be reducing the delay specific to developing training products by a factor of two.

PHASE I: Develop a concept for an automated capability to generate exams with answer keys using AI/ML-powered data mining that meets the parameters in the Description. Demonstrate that the concept can feasibly meet the requirements through analysis and modeling. 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 automated capability to generate exams with answer keys using AI/ML-powered data mining. Demonstrate functionality under the required service conditions. Demonstrate the prototype performance through the required range of parameters given in the Description. The prototype will be tested by Government subject matter experts (SMEs).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. The final product will consist of a capability to generate exam questions and answer keys from system documentation, generate delta questions and associated keys, and appropriately adjust the core knowledge base to remove deprecated content. The resultant technology will be used and tested by the training and Integrated Logistics Support (ILS) team supporting Undersea Warfare Systems such as AN/SQQ-89A(V)15 and AN/UYQ-100.

The technology developed could also be used to develop training products for any complex skillset subject to rapid change due to policy or technology changes. Examples of such complex skillsets include law enforcement and air traffic control.

REFERENCES:

1. Deshpande, Adit "Deep Learning Research Review Week 3: Natural Language Processing." 10 Jan 2017. https://adeshpande3.github.io/Deep-Learning-Research-Review-Week-3-Natural-Language-Processing
2. Mooney, Raymond J. and Razvan Bunescu "Mining Knowledge from Text Using Information Extraction" SIGKDD Explorations June 2005: Vol. 7:1. https://www.cs.utexas.edu/~ml/papers/text-kddexplore-05.pdf
3. Navy Fact Files "AN/SQQ-89(V) Undersea Warfare / Anti-Submarine Warfare Combat System." Updated 20 Sep 2021. https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166784/ansqq-89v-undersea-warfare-anti-submarine-warfare-combat-system/
4. Navy Fact Files "AN/UYQ-100 Undersea Warfare Decision Support System (USW-DSS)." Updated 20 Sep 2021. https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166791/anuyq-100-undersea-warfare-decision-support-system-usw-dss/
5. Piontek, Mary E. "Best Practices for Designing and Grading Exams." Center for Research on Learning and Teaching (CRLT) Occasional Papers No. 24. 2008. http://www.crlt.umich.edu/sites/default/files/resource_files/CRLT_no24.pdf

KEYWORDS: Automatically generate tests and answer keys; Artificial Intelligence and Machine Learning; AI/ML; natural language processing; NLP; functional description documents; FDDs; concepts of employment' CONEMPs; concepts of operation; CONOPs

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N23A-T015 TITLE: Scalable Net-Zero JP-10 Production from Non-Fossil Fuel Resources

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

OBJECTIVE: Develop a scalable prototype system to produce JP-10 from non-fossil sustainable energy resources.

DESCRIPTION: The objective is to develop a scalable synthetic approach to producing JP-10 that meets military specification, MIL-DTL-87107E from non-fossil sustainable energy resources such as carbon dioxide (CO2), biomass, and waste products. JP-10 is primarily composed of exo-tetrahydrodicyclopentadiene, C10H15, and synthesized by the hydrogenation, isomerization, and separation and purification of dicyclopentadiene, a petroleum-based resource. The proposed synthetic process may be chemical or bio-manufacturing in nature, and must be low in temperature (not to exceed 500 °C) with pressures not to exceed 600 psi. Initial prototype demonstrations of the technology will be up to 1 gal/day. For future design and scaling purposes the objective will be to synthesize 1,000 gal/day of finished JP-10 from a process that can be placed in a Conex shipping container.

PHASE I: Define, develop, and perform initial laboratory assessment of the proposed synthetic process to validate the technical feasibility of the synthetic approach to producing JP-10 that meets MIL-DTL-87107E. Perform analysis of the fuel and determine initial process selectivity. Based on the laboratory approach, define and develop a concept for a modular, scalable JP-10 synthetic process, that can meet the performance and design specifications listed in the Description. Develop a Phase II plan.

PHASE II: Develop a prototype process based on the work achieved in Phase I. The prototype will be designed to produce 1 gal/day of finished JP-10 that meets MIL-DTL-87107E. The prototype will establish performance parameters and proof of concept for development of full-scale process in Phase III.

PHASE III DUAL USE APPLICATIONS: The integrated 1 gal/day prototype process will provide equipment, process, design criteria, energy and material balance, and establish operational performance parameters. This data will be used to provide the design criteria for transitioning the technology to larger capacities. A 100-1,000 gal/day process will be developed and tested in Phase III. The design criteria and performance parameters will enable the system to be designed into a Conex container for transport.

REFERENCES:

1. 1. Department of Defense, MIL-DTL-87107E PROPELLANT, HIGH DENSITY SYNTHETIC HYDROCARBON TYPE, GRADE JP-10 12-January-2012.
2. 2. Department of the Navy Climate Action 2030, 24 May 2022. https://www.navy.mil/Portals/1/Documents/Department%20of%20the%20Navy%20Climate%20Action%202030.pdf

KEYWORDS: JP-10; Fossil Fuel; Prototype; Sustainable; Energy; Synthesis

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N23A-T016 TITLE: Lightweight Turbogenerator for Vertical Take-off and Landing Unmanned Aerial Systems- in Marine Environments

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

OBJECTIVE: Develop a lightweight (prioritizing weight above efficiency) integral turbogenerator in a compact package intended for embedded integration into a Vertical Take-off and Landing Unmanned Aerial System (VTOL UAS) for support of high-power conditions on takeoff and landing.

DESCRIPTION: Current VTOL UASs in development, and concepts being pursued by both commercial and military operators, require high-power delivery on takeoff and landing segments that can be delivered by small turbogenerators also in development. At small scales, around 50 shaft horsepower (shp) output, turbines with centrifugal compressors can provide high specific power but are typically less efficient than equivalent power reciprocating engines. Fabrication of turbines without the need to couple to a low-spool shaft for thrust generation, and instead coupling to a high-speed generator, can provide a path toward delivering high power levels during VTOL mission segments. New hybrid power architectures and electrical components can then support a serial or parallel propulsion system that could leverage the very low Brake Specific Fuel Consumption (BSFC) of the primary reciprocating engine, and provide additional power via a small lightweight turbogenerator that could generate sufficient power for the short-segment VTOL maneuvers, with much lower requirements on specific fuel consumption due to the short (on the order of one minute) durations involved.

Modifying the cycle of a turbogenerator to optimize the design for high power output without concern for SFC could simplify the design as well as reduce the cost of the unit by lowering aerodynamic design tolerance requirements, and reducing the thermal cycle requirements in terms of pressures and temperatures, as well as simplifying the mechanical design without the need to couple a low-speed turbine to generate thrust.

KEY SMALL AUXILIARY LIGHTWEIGHT TURBOGENERATOR ENGINE (SALT-E) PARAMETERS

- Multi fuel operation on F-24, JP-8, JP-5, Diesel
- Specific fuel consumption not to exceed 3.0 lb / hp-hr while operating at maximum design power level at 15,000 ft MSL STD day
- High specific power > 2.0 shp/lb turbine output (Threshold), 4.0 shp/lb (Objective) including the generator system (does not include power control unit or fuel system)
- System must include integral generator operating at peak efficiency of > 90%
- Cold, electric remote start capability (-20°C) without ground support
- Capable of operating in marine environments for sea-based operations
- System should include air bearings to allow for oil-free operation and that include material systems that are marinized and capable of operation in sea-based environments with a time between overhaul (TBO) target for the design of >1500 hrs
- Recuperators should be included in the design to increase BSFC (lbm/hr/kW-electric output) at an appropriate effectiveness (target minimum of 70% effectiveness) and weight
- Recuperator temperatures that can support turndown to power level angles (PLA’s) with an objective of 30%
- Capability of high specific temperature materials for the turbine wheel should be included
- Multi-orientation capability: 10 minutes continuous operation at maximum power with a change in orientation of 90 degrees from about a horizontal axis without degradations to operability, durability or shaft power output.
- Demonstrate a minimum of 150 hr durability for initial test articles

• Must be capable of continuous operation at peak load for 24 hours
• Unit must be capable of a minimum of 14 shp output (at the turbine shaft) and not more than 60 shp at sea level standard day conditions

PHASE I: Develop a test unit turbine section with a measured output of 14 - 60 shp continuous power output with a specific power of >2.0 shp/lb for the turbine system. System should include design and consideration of air bearing material systems and designs compatible with marinization requirements for operations in salt spray environments.

PHASE II: Integrate the turbine with the generator and demonstrate a fully integrated electrical machine capable of operations with simulated load profiles with controlled power output for supporting a VTOL hybrid power system. The combined unit should demonstrate continuous performance for up to 12 hours with logistical fuels.

PHASE III DUAL USE APPLICATIONS: Demonstrate the unit in a VTOL UAS flight test asset in a hybrid power system demonstration. Ground testing in an altitude cell will confirm altitude capability up to 15k ft MSL altitude. Flight testing will demonstrate the controllability of the unit and the viability of the hybrid power architecture.

Multiple commercial entities are developing, and have interest in small VTOL UAS for delivery of medical and other supplies to remote areas. Several capabilities exist that are less robust, and less capable than what a power turbine could enable in terms of payload and range capabilities, and in inclement weather. Likely there would be significant commercial interest in the technologies and capabilities developed in this type of power unit for both UAS and portable ground power applications.

REFERENCES:

1. Cinar, G.,Markov, A., Gladin, J., Garcia, E., Marvis, D., Patnaik, S. (2020). Feasibility assessments of a hybrid turboelectric medium altitude long endurance unmanned aerial vehicle. AIAA Propulsion and Energy 2020 Forum. https://doi.org/10.2514/6.2020-3577.
2. Pamireddy, S. R. (2020). Comparison of power sources with scalability effects for rotorcrafts (Order No. 28149981). Available from ProQuest Dissertations & Theses Global. (2503638599). Retrieved from https://niu.idm.oclc.org/dissertations-theses/comparison-power-sources-with-scalability-effects/docview/2503638599/se-2. https://www.proquest.com/docview/2503638599?pq-origsite=gscholar&fromopenview=true
3. Avera, M., & Singh, R. (2019, October). Scalability of Hybrid-Electric Propulsion for VTOL UAS. In Proceedings of the NATO Research Symposium on Hybrid/Electric Aero-Propulsion Systems for Military Applications, Trondheim, Norway (pp. 7-9). https://www.sto.nato.int/publications/STO%20Meeting%20Proceedings/STO-MP-AVT-323/MP-AVT-323-10.pdf

KEYWORDS: Turbogenerator; turbine; generator; recuperator; vertical take-off and landing; VTOL; hybrid; propulsion; hybrid-electric; hybrid propulsion; unmanned aerial system; UAS

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N23A-T017 TITLE: Coherent Sensing Approaches for Dynamic Spectrum Allocation

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

OBJECTIVE: Design a distributed, coherent sensing solution to generate a spectrum map of available channels in sparse or dense spectral environments for channel allocation in a decentralized multi-hop network. Develop a scheme for sharing spectrum sensing results across the network for all channels to reach distributed consensus on the spectrum map between multiple geographically-dispersed nodes.

DESCRIPTION: Wireless multi-hop networks, and the understanding thereof, are key components to military and commercial communications. These networks are non-centralized, highly dynamic, and often either sparse or dense. With wireless communications and networking now necessitating dynamic spectrum allocation, such as with fifth generation (5G) and sixth generation (6G) cellular technology, military and commercial users must develop a more coherent approach to understanding spectral environments for maintaining reliable connectivity.

There are many signal processing solutions for detection and classification of spectral energy, such as those based on machine learning (ML). Standard ML metrics are often used to evaluate the accuracy of these techniques, such as number of false positives/negatives. System performance may also be quantified with temporal metrics such as latency and speed. While being agnostic to any particular sensing approach is the objective, it may be through the course of this STTR topic that a greater understanding of ML characteristics specific to the radio frequency (RF) modality is a key component to coherently linking multiple, geographically-dispersed sensing systems for the complete spectral mapping that fully supports dynamic allocation in sparse and/or dense environments. Indeed, sharing ML data model updates instead of in-phase and quadrature (I/Q) data is much more efficient. An adequate understanding to baseline spectral activity can be achieved through sensing at a single node, but distributed spectrum sensing would provide much greater fidelity on activity for dynamic spectrum allocation. Metrics similar to those used for quantifying accuracy and performance of a single node may also be used for evaluating these distributed sensing systems with multiple nodes.

Overcoming the coherence challenges behind a distributed spectrum sensing approach would enable a network-wide mapping of available channels. This awareness of the spectral environment would then inform proper channel allocation for resilient communications that support both military and commercial users. It would also enable adaptation within the spectrum, as well as identification of primary and secondary users. The solution to these problems must be computationally efficient and require little overhead to share sensing results/updates to nodes across the network. The goal is for coherency to be as agnostic to the sensing technique as possible.

This STTR topic will develop the foundational mathematical analysis to address coherence for distributed sensing in dynamic spectral environments. This topic also seeks an initial design of a methodology for disseminating results and awareness across the network to achieve distributed consensus among the sensing nodes for applications such as adapting communications within the spectrum and identifying primary and secondary users. The innovation and focus is on solving coherency issues in order to map out spectral environments for dynamic spectrum allocation, and on a means for efficiently sharing results to multiple nodes across the network to reach a desired end state of distributed consensus on spectral activity for dynamic allocation.

PHASE I: Conduct analysis to design an approach for coherent distributed sensing. Use this analysis to inform and demonstrate a proof of concept that provides a network-wide mapping of available channels. Perform a trade study and literature survey on sharing results for distributed consensus of spectral activity.

PHASE II: Refine, test, and prototype a scalable, mathematically-founded approach to coherent distributed sensing for network-wide mapping of available channels with means for sharing results/updates across the network to reach consensus amongst the nodes.

PHASE III DUAL USE APPLICATIONS: Support knowledge transfer and demonstrations/testing of the capability developed as a result of Phase II. The transition of a spectral mapping capability will help both military and commercial users with spectrum sharing and dynamic spectrum allocation amid the current proliferation of 5G, and future proliferation of 6G, communications and networking technologies. The envisioned coherency techniques for distributed sensing and means for disseminating consensus to enable dynamic spectrum allocation can provide many opportunities with military and commercial transition.

REFERENCES:

1. Olivieri, M.P., Barnett, G., Lackpour, A., Davis, A., and Ngo, P. "A Scalable Dynamic Spectrum Allocation System with Interference Mitigation for Teams of Spectrally Agile Software Defined Radios," First IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Networks, 2005. DySPAN 2005., 2005, pp. 170-179, doi: 10.1109/DYSPAN.2005.1542632.
2. Rajesh Babu, C., Ramana, K., Jeya, R., and Srinivasulu, A. "COCO: Coherent Consensus Scheme for Dynamic Spectrum Allocation for 5G." Complexity and Robustness Trade-Off for Traditional and Deep Models 2022 (Special Issue). 6 Jul 2022.
3. Tran, C. et al., "Dynamic Spectrum Access: Architectures and Implications," MILCOM 2008-2008 IEEE Military Communications Conference, 2008, pp. 1-7, doi:10.1109/MILCOM.2008.4753454.
4. Zhao, Q. and Sadler, B.M. "A Survey of Dynamic Spectrum Access," in IEEE Signal Processing Magazine, vol. 24, no. 3, pp. 79-89, May 2007, doi:10.1109/MSP.2007.361604.

KEYWORDS: Distributed Sensing; Network Mapping; Dynamic Spectrum Allocation; Spectrum Sharing; 5G; 6G; Wireless Communications; Distributed Consensus; Wireless Multi-hop Networks

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N23A-T018 TITLE: Reliable Hydroxyl-Terminated PolyButadiene for Rocket Motors

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics
OBJECTIVE: Establish combined modern analytical methods and a resultant predictive model for characterizing Hydroxyl Terminated PolyButadiene (HTPB) polymer binder resin in parallel with chemical cure, mechanical properties, and aging assessments, to support the successful development and use of military grade HTPB in existing and emerging solid rocket motors. The combined analytics and predictive model will reliably correlate binder resin chemical and physical properties with gum stock and formulation quality, provide key characterization parameters leading to updated military specification(s), and improved sourcing of HTPB for successful manufacture of rocket motor, ejection seat, and related propellants.

DESCRIPTION: The DoD has a need for proper analytics coupled with predictive material models for Hydroxyl Terminated PolyButadiene (HTPB) as used in rocket motors and other energetic formulations. Even when meeting military specifications, the binder resin, often and unpredictably, suffers from a too short and variable pot-life, slow and incomplete curing, poor gum stock mechanical properties, and poor aging behavior. As a result, DoD propellant production is often greatly hindered. As the need for more of this DoD-specific HTPB binder resin continues to grow, the fundamental chemical and physical properties of this polymer that lead to desirable rocket motor formulation characteristics remain poorly understood.

One major challenge for HTBP variants used in energetic formulations is that there are several ways to meet outdated military specifications (WS 20700, dated June 1981) that do not define necessary formulation-enabling chemical properties. An HTPB lot can meet specifications as a monodisperse straight-chain, telechelic polymer, or as a complex mixture of variable length, distribution of branches, and reactive sites. Ultimately, this variability leads to inconsistent and unwanted end use behavior. For instance, the variability in branching and the locations of the hydroxyl groups greatly affects how the polymer cross-links, which is magnified by other ingredients when formulating a rocket motor grain. Another example of the problems facing end users of HTPB binder is that processing techniques and the variability in the distribution of reactive sites greatly change the effectiveness of antioxidant protocols when formulating. These are only two examples of the problems associated with the currently available supply of HTPB. OSD and the DPA Title III office recognized the inadequacy of the weapon specification test requirements in determining whether any given lot of HTPB will work sufficiently in a propellant formulation and as such recommended additional tests be performed [Ref 1]. Further, the hydroxyl value of the product obtained from the current, domestic supplier appears to have decreased from historical levels upon attempting to target a lower hydroxyl functionality initially sought for prior program requirements. Concurrent with this change, formulators are finding it even more difficult to consistently produce a propellant that meets their requirements due to the polymer not having sufficient molecular weight or functionality fraction to permit the manufacture of a robust propellant, especially for air-launched applications.

To date, private industry has been unable to solve the technical challenges associated with analytical methods development, detailed understanding of the chemistry, reaction kinetics, safety, reproducibility, and scalability in order to produce a reliable HTPB variant and associated specifications. While there have been prior efforts to develop a greater understanding of the HTPB polymer characteristics [Refs 2-5], to date there has been no definitive model developed using appropriate, modern analytics to correlate polymer structure to performance. Future sources and suppliers of HTPB for energetic formulation use will require this type of analytically driven HTPB predictive model to inform updated military specifications and production practices.

PHASE I: Identify and/or develop combinations of key analytical methods for correlating HTPB polymer system chemical and physical characteristics with gum-stock and formulation end use properties leading toward development of a strong predictive tool. HTPB samples of varying quality should be obtained from the Government and other contractor rocket motor manufactures to assist in Phase I material analytical method development efforts. The quality of the HTPB should not be defined as simply "good" or "bad" but will be assessed by quantifiable data pertaining to pot-life, degree of chemical cure, oxidative susceptibility, mechanical properties, specification, and any other relevant test results that relate binder ingredient characteristics to formulated rocket motor characteristic requirements. Generate needed characterization data otherwise unavailable from Government and other sources. Phase I should culminate in a planned framework approach to building a predictive model that correlates HTPB chemical, physical, and any other relevant properties to resulting gum-stock and formulation characteristics, describing the analytical methods and characteristics to be used and validated in Phase II.

PHASE II: Refine HTPB polymer analytical methods and perform cure studies and aging assessments as needed to fully develop and validate the predictive model. The model should incorporate the capability to predict cured polymer gum stock mechanical properties, cure characteristics including pot-life, and aging characteristics based on a suggested set of analytically generated chemical and physical properties data. Make final model modifications based on validation studies and complete model development. The model will serve to ensure that a fully tested lot of HTPB, using the newly developed and defined set of analytical characterization tests, will meet required gum-stock pot life, cure profile, and aging characteristics.

PHASE III DUAL USE APPLICATIONS: Using the developed HTPB model, work with Government and other contractor entities, as applicable, to develop robust processing and controls to produce HTPB at pilot scale meeting desired material chemical and physical characteristics as previously identified that lead to successful gum stock formulations (i.e., meeting various exemplar rocket motor formulation specification requirements). Additionally, the predictive model and associated data will be used to assist in development a modern DoD specification for HTPB. Outcomes from work under this STTR topic would likely benefit other industrial/commercial uses for HTPB type polymer resins where similar chemical/physical property characteristics are critical to material performance (i.e., rubbers).

REFERENCES:

1. Funding Opportunity Announcement (FOA) #FA8650-19-S-5010 Call 009 "Hydroxyl Terminated Polybutadiene (HTPB) Production Capability for DOD Munitions Project", 2021.
2. Vilar, W. D., Menezes, S. M. C., & Akcelrud, L. (1994). Characterization of hydroxyl-terminated polybutadiene. Polymer Bulletin, 33(5), 557–561. doi:10.1007/bf00296164
3. Vilar, W. D., Menezes, S. M. C., & Akcelrud, L. (1994). Characterization of hydroxyl-terminated polybutadiene. Polymer Bulletin, 33(5), 563–570. doi:10.1007/bf00296165
4. Regan, P. R., Teo, H. H., Booth, C., Cunliffe, A. V., & Hudd, A. L. (1985). The molecular characteristics of hydroxyl-terminated polybutadiene. British Polymer Journal, 17(1), 22–26. doi:10.1002/pi.4980170106
5. Prine, N. 2018 'Characterization and Selection of Hydroxyl-Terminated Polybutadiene Polymers for High-Strain Applications', Honors Thesis, University of Southern Mississippi, Hattiesburg, MS.

KEYWORDS: Hydroxyl-Terminated Poly Butadiene; HTPB; predictive model; polymer analytics; material specification; Solid Rocket Motor; SRM; propellants; explosives; energetic materials

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N23A-T019 TITLE: Electrochemical Machining of Turbine Engine Components

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

OBJECTIVE: Develop an electrochemical machining process which has lower up-front non-recurring engineering expenses while still enabling fast material removal for a reduction in machining times of turbine engine components and enabling more fuel efficient gas turbine engines.

DESCRIPTION: Electrochemical machining (ECM) processes have been utilized for subtractive machining of aerospace materials such as nickel and titanium alloys. The process is particularly attractive due to its high metal removal rate in tough or heat-resistant materials common to the requirements of propulsion and power generation engines. The surface quality provided by ECM is also advantageous due to the low roughness and no heat affected zones or recast layer. In addition, the lack of electrode wear can lead to high process repeatability and lower production costs.

ECM is relevant for a number of Navy propulsion needs, including compressor and turbine airfoils, integrally bladed rotors (IBRs) or bladed disks (blisks), cases, disks, and combustor components. IBRs and blisks, for example, are particularly expensive for 5-axis Computer Numerical Control (CNC) machining due to challenging materials (e.g., Ti6242, Inconel 718), tight geometric tolerances on 3D surfaces (e.g., +/- .001-.003”), and smooth surface finish requirements (e.g., =10 µin Ra). In addition, new IBR and blisk designs feature tighter blade-to-blade spacing, intentional mistuning, and thinner walls, which further increase costs for both new engine designs and Navy sustainment needs. These requirements increase the potential need for an ECM manufacturing solution.

In addition, advanced designs are challenging the limits of current manufacturing techniques. Sharper leading edges, thinner walls, exotic tip geometries, and more complex curvatures can improve the overall engine efficiency or stall margins, but are more expensive, time consuming, or impossible to manufacture with conventional techniques. New material systems are being developed, such as titanium aluminides, high entropy alloys, and refractory alloys, which often have improved mechanical properties or heat resistance, increasing the challenge for contact-based machining processes and furthering the need for non-contact electrochemical methods.

Finally, there is growing interest in near-net-shape processes, such as low-cost casting or metal additive manufacturing. In these cases, a secondary subtractive machining process is often necessary to improve final part tolerance and reduce surface roughness. To take advantage of the single-part nature of near net components, the subtractive manufacturing process needs the ability to access hard-to-reach areas, an area where ECM can excel.

The low forces and insensitivity to material mechanical properties makes ECM a promising manufacturing technique to address all of these concerns, but its adoption has been largely limited to high volume commercial applications. The primary barrier facing greater adoption of ECM is the up-front non-recurring engineering expense (NRE) and process development costs. ECM is inherently inaccurate but repeatable, requiring iterations of the tooling to achieve the necessary accuracy. This iterative process of electrode design and process parameter selection is largely based on intuition and has limited its use to a few specialized firms, which rely on the knowhow and experience of its personnel. In addition, the tooling can be damaged by short circuit conditions during the testing phase, which damage the electrode and workpiece, leading to a time-consuming re-manufacturing process.

Given these challenges, the United States Navy is seeking improvements to the electrochemical machining process which can:

- Reduce the upfront tooling and NRE expense associated with current ECM processes

• Yield cost and lead time reductions of > 25% for turbine engine components including fan, compressor and turbine blades, advanced casing treatments and combustor liners, when compared to current best practices
• Be used for next generation metal material systems and geometries, including nickel superalloys and high entropy alloys
• Promote the standardization of ECM procedures, accessibility to the machining method for lower production rates, and ECM workforce development

PHASE I: Demonstrate proof-of-concept manufacturing of the improved ECM process on a relevant material system (e.g., Ti64 or IN718). Identify major risks to the proposed solution through analysis and/or experimentation. Identify solutions to the major risks. Test the proposed solutions on a representative geometry.

PHASE II: Address the risks and challenges by modifying or improving the baseline manufacturing technique demonstrated in Phase I. Additional manufacturing demonstrations will be performed on representative propulsion engine components and materials. Demonstration components will be inspected to identify quality issues (e.g., metallurgy impacts, surface defects), geometric tolerances, and material removal rates. A cost model will be developed demonstrating a pathway towards 25+% cost reduction and identifying the total manufacturing process chain (i.e., proposed technique + pre- or post-processing steps), the capital equipment and NRE costs associated with the proposed technique, and the operating expenses of the proposed technique.

PHASE III DUAL USE APPLICATIONS: Create a full-scale component using the developed manufacturing technique which could be used for further performance evaluation including rig testing, spin pit testing, or flow testing. If successful, this technology would have wide application in commercial advanced manufacturing for a variety of products.

REFERENCES:

1. Xu, Z., Wang, Y.(2021). Electrochemical machining of complex components of aero-engines: Developments, trends, and technological advances. Chinese Journal of Aeronautics, Volume 34, Issue 2, 28-53. https://www.sciencedirect.com/science/article/pii/S1000936119303462
2. Klocke, F., Zeis, M., Klink, A., Veselovac, D. (2013). Experimental research on the electrochemical machining of modern titanium- and nickel-based alloys for aero engine components. Procedia CIRP, 6, 368–372. .; https://www.sciencedirect.com/science/article/pii/S2212827113001145

KEYWORDS: Advanced manufacturing; electrochemical machining; compressor; turbine; jet engine; blisk; IBR; machining; surface finish

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N23A-T020 TITLE: Scalable Production of Carbon-Based Composites from Sequestered Environmental Carbon

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

OBJECTIVE: Develop a low-cost, energy efficient synthetic approach to producing carbon-based composites from environmental carbon resources.

DESCRIPTION: The objective of this STTR topic is to develop a low-cost, low-energy synthetic approach to producing carbonaceous materials to be used in carbon-based composites to advance defense materials for the warfighter. These materials include carbon fibers, carbon nanotubes, carbon nanofibers, graphene, and graphite. Carbonaceous materials are typically used as fillers in polymer-matrix composites and ceramic-matrix composites. There is growing interest in utilization in Li-ion batteries, capacitors, and high strength building materials. The proposed synthetic process will reduce the complexity and cost associated with utilizing environmental carbon resources to synthesis the carbonaceous material while maximizing yield and purity.

PHASE I: Define the specific carbonaceous material to be synthesized, utilizing environmental CO2. Define, develop, and perform initial laboratory assessment of the proposed synthetic process to validate the technical feasibility of the approach to producing the carbonaceous material. Perform analysis of the material and determine initial yield and purity.

PHASE II: Based on findings in Phase I, define and develop a concept to produce kilogram-scale quantities of carbonaceous material. Produce selected materials and determine the physical characteristics (size and shape) along with strength, thermal and electrical conductivities, impurities, and yield as a function of changes in synthetic conditions. From the analysis and characterization, determine the appropriate steps to maximize CO2 usage, minimize energy, and costs associated with the approach. Identify Navy operational platform applications that are likely to benefit the most from this technology. Conduct a demonstration of the process and technology.

PHASE III DUAL USE APPLICATIONS: Identify opportunities where carbonaceous materials can be utilized from an installations / building materials perspective that could benefit Naval and commercial facilities. Provide a cost-benefit analysis to show effects of utilizing CO2 on cost and production of material.

REFERENCES:

1. Recent applications of carbon-based composites in defence industry:A review, Defence Technology, https://doi.org/10.1016/j.dt.2022.03.006
2. Department of the Navy Climate Action 2030, 24 May 2022, https://www.navy.mil/Portals/1/Documents/Department%20of%20the%20Navy%20Climate%20Action%202030.pdf

KEYWORDS: carbon-based composites; carbon fibers; carbon nanotubes; carbon nanofibers; graphene; graphite; synthesis

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N23A-T021 TITLE: Autonomous, Long-Duration, Directional Ambient Sound Sensor

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy
OBJECTIVE: Develop an autonomous, long-duration, directional ambient sound sensing system capable of being integrated into a variety of platforms including floats, gliders, and ocean observation buoys. The system should output soundscape-related information in a manner that is scaled to match platform communications bandwidth.

DESCRIPTION: Sound waves generated by natural (both abiotic and biotic) and anthropogenic sources convey information about both the source and the environment in which they travel. Underwater recordings of ambient sound have been previously used to estimate local weather (wind, rain), to identify the presence/absence of marine organisms, and, particularly when directional information is included, to characterize the undersea environment. These systems, however, have not found widespread usage in the near-real-time reporting systems that currently exist in ocean observing networks (e.g., systems of floats and gliders, observational buoy networks). This STTR topic seeks to develop a low power (~1 W), long duration (months to years) system that can be widely integrated into ocean observing networks. Successful solutions will include onboard processing to provide generalized soundscape information, including sound intensity levels as a function of frequency and direction (both horizontal and vertical), event detection, and scalable reporting options that can be matched to host platforms (e.g., low data rate satellite communications, moderate data rate cellular communications). The system should output soundscape-related information in a manner that is scaled to match platform communications bandwidth. Innovations are anticipated at both the sensing level, particularly for the directionality of ocean sound and its use in characterizing the ocean environment, and at the onboard processing level where the information content of ambient sound is efficiently and autonomously extracted from the raw data. The successful solution will be scalable to wide-region distributed sensing (e.g., 10's to 100's of sensors throughout a sea, or 1000's of sensors distributed throughout the world's oceans).

PHASE I: Develop an initial concept design that can accommodate various host platforms including floats, gliders, and observation buoys. The concept design should include sensing concept and configuration, mechanical packing, power consumption, communication interfaces, sensor (re)calibration methodology, algorithms to extract the information content of the ocean sound, and estimated data rate(s). Algorithms are expected to be tested on previously collected or simulated data (e.g., passive acoustic data held by the NOAA National Centers for Environmental Information).

PHASE II: Develop a prototype autonomous, long-duration, directional ambient sound sensor, integrate it into a host platform, and use real-world data to analyze its performance including sensitivity, self-noise, dynamic range, direction-resolving capability, power consumption, longevity, and sensitivity stability.

PHASE III DUAL USE APPLICATIONS: Demonstrate the use of a regional network of sensors (e.g., 10's of systems) including deployment, data collection/communication, and data analysis (e.g., generalized soundscape information and event detection).

Naval applications of this system include the capability to validate and fine-tune ambient sound models and databases in operational environments, including real-time updates in the temporally and spatially varying ocean. Although the direct sensor output data will be unclassified, its use in direct coordination with Navy ambient sound models and databases may be CUI or classified.

Commercial application of this technology is anticipated to be tied to the blue economy, including the detection of protected species in areas of interest to commercial fishing and offshore wind technologies.

REFERENCES:
1. Vagle, S., Large, W. G., & Farmer, D. M. (1990). An evaluation of the WOTAN technique of inferring oceanic winds from underwater ambient sound. Journal of atmospheric and oceanic technology, 7(4), 576-595. https://doi.org/10.1175/1520-0426(1990)0072.0.CO;2
2. Van Uffelen, L. J., Roth, E. H., Howe, B. M., Oleson, E. M., & Barkley, Y. (2017). A Seaglider-integrated digital monitor for bioacoustic sensing. IEEE Journal of Oceanic Engineering, 42(4), 800-807. https://doi.org/10.1109/JOE.2016.2637199
3. Siderius, M., & Gebbie, J. (2019). Environmental information content of ocean ambient noise. The Journal of the Acoustical Society of America, 146(3), 1824-1833. https://doi.org/10.1121/1.5126520

KEYWORDS: Ambient Noise; Soundscape; Sonar; Autonomous; Ocean Observing; Environmental Sensing

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N23A-T022 TITLE: Lightweight Mirrors for Microsatellites and Small Satellites

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Space Technology
OBJECTIVE: Develop innovative manufacturing methods to produce high-quality lightweight optical mirrors for use in space on microsatellites (microsats) and small satellites (smallsats), particularly at ultraviolet (UV) and extreme ultraviolet (EUV) wavelengths.

DESCRIPTION: The Navy seeks improvements in the manufacturing of lightweight optical mirrors to meet size and weight demands of compact optical systems designed for operation in space on the next generation of microsats being designed to study the ionosphere [Refs 1, 2] and other Navy applications. Availability of high-quality lightweight optics will allow for future mission growth. The Navy seeks to foster the development of affordable optical components and systems that could have broad application to space systems. Current mirror technology involves either fragile glass optics or metal or composite mirrors that have lower optical quality. Innovative substrate materials are sought with the ruggedness, mass, and material properties necessary to produce light weight high-quality optical elements. Innovative techniques are sought to polish and figure these substrates to yield the high optical quality reflective surfaces needed for the new class of remote sensing instruments.

Typical cube satellite (CubeSat) mirrors used in smallsats have been fabricated from special aluminum alloys that are hard enough to be polished with moderate difficulty. Their density is 2.7 g/cm3, leading to significant mass penalties. The example sizes range from a fixed flat mirror (3” x 3.5” by 0.080” thick) to a scanning mirror (2” X 3.5” by 0.375” thick). Improvements are sought in the density, stiffness, polishability, roughness, figure accuracy, and moment of inertia in the scanning case. Goals are figure accuracies of λ/4 at the working wavelength, scratch/dig of 60-40, rms roughness of < 1nm, Coefficient of Thermal Expansion (CTE) compatible with typical spacecraft materials (< 4ppm/K), low outgassing (CVC < 0.1% and TML < 1%), survival at temperatures of -50 – +60°C, and the ability to survive a NASA GEVS3 vibration specification and thermal test environment, all typical of the requirements imposed for flight on small spacecraft.

Technologies proposed should not contain hazardous or high outgassing materials and should be capable of being integrated into typical optical systems. It is desired that they be moderately (> 10-5 O-1/m) electrically and thermally conductive (> 10W/mK) to avoid developing static charge and thermal gradients in space. They should be durable and able to withstand normal optical component handling procedures. They should be delivered in an optically clean state and be robust enough to withstand precision cleaning and vacuum baking as part of normal spacecraft processing.

PHASE I: Demonstrate the feasibility of a concept for an innovative lightweight mirror technology meeting Navy needs for microsat optical systems in the ultraviolet/vacuum ultraviolet (UV/VUV). Demonstrate performance advantages over current technology by producing small (25mm or larger) flat sample mirrors that can be tested to Navy requirements. While exact mirror dimensions are not specified for Phase I, the awardee will establish that the concept can be scaled to sizes of 100 mm diameter or larger. Phase I technology is expected to focus on the small flat mirrors that are needed to fold optical systems into compact smallsat envelopes. The path to using this technology to produce curved mirrors should be defined.

Proposed mirror concepts should meet the following thresholds:

Deliverable Design Characteristics	**Value**
Mirror major dimension	25mm or larger

Mirror thickness	low, < 1/6 major dimension
Substrate density	< 1 g/cm^3
Mirror flatness	< 1 wave
Mirror scratch-dig	60-40
Mirror roughness	< 1nm
Survival Temp range	-50 - +60°C
Reflective Coating	for UV or VUV
Vibration, shock, and Thermal	NASA GEVS3

PHASE II: Develop a Phase II prototype mirror of the 100 mm size class for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II Statement of Work (SoW) and the Navy's need for lightweight flight mirrors. The prototype design should provide reflective areas no less than 90mm by 40mm (objective), and should show applicability to be utilized with various mirror geometries and spacecraft architectures. Deliver a minimum of five of these prototypes to the Navy for evaluation. Perform detailed analysis to ensure materials are rugged and appropriate for Navy application. Environmental, shock, and vibration analysis will be performed. Optical checks will include flatness, roughness, and reflectivity. Prototype concave mirrors of 25mm diameter and ~100mm Radius of Curvature (ROC) will be produced and evaluated.

PHASE III DUAL USE APPLICATIONS: Apply the knowledge gained in Phase II to build an advanced mirror, suitably configured for a smallsat application, including flight spares, and characterize its performance in the UV/VUV as defined by Navy requirements. Working with the Navy and applicable Industry partners, demonstrate application to a NAVY Space Test program (STP) flight test. Support the Navy for test and validation to certify and qualify the system for Navy use. Explore the potential to transfer the light weight mirror system to other military and commercial systems (NASA, University, Optics Industry).

Market research and analysis shall identify the most promising technology areas. Develop manufacturing plans to facilitate a smooth transition to the Navy.

REFERENCES:

1. Budzien, Scott; Fritz, Bruce; Stephan, Andrew; Marquis, Peter; Powell, Steven; O'Hanlon, Brady; Nicholas, Andrew; Dymond, Kenneth and Brown, Charles. "Comparison of second and third generation 135.6 nm ionospheric photometers using on-orbit and laboratory results.", SPIE Proceedings, Volume 11131, CubeSats and SmallSats for Remote Sensing III; 1113102 (2019). https://doi.org/10.1117/12.2528791
2. Attrill, G.D.R.et al. "Coordinated Ionospheric Reconstruction CubeSat Experiment (CIRCE), In situ and Remote Ionospheric Sensing (IRIS) suite." Journal of Space Weather and Space Climate, (2020) . J. Space Weather Clim. 11, 16, (2021). doi.org/10.1051/swsc/2020066.
3. "NASA General Environmental Verification Standards (GEVS), Rev. A, GSFC-STD-7000 (2013)." https://standards.nasa.gov/standard/gsfc-std-7000

KEYWORDS: Lightweight space qualified mirrors, mirror technology, optical fabrication, spaceflight optics, spaceflight structures; microsatellites; small satellites; cube satellites

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N23A-T023 TITLE: Integrated Optical Imaging of the Environment on Underwater Autonomous Vehicles

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

OBJECTIVE: Advance integration of camera imagery collection and onboard processing for environmental sensing on low-power, long-duration oceanic gliders and/or profiling floats. The system should allow for two-way communication between the sensor and platform microcontrollers; and software architecture should be tunable to specific parameters, e.g., adaptive capability to turn on imagery collection at target locations or times (e.g., within a set distance from the surface or bottom). Onboard processing and file reduction should allow for near-realtime data delivery of select low-resolution imagery and/or analysis products from imagery via satellite comms (iridium, Starlink, etc.).

DESCRIPTION: Long-endurance profiling floats and gliders are critical components of today's ocean environmental monitoring systems with standard sensor payloads sampling scalar fields (e.g., temperature, salinity, fluorescence). These platforms, which are available as off-the-shelf units or manufactured in house at academic institutions, can be modified to carry additional specialized sensors. Such efforts are often targeted to a specific science need, but are rarely fully integrated with the platform, and exist primarily as one-off prototypes. The field of underwater optical imaging has a long history with significant recent advances afforded by continued development of low-cost, high-performance sensors and computational capabilities for onboard processing [Ref 1]. Recent developments have included optical sensing packages with low-power and small space requirements making them suitable for integration on long-endurance platforms [Ref 2].

The Navy seeks a fully integrated, low-power optical imaging system on long-endurance (~6 month mission capability) profiling platforms. While all components—the platform, optical sensing packages, and compression/analysis software—are available in some form as commercial off-the-shelf systems; integrated systems that allow for real-time delivery of compressed information are in their infancy. Additionally, most optical imaging systems appropriate for use on small displacement vehicles target imaging of plankton [Ref 3]. This STTR topic seeks a design capable of imaging both the near-field (order 1 cm) and mid-field (order 1 m) of view, with camera sensors capable of resolving both millimeter- and meter-scale objects. The system can consider either passive or active imaging techniques optimized for the euphotic zone. Imaging should extend both below and above the surface with potential sensing targets: relative motion of marine snow and particulates, near-surface bubble concentration, above-surface environmental conditions (e.g., films, white-capping). Critically, the design must be integrated allowing for adaptive sampling with the sensor package and include onboard processing capable of providing near-realtime data delivery of select low-resolution imagery and/or analysis products from imagery via satellite comms (iridium, Starlink, etc.).

PHASE I: Identify hardware components that can meet the stated requirements. Develop a concept for onboard software, including analysis of bandwidth and data transfer constraints. Develop a design concept for the integrated optical imaging system. Analyze for strengths and weaknesses of the proposed design. Develop a design review to be conducted in Phase II.

PHASE II: Develop and test a prototype system. Complete an analysis of the performance of the system and report on the results. Conduct multi-stage testing allowing for redesign between tests with initial tests in a surrogate ocean environment (e.g., lake or tank), interim test in the ocean under controlled conditions (e.g., coastal bay), and final test in the field under a range of environmental conditions. Develop and test both hardware and software systems. The final prototype should include a fully integrated sensing package capable of adaptive sampling and delivery of data via satellite. Analyze and report on the strengths and weaknesses of the final design based on results of the field tests.

PHASE III DUAL USE APPLICATIONS: The developed technology has potential use in any DoD, civil, or commercial application that requires detailed information on the ocean environment as certain elements, like the presence of marine vegetation or surface slicks/films, are not easily sensed through other means. Field testing in Phase II will constrain the parameter space under which the system is operationally capable for the Navy. Other potential use sectors include the oil and gas industry (e.g., tracking of spills under ice), and state/federal marine life monitoring agencies (e.g., NOAA Fisheries Monitoring and Analysis Division).

REFERENCES:

1. J. S. Jaffe, "Underwater Optical Imaging: The Past, the Present, and the Prospects," in IEEE Journal of Oceanic Engineering, vol. 40, no. 3, pp. 683-700, July 2015, doi: 10.1109/JOE.2014.2350751.
2. Picheral, M., Catalano, C., Brousseau, D., Claustre, H., Coppola, L., Leymarie, E., Coindat, J., Dias, F., Fevre, S., Guidi, L., Irisson, J.O., Legendre, L., Lombard, F., Mortier, L., Penkerch, C., Rogge, A., Schmechtig, C., Thibault, S., Tixier, T., Waite, A. and Stemmann, L. (2022), The Underwater Vision Profiler 6: an imaging sensor of particle size spectra and plankton, for autonomous and cabled platforms. Limnol Oceanogr Methods, 20: 115-129. https://doi.org/10.1002/lom3.10475
3. Ohman, Mark D., et al. "Zooglider: an autonomous vehicle for optical and acoustic sensing of zooplankton." Limnology and Oceanography: Methods 17.1 (2019): 69-86.

KEYWORDS: optical imaging, underwater autonomous vehicles, ocean gliders

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N23A-T024 TITLE: Compact Condensers Enabled by Additive Manufacturing

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

OBJECTIVE: Develop novel, additively manufactured refrigerant to water condensers for use in electronic cooling systems.

DESCRIPTION: Cooling of high power electronics via refrigerant evaporation presents a significant opportunity to reduce the size, weight, and power (SWaP) consumed by thermal management systems. Recent advances have led to demonstration of compact microchannel evaporators with heat transfer coefficients in excess of 100 kW/m2^K and low pumping powers. Condensers are often the largest component in a two-phase cooling system. Commercial condensers are typically shell and tube designs with heat transfer coefficients less than 5000 W/m^2K. Military systems often use a secondary coolant loop to transport heat from condensers. For example, naval platforms use a freshwater cooling system, while air platforms have a polyalphaolefin (PAO) coolant loop. Recent progress in metal additive manufacturing has enabled the fabrication of air heat sinks and cold plates with complex flow geometries. Additive manufacturing also allows for thinner walls, reducing weight and thermal resistance. Most metal additive manufacturing technologies are based on powder processing, with a limited number of alloys commercially available. Process parameters can greatly affect the microstructure and mechanical properties of the resulting metallic heat exchanger, leading to concerns about long term durability. Heat transfer enhancement using internal structures embedded inside flow passages is commonly used to increase local convection heat transfer, but has been limited to simple structures by conventional manufacturing techniques. Additive manufacturing can enable more complex structures, but demonstrations to date have been largely limited to intuitive designs. Topology optimization has recently been applied to the design of additively manufactured cold plates, but the designs are limited to two-dimensional optimization due to computational complexity. New tools are needed to enable the full potential of additive manufacturing to realize optimal three-dimensional designs. This STTR topic seeks innovative condenser designs enabled by metal additive manufacturing for efficient cooling of electronics.

PHASE I: Design a compact, additively manufactured, metal heat exchanger for condensing a refrigerant with saturation temperatures below 35 °C (R134a preferred) using freshwater at 25 °C for heat rejection. Pressure drop on both the refrigerant and water side should be minimized to optimize efficiency. Verify feasibility using modeling and/or component demonstration. Perform rough manufacturing cost analysis. Develop a Phase II plan.

PHASE II: Demonstrate a prototype R134a condenser using the concept developed in Phase I. The prototype should be able to reject 50 kW of heat to a fresh water system at 25 °C. Evaluate the efficiency of the prototype under various electrical and cooling loads and temperatures. Performance data, including heat transfer and pressure drop, shall be collected at a variety of flow rates (both refrigerant and water), temperatures, and entrance qualities. Validate analytic models developed in Phase I and evaluate scalability of design.

PHASE III DUAL USE APPLICATIONS: Design and develop the next generation of compact, high efficiency condensers using the knowledge gained during Phases I and II. These heat exchangers must meet military unique requirements, e.g., shock and vibration. Advanced condensers developed here would be suitable for use in a variety of commercial applications, from hybrid vehicles to building air conditioning.

REFERENCES:

1. X Zhang, R Tiwari, A.H. Shooshtari, and M.M. Ohadi, “An additively manufactured metallic manifold-microchannel heat exchanger for high temperature applications,” Applied Thermal Engineering, vol. 143, pp. 899-908 (2018). https://doi.org/10.1016/j.applthermaleng.2018.08.032
2. S. Sun, P. Liebersbach, and X. Qian, “3D topology optimization of heat sinks for liquid cooling,” Applied Thermal Engineering, vol. 178, 115540 (2020). https://doi.org/10.1016/j.applthermaleng.2020.115540
3. H. Moon, D. J. McGregor, N. Miljkovic, and W. P. King, “Ultra-power-dense heat exchanger development through genetic algorithm design and additive manufacturing.” Joule vol. 5, pp 3045-3056 (2021). https://doi.org/10.1016/j.joule.2021.08.004

KEYWORDS: thermal management; two-phase cooling; condenser; additive manufacturing; heat exchanger

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N23A-T025 TITLE: Cloud Nowcasting Data/Model Fusion

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

OBJECTIVE: Develop an algorithmic tool for the seamless assessment of previous, current and short term forecast (0-24 h) atmospheric cloud characteristics such as ceiling, thickness, and optical depth for single and multiple overlapping cloud fields using machine learning methods to combine satellite based environmental monitoring (SBEM) analysis information, ground based remote sensing, and numerical weather prediction model fields.

DESCRIPTION: Despite increasing complexity and accuracy of weather forecast models, tools for their use in diagnosing cloud and visibility characteristics are relatively unsophisticated. Many use cases assume a relatively static cloud field based on available satellite analysis data, climatological occurrence of cloud locations, or derived numerical weather prediction output (such as relative humidity fields). Using state of the art technology, this STTR topic seeks to bridge the gap between cloud analysis by satellite and forecasts from numerical modeling by using machine learning techniques and other data fusion capabilities to improve forecast uncertainty and cloud representation through a 24 hour forecast lead-time. Effort should focus on improved post processing of cloud characteristics in numerical modeling as well as techniques to seamlessly morph a true cloud analysis field from satellite into the predicted field. Implementation should take advantage of modern software strategies, including concise data presentation and intuitive user interface to display custom visualization of clouds from any 3 dimensional angle.

PHASE I: Determine and demonstrate the technical capability to smoothly transition observed satellite observations of cloud cover into simulated cloud (or meteorological variables interpreted as cloud) forecasts. Work should identify methodological details to preserve the physical structure of observed cloud visibility characteristics, aesthetics and ease of interpretation, and incorporation of probabilistic information for metrics of uncertainty and/or alternate future scenarios. Skill with respect to aviation needs should be enumerated (e.g., accuracy of cloud ceilings, error in horizontal and vertical positioning, treatment of overlapping cloud layers) given validating data from ground lidar or other full atmosphere representation. 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: Expanded technical development and validation of a robust prototype system of seamless historical, current, and future cloud state. Effort should be focused on 1) maturing complex machine learning algorithms that improve forecast representation of clouds given observed satellite cloud state (including advective schemes such as optical flow, clustering of cloud types, and texture analyses), 2) adding additional data sources and expanded spatial domain to prove application to any global location, and 3) iterating on accuracy and ease of user interface in display of cloud fields. Given the need to add many different satellite platforms and forecast model data, substantial subtasks on developing generic data reader capabilities and automated metadata generation and labeling are anticipated. While the code itself may need nominal high performance computing to run, output of prototype algorithm should be capable of being visualized on a standard laptop or cellphone with modest data bandwidth (such as by tiling). It is anticipated that the prototype data output and software package will be compatible with running from open source python data analysis libraries at the conclusion of Phase II efforts. 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, as well as downstream applications. Further follow-on Phase II efforts include expansion of observational and remote sensing datasets used to generate and validate the algorithmic tool, software refinements and

hardening based on real-world operational constraints (such as data latency and drop outs, quality issues, etc.), and further tests of blending code to similar meteorological variables (such as atmospheric water constituents). DoD, civil, and private aviation will particularly benefit by having a state-of-the-art product aimed at understanding cloud visibility evolution at all stages of flight operations, from take-off through ferry and landing. Naval applications will particularly benefit by the significant increase in specific environmental data and available at any point where the Naval aircraft operations can occur. Other civil and commercial applications will benefit from enhanced data streams and software implementations for broad aviation and visibility applications, improved predictability in weather forecasts, and increased cross-over between civil and commercial satellite remote sensing activities. This effort has the potential to fill a data gap in all aspects of meteorological analysis as well as provide a foundation for additional data fusion opportunities.

REFERENCES:

1. Mecikalski, John R., et al. "Probabilistic 0–1-h convective initiation nowcasts that combine geostationary satellite observations and numerical weather prediction model data." Journal of Applied Meteorology and Climatology 54.5 (2015): 1039-1059.
2. Veillette, Mark S., et al. "Creating synthetic radar imagery using convolutional neural networks." Journal of Atmospheric and Oceanic Technology 35.12 (2018): 2323-2338.
3. Wang, Chenxi, et al. "A machine-learning-based cloud detection and thermodynamic-phase classification algorithm using passive spectral observations." Atmospheric Measurement Techniques 13.5 (2020): 2257-2277.
4. Nachamkin, Jason E., et al. "Classification and Evaluation of Stable and Unstable Cloud Forecasts." Monthly Weather Review 150.1 (2021): 81-98.

KEYWORDS: meteorology; weather; clouds; visibility; nowcasting; forecasting; numerical weather prediction; Satellite Based Environmental Monitoring; SBEM; satellite; remote sensing; data fusion; machine learning; optical flow; visualization; metadata; aviation

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N23A-T026 TITLE: Development of Finite-Rate Ablation Toolset for Hypersonic Vehicles

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

OBJECTIVE: Formulate, implement, and validate finite-rate ablation models for hypersonic boost-glide vehicle thermal protection systems (TPS) such as 2D and 3D carbon-carbon (C/C) for accurate prediction of vehicle shape change, temperature distributions, and ablated species.

DESCRIPTION: Boost-glide vehicles primarily rely on ablating TPS. Unlike strategic ballistic missiles, boost-glide weapons operate for a long duration in a range of altitudes and velocities where the rates of energy excitation, chemical reactions, ionization, and gas-surface interactions are comparable to the rate of fluid motion. This implies that the accuracy of legacy modeling approaches that assume equilibrium thermo-chemistry and equilibrium ablation are questionable for such systems. Recent numerical studies of graphite ablation at boost-glide relevant flight conditions have shown that equilibrium ablation models (i.e., B' method) significantly over-predict nose-tip ablation compared to finite-rate ablation models [Ref 1].

Over the last decade, significant improvements have been made in the understanding and prediction of finite-rate processes in hypersonic flows by using ab initio quantum chemistry methods to generate potential energy surfaces (PES) for molecular interactions [Ref 1]. The PES can be used for the direct simulation of collisions between air species to obtain data for relaxation and reaction rates at specified conditions [Ref 2]. These data have enabled improved finite-rate chemistry models for computational fluid dynamics (CFD) simulations that accurately account for the vibrational energy state of the air species in the dissociation process [Ref 3]. Over the same time period, improvements have been made in the development of finite-rate carbon oxidation models based on molecular beam experiments of high-velocity O, and O2 species impacting high-temperature carbon material [Ref 4]. Such experiments enable the characterization of individual reactions and rate parameters as opposed to plasma wind tunnels experiments that measure the combined outcome of many reactions such that multiple combinations of parameters can be used to match the measured recession rate. Different finite-rate ablation models that produce comparable ablation rates can predict large difference in the ablation species such as CO, CO2, and CN. Very recently, molecular beam experiments that included the interaction with N and N2 species have provided the data needed for the development of construction of air-carbon ablation models relevant to hypersonic flight that include nitration in addition to oxidation [Ref 5].

Recent progress in the development of finite-rate carbon ablation models is encouraging, but these models need to be validated under a range of relevant hypersonic conditions and geometries for simple and relevant materials such as 2D and 3D C/C. This is needed as current molecular beam data has been obtained on highly oriented pyrolytic graphite (HOPG) and vitreous carbon as experimental models for the fibers and matrix, respectively, of C/C.

It is also imperative to implement the new finite-rate ablation models in fully coupled CFD / material response codes to predict the TPS shape change, temperature distributions and ablated species. In addition, the assessment of TPS thermo-structural properties, surface roughness, and damage requires the simulation of the material microstructure.

PHASE I: Formulate and implement finite-rate air-carbon ablation models in coupled CFD material response. Perform comparison against existing experimental data for simple materials such as HOPG and vitreous carbon. Quantities of interest include ablation rates (shape change), surface temperature, and ablated species. Criteria for success include the successful model implementation in material response code and validation.

PHASE II: Refine the finite-rate ablation models and their implementation for relevant materials such as 2D and 3D C/C. The model refinement could include fundamental measurements on C/C to understanding the effect of the material microstructure on the reaction rates and parameters. Validation under a range of relevant hypersonic flow conditions in an arc-jet and or inductively coupled plasma torch (ICP) for nose-tip, leading-edge, and acreage are required to assess the accuracy of the ablation models.

PHASE III DUAL USE APPLICATIONS: Improve the models and efficiency of the coupled hypersonic CFD / ablation toolset for prediction of shape change on complex geometries. The ablation toolset will ultimately be demonstrated on a relevant Navy weapons geometry via ground and/or flight test once a sufficient TRL is achieved.

In the near term, this technology is geared toward military applications, but the methodologies for ablation model development and ablation toolset can be commercialized for commercial space vehicles using C/C TPS. Additional development for carbon-phenolic materials are also possible to expand the range of applications.

REFERENCES:

1. G. V. Candler, "Rate effects in hypersonic flows," Annual Review of Fluid Mechanics, vol. 51, pp. 379-402, 2019.
2. R. L. Jaffe, D. W. Schwenke and M. Panesi, "First Principles Calculation of Heavy Particle Rate Coefficients," in Hypersonic Nonequilibrium Flows: Fundamentals and Recent Advances, Reston, American Institute of Aeronautics and Astronautics, Inc., 2015, pp. 103-158.
3. R. S. Chaudhry, J. D. Bender, T. E. Schwartzentruber and G. . V. Candler, "Quasiclassical Trajectory Analysis of Nitrogen for High-Temperature Chemical Kinetics," Journal of Thermophysics and Heat Transfer, vol. 32, no. 4, pp. 833-845, 2018.
4. S. Poovathingal, T. E. Schwartzentruber, V. J. Murray, T. K. Minton and G. V. Candler, "Finite-rate oxidation model for carbon surfaces from molecular beam experiments," AIAA journal, vol. 55, no. 5, pp. 1644-1658, 2017.
5. V. j. Murray, P. Recio, A. Caracciolo, C. Miossec, N. Balucani, P. Casavec and T. K. Minton, "Oxidation and nitridation of vitreous carbon at high temperatures," Carbon, vol. 167, pp. 388-402, 2020.

KEYWORDS: Ablation; carbon-carbon; finite-rate; boost-glide; molecular-beam; oxidation; nitration

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N23A-T027 TITLE: Digital Sidekick for Submarine Watchstander Augmentation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy; Integrated Network Systems-of-Systems
OBJECTIVE: Develop a haptic alert system (Digital Sidekick for Submarine Watchstander) to substantially accelerate information delivery timelines for critical alerts, which can be delayed or completely missed due to information overload.

DESCRIPTION: Information overload is a critical factor negatively impacting the effectiveness of submarine watchstanders. Wrist or body worn haptic devices and haptic notifications have been shown to substantially shorten response times by immediately focusing attention on critical information or alerts being delivered by an artificial intelligence/machine learning (AI/ML) process designed to aid a watchstander. These devices are not currently deployed for submarine watchstations, Creating a process for accelerating delivery of critical information and alerts for submarine watchstanders can increase efficacy of numerous watchstations in time critical scenarios that will increase platform lethality, overall operational effectiveness, and platform survivability. This STTR topic seeks to deliver a haptic alert system that can be configured for a particular watchstation or individual to immediately alert and orient the person to critical information that requires urgent action. The principal objective will be to offer information delivery methods that cannot be missed in the most stressful scenarios, enabling a clear and focused response to the alert being provided. Key attributes for the project will include certainty of notification and watchstander awareness and understanding of information delivered which will result in measurable time savings for the required response. Ideal measure of effectiveness would include no missed alerts and substantially accelerated response times compared to scenarios without a haptic alert system.

PHASE I: Identify technical design options to enable haptic delivery of alerts for a variety of submarine watchstations (e.g., sonar, electronic warfare, roving watchstanders, etc.). Technical solutions should address certainty of alert, durability and resiliency of devices and systems being utilized to provide the alert, and methods to reduce false alerts. Establish the feasibility of the concepts. Work to identify suitable testing locations for Phase II.

PHASE II: Develop and deploy prototypes to suitable testing locations, including schoolhouse and platforms, to evaluate and determine impact of the prototype haptic critical alert and information delivery system(s). Work with users to define the most effective applications and use cases for most impactful technical applications for information delivery augmentation.

PHASE III DUAL USE APPLICATIONS: The products and capabilities developed under this topic will transition to submarine watchstanders that can benefit most from the new information delivery approach. It is envisioned that multiple approaches will be viable with ADNS/SWFTS, Sonar, EW, Engineering Space and Forward Roving watchstanders obtaining clear benefit from improved information delivery and receiving critical alerts immediately through haptic notification. A dual use commercial application could also be pursued with similar haptic alert applications in a variety of scenarios involving commercial power generation or mechanical fabrication facilities. Due to the routinely quiet and vibration free environment on a submarine, it is uniquely suited to benefitting from haptic information delivery technology, but some stationary or low noise/vibration monitoring activities in the commercial sector could also potentially benefit from this technical approach.

REFERENCES:

1. Giri, G.S.; Maddahi, Y. and Zareinia, K. “An Application-Based Review of Haptics Technology.” Robotics 2021, 10, 29. https://mdpi-res.com/d_attachment/robotics/robotics-10-00029/article_deploy/robotics-10-00029-v2.pdf?version=1612746858

2. Hayward, Vincent. “Haptics: A Key to Fast Paced Interactivity.” Center for Intelligent Machines, McGill University, Montreal, Quebec, Canada. https://www.sciencedirect.com/science/article/pii/B9780444506498500048
3. Dix, Annika; Schwendicke, Anna; Pannasch, Sebastian; Altinsoy, Ercan; Helmert, Jens R. “Chapter 7 - Augmented Perception and Interaction.” Tactile Internet Human-in-the-Loop, 2021, https://www.sciencedirect.com/science/article/pii/B9780128213438000186
4. Almeida de Souza, Gabrielle et al. “Evaluation of Visual, Auditory and Vibro-Tactile Alerts in Supervised Interfaces.” 20th Symposium on Virtual and Augmented Reality (SVR), 30 Oct. 2018. https://ieeexplore.ieee.org/document/8802446
5. “Haptic Technology: The Future of Engagement?” MassChallenge, 23 September 2021, https://masschallenge.org/article/haptic-technology

KEYWORDS: Haptic; Perception; Multisensory; Feedback; Information Overload; Critical Alert; Interaction; Digital Sidekick; Watchstander Augmentation; Kinesthetic Feedback; Wearable Devices

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N23A-T028 TITLE: Broadband, High Power, Low Loss N-polar GaN Radio Frequency (RF) Switches

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

OBJECTIVE: Maximize radio frequency (RF) Switch performance in Nitrogen-polar (N-polar) Gallium Nitride (GaN) based on a high electron mobility transistor (HEMT) epitaxial layer structure capable of 4 W/mm power density.

DESCRIPTION: RF switches are used in virtually all wireless systems. Losses or distortion in front-end switches directly impacts final system performance metrics. Traditional solid state RF switch performance is limited by the underlying switch transistor or diode device's figures of merit including switch cutoff frequency, linear and saturation current density, and breakdown voltage. New switch device technologies including MEMS and phase change materials have shown higher performance but have drawbacks including lacking the switch cycle endurance needed for many applications, the difficulty of integration that adds losses which can negate some of their performance advantages, and for MEMs a greater vibration/shock susceptibility.

N-polar GaN has recently shown record solid-state transistor switch performance metrics including a 1.7 THz switch cutoff frequency, and a straightforward path exists for monolithic integration of N-polar GaN power amplifiers (PAs) which are expected to also show record performance. Integration of an RF switch, power amplifier, and low noise amplifier (LNA) will enable low cost transceiver technology for applications addressing microwave to mm-wave systems. Recent results reported for N-polar GaN HEMT on Sapphire point to a very low-cost manufacturing for an integrated RF switch with a PA, and complete transceivers.

Switch circuit application examples and metrics that can be pursued in this STTR topic:

Ultra-broadband medium power low-loss switch: DC-100 GHz SPDT switch with > 2W 1dB compression point, > 10W off-state power handling, < 2 dB loss, 20 dB isolation

Low-loss, high linearity, Ka-band antenna tuning switch: 26.5-40 GHz SP4T switch with 50 dBm IP3

High-power S-Ku band switch: 2-18 GHz SPDT switch with > 10W P1dB

Alternate switch applications offered by proposers will be considered.

PHASE I: Fabricate, characterize, and model switch device cells needed for the range of designs. Design and simulate switch circuits, using an epitaxy which supports power devices with 4W/mm and 25% power-added efficiency (PAE) at W-band. Characterize the switch device cell for loss, isolation, linearity, and power handling. Report on switch circuit design and simulation including loss, isolation, linearity and harmonic performance, and power handling for different applications.

PHASE II: Refine models and fabricate switch circuits. Characterize switch circuits against the metrics and fabricate optimized designs based on specific applications proposed for Phase II. Implement fabrication process variations to correlate process parameters on field-effect transistor (FET) performance in a fab process flow suitable for integration with N-polar GaN PAs.

PHASE III DUAL USE APPLICATIONS: Demonstrate an integrated RF switch with PA in N-polar GaN, and alternatively a complete transceiver including RF switch, PA, and LNA relevant to the metrics in the above Description and the Phase I goals.

Dual use applications are expected to include commercial SATCOM, terrestrial backhaul communications for 6G and higher, Wi-Fi 6, and next generation wireless networks.

REFERENCES:

1. Romanczyk, Brian et al, "Evaluation of linearity at 30 GHz for N-polar GaN deep recess transistors with 10.3 W/mm of output power and 47.4% PAE", Applied Physics Letters, vol.119, no.7, pp.072105, 2021
2. Romanczyk, Brian et al., ”Demonstration of Constant 8 W/mm Power Density at 10, 30, and 94 GHz in State-of-the-Art Millimeter-Wave N-Polar GaN MISHEMTs,” in IEEE Transactions on Electron Devices, vol. 65, no. 1, pp. 45-50, Jan. 2018, doi: 10.1109/TED.2017.2770087
3. Romanczyk, B. et al. “mm-Wave N-polar GaN MISHEMT with a self-aligned recessed gate exhibiting record 4.2 W/mm at 94 GHz on Sapphire.”2016 74th Annual Device Research Conference (DRC), Jun. 2016, vol. 2016,pp. 1–2. doi: 10.1109/DRC.2016.7548464

KEYWORDS: GaN; Gallium Nitride; High Electron Mobility Transistor; HEMT; Nitrogen Polar; RF Switch

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N23A-T029 TITLE: Non-Intrusive Aerodynamic State Sensing for Hypersonic Flight Control

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

OBJECTIVE: We will develop the flow theory, measurement technology, and estimation algorithms to enable non-intrusive aerodynamic state sensing for hypersonic flight control. The flow theory will describe measurable flow phenomena and their correlation to a weapon's aerodynamic state. The measurement technology will sense the flow phenomena and produce correlated signals without devices that protrude into the flow around the weapon. The estimation algorithms will process the signal data to produce accurate and precise estimates of the weapon's aerodynamic state. Collectively, the flow theory, measurement technology and estimation algorithms will be the foundation of a non-intrusive air data system that can operate in sustained hypersonic flight conditions. The system will produce aerodynamic state estimates at a rate sufficient for flight control.

DESCRIPTION: Hypersonic flight conditions drive phenomena, e.g., chemical dissociation, material ablation, etc., that are generally not encountered in other flight regimes. Recent hypersonic flight experiments seek to understand phenomena such as boundary layer transition and its impact on heat transfer [Ref 1]. Ground-based hypersonic research has spurred successful investigations for non-intrusive flow measurement in a wind tunnel [Refs 2, 3]. Researchers have long recognized air data's critical importance to controlled hypersonic flight. Driven by the promise of hypersonic flight sustained by air breathing propulsion, researchers investigated air data systems needed for highly coupled flight and propulsion control systems [Ref 4]. Despite the lack of an air-breathing engine, successful hypersonic flights with the X-15 rocket plane provided useful information on air data challenges. Even a sensor with 1% accuracy is not sufficient for control under the extreme pressures and temperatures associated with hypersonic flight. Researchers investigated a broad array of technologies ranging from pressure transducers to gas fluorescence with laser excitation as they worked to solve the air data problem for hypersonic flight [Ref 5]. Thus far, researchers have not identified a single technology capable of producing sufficient accuracy, precision, and bandwidth across the entire flight envelope of a hypersonic weapon, especially for weapons that cover subsonic, supersonic, and hypersonic conditions in a single flight. This raises the importance of state estimation algorithms that will need to fuse data from varying sensors over a broad range of conditions and aerodynamic phenomena. As flow diagnostic science and technology advanced for hypersonic wind tunnel experiments, researchers began to investigate these approaches for flight experiments. Researchers investigated electron beam fluorescence as a tool for non-intrusive flow diagnostics of the boundary layer in a hypersonic vehicle [Ref 6]. Researchers have also proposed using Raleigh Lidar to measure upstream density in concert with electron beam fluorescence to measure density and temperature of gas species within the boundary layer [Ref 7]. Given the potential and historical significance of using surface pressure measurements to estimate a vehicle's aerodynamic state, researchers developed algorithms and an array of flush-mounted pressure sensors to estimate the aerodynamic state of an uncontrolled hypersonic flight experiment [Refs 8, 9]. A more recent flow visualization method that researchers have proven in the wind tunnel is Femtosecond Laser Electronic Excitation Tagging (FLEET), and they investigated FLEET as a measurement solution for a hypersonic air data system [Ref 10]. Researchers have demonstrated flow-imaging rates of 100 kHz using FLEET [Ref 11]. Given the extremely high speed of hypersonic vehicles, one might reasonable consider using only the inertial velocity vector to estimate the aerodynamic state. However, hypersonic vehicles go through large speed ranges as they accelerate to hypersonic speeds and decelerate while maneuvering. The difference between Earth-relative and Air-relative velocities can become non-trivial, and this large flight envelope ultimately requires hypersonic air data systems that also work below hypersonic speeds. Researchers addressed this challenge by investigating air data solutions built primarily on more complex algorithms rather than more complex sensors [Ref 12].

Continuing these scientific and technological developments, the objective is to develop the flow theory, measurement technology and estimation algorithms to enable non-intrusive aerodynamic state sensing for hypersonic flight control. Researchers have investigated and demonstrated numerous methods for hypersonic flow visualization in a wind tunnel, and they have made some headway towards translated these methods to flight vehicles. Successful performers will prototype a flight-representative, non-intrusive air data system with performance sufficient for flight control from subsonic through hypersonic conditions. Detailed modeling and analysis of the air data system, rigorous testing and model validation of subcomponents are critical first steps. Key system parameters and outputs are:

- Air data measurement accuracy & precision
- Air data measurement rate
- Air data measurement time delay
- Air speed
- Aerodynamic angles
- Air density and temperature
- Robustness to hypersonic conditions, e.g., ablation, temperature, plasma, shocks, etc.
- Robustness to weather and environmental conditions
- Measurement range from subsonic through hypersonic

Proposers must explicitly answer all of the Heilmeier questions to be considered for an award.

PHASE I: The performer will work with Government and Industrial partners to establish a range of flight conditions for aerodynamic state sensing. Once the flight envelope is established, the performer will focus on evaluating current air data technology as well as investigating potential new approaches. New approaches may be driven by recent advancements in measurement techniques for flow diagnostics, modelling techniques for flow/structure interaction, high temperature materials for sensors, or any other technology that can produce a signal with a reliable correlation to a vehicle's aerodynamic state.

The performer will deliver the theory, modelling, and analysis of an air data system that functions from subsonic to hypersonic flight conditions. The theory will include a detailed explanation of the working principles behind the system, from flow dynamics to sensor dynamics. Modelling will include first order dynamics of the vehicle flow and sensors as well as algorithms for estimating a vehicle's aerodynamic state. Analysis will include simulation results and predicted performance of the system based on the first order models. These deliverables will be in addition to the Navy's standard Phase I deliverables listed in a contract award. A milestone for continuing to Phase II will be conceptual design calculations indicating that the proposed solution meets the established performance criteria.

PHASE II: The performer will refine the theory of operation, increase model fidelity, and conduct higher order analysis to support the detailed air data system design. The performer will complete the engineering and detailed design for the concept developed in Phase I. Design details include physical and electrical interfaces, materials & devices, fabrication & assembly methods, signal conditioning electronics, embedded software, processors, power supply, cooling, etc. The analytical model developed in Phase I will be updated to include component models with sufficient complexity to predict the prototype system's performance. The detailed explanation of the working principles behind the system will be updated to include implementation considerations such as quantization, sensor noise, sampling delays, filter dynamics, data fusion, etc. The model will be used to justify component requirements and predict the prototype system's accuracy. The Phase II base scope will also produce a detailed test plan to validate both the system and the dynamic model. The test plan will cover everything from component level testing, ground testing, and flight testing. Ideally, flight testing would include hypersonic flight, but testing may be limited to supersonic flight. Test and validation for critical components will be included in the Phase II base period. Milestones required for the Phase II Option, if exercised, will be a detailed prototype design, validated test results for critical components, a detailed system model predicting

acceptable performance, and an approved test plan. The Phase II Option will continue with any necessary component testing and fabrication of the prototype air data system. The milestone required for any Subsequent Phase II funding will be successful ground testing to demonstrate agreement between predicted and measured sensor dynamics. Subsequent Phase II awards will complete the test plan through flight test.

PHASE III DUAL USE APPLICATIONS: Phase III will consist of four parts:
Phase IIIa will refine the prototype design to ensure compliance with production requirements for vibration, shock, electromagnet interference, security, electrical & mechanical interfaces, etc. Three serialized production representative air data systems will be produced in collaboration with an airframe manufacturer. Calibration data will be collected and archived for all of the systems. System Serial Number 0 (SN0) will be subjected to environmental testing necessary to qualify for flight.
Two milestones required for Phase IIIb funding are acceptable calibration data for all sensors and environmental test data to demonstrate that the production design meets requirements. Phase IIIb will integrate the system SN1 into a supersonic air vehicle in collaboration with an airframe manufacturer. System SN2 will be maintained as a spare. Flight test instrumentation will be installed to gather high rate sensor data as well as truth data from conventional sensors. A ground test plan will be developed, and ground testing will be conducted to ensure proper mechanical and electrical interfacing with the host vehicle as well as functionality of the air data system and flight-test instrumentation. The performer will develop a Flight Test Plan (FTP) for testing and evaluating the system. The FTP will include prescribed maneuvers, predicted responses, and pass/fail criteria for each test case. Highly dynamic maneuvers and variable atmospheric conditions will be included. Where possible, the FTP will include experiments to simulate phenomena present in hypersonic flight, e.g., ablative particulates, high temperatures, chemical dissociation, etc. The FTP will also specify equipment, team members and training requirements. A Flight Test Readiness Review (FTRR) will be conducted to get approval to execute the FTP.

The milestone required for Phase IIIc funding is a successful FTRR. Phase IIIc will execute flight tests following the FTP. The flight experiments should produce data suitable for documenting the air data system's accuracy and precision in an operational environment. The performer will assess the results and estimate the impact of hypersonic flight conditions on the system performance. The performer will draft a Flight Test Plan for conducting a hypersonic flight test of the air data system.

The two milestones required for Phase IIId funding will be successful supersonic flight experiments with simulated hypersonic flight phenomena and an approved FTP for a hypersonic flight test. Phase IIId will execute the hypersonic FTP. The FTP will include vehicle integration, flight test instrumentation, telemetry, ground testing, training, and execution of the flight experiment. The milestone for a successful Phase IIId will be hypersonic flight data demonstrating the efficacy of the air data system as a flight control sensor for precise, accurate, and high rate measurements of a hypersonic vehicle's aerodynamic state.

REFERENCES:

1. Leyva, I. "Introduction to the Special Section on the Boundary Layer Transition (BOLT) Flight Experiment". Journal of Spacecraft and Rockets. Vol. 58, No. 1, Jan – Feb 2021
2. Boutier, A. (Ed.). (2012). New trends in instrumentation for hypersonic research (Vol. 224). Springer Science & Business Media.
3. Brooks, J. M., Gupta, A. K., Smith, M., Marineau, E. C. "Development of Non-Intrusive Velocity Measurement Capabilities at AEDC Tunnel 9". AIAA 2014-1239. 52nd Aerospace Sciences Meeting. 13-17 January 2014. National Harbor, Maryland. https://doi.org/10.2514/6.2014-1239
4. Kang, B. H. Air data and surface pressure measurement for hypersonic vehicles. Master of Science Thesis, Massachusetts Institute of Technology, 1989

5. Hattis, Philip. “Hypersonic Vehicle Air Data Collection: Assessing the Relationship Between the Sensor and Guidance and Control System Requirements”. 1990 American Control Conference [ACC 1990], May 23, 1990 - May 25, 1990, San Diego, CA, United States
6. Cattolica, R., Schmitt, R., Palmer, R. “Feasibility of non-intrusive optical diagnostic measurements in hypersonic boundary layers for flight experiments”. AIAA 28th Aerospace Sciences Meeting. 1990, January, p. 627
7. Mohamed, A. K., Bonnet, J. “Advanced Concept for Air Data System using EBF and Lidar”. Flight Experiments for Hypersonic Vehicle Development, pp. 16-1 - 16-32. 2007. Educational Notes RTO-EN-AVT-130, Paper 16. Neuilly-sur-Seine, France. https://apps.dtic.mil/sti/citations/ADA476499
8. Bode, C., Eggers, T., Smart, M. “Numerical Generation of a Flush Air Data System for the Hypersonic Flight Experiment HIFiRE 7”. New Results in Numerical and Experimental Fluid Mechanics VIII. Notes on Numerical Fluid Mechanics and Multidisciplinary Design. Vol 121. Springer, Berlin, Heidelberg. 2010. https://doi.org/10.1007/978-3-642-35680-3_13
9. Razzaqi, S. A., Bode, C., Eggers, T., Smart, M. K. “Development of functional relationships for air-data estimation using numerical simulations”. 18th Australasian Fluid Mechanics Conference. Launceston, Australia. 3-7 December 2012.
10. DeLuca, N. J. “Femtosecond laser electronic excitation tagging (FLEET) for a hypersonic optical air data system”. M.S.E. Thesis, Princeton University, Department of Mechanical & Aerospace Engineering, June 2014.
11. DeLuca, N. J., Miles, R. B., Jiang, N., Kulatilaka, W. D., Patnaik, A. K., & Gord, J. R., “FLEET velocimetry for combustion and flow diagnostics”. Applied Optics, 56(31), 8632-8638. 2017.
12. Nebula, F., Ariola, M. “A Hypersonic Application of the Fully Sensor-Less Virtual Air Data Algorithm”. AIAA 2018-1350. 2018 AIAA Guidance, Navigation, and Control Conference. January 2018.

KEYWORDS: Hypersonic flight; flight control; air data; aerodynamic state estimation; conformal sensors; high temperature sensors; in situ hypersonic flow measurement

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DEPARTMENT OF THE AIR FORCE (DAF)
23.A SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) Phase I
PROPOSAL PREPARATION INSTRUCTIONS

The DAF intends these Phase I proposal submission instructions 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 23.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 23.A STTR BAA. Offerers are responsible for ensuring proposals comply with the requirements in the most current version of this instruction at the proposal submission deadline date/time.

The DAF recommends early submission, as computer traffic gets heavy near the proposal submission date/time and could slow down the system. **Do not wait until the last minute.** The DAF is not responsible for incomplete proposal submission due to system lag or inaccessibility. Please ensure contact information, i.e., names/phone numbers/email addresses, in the proposal is current and accurate. The DAF is not responsible for ensuring notifications are received by firms for which this information changes after proposal submission without proper notification. Changes of this nature shall be sent to the Air Force SBIR/STTR One Help Desk.

Please ensure all e-mail addresses listed in the proposal are current and accurate. The DAF 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 DAF. **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, "23.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 23.A STTR BAA.
- Air Force SBIR/STTR BAA Contracting Officers (CO):
    - Mr. Daniel Brewer, Daniel.Brewer.13@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 provide Government contracting assistance and guidance to small businesses, generally at no cost.

PHASE I PROPOSAL SUBMISSION

DoD 23.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 (DAF-1) for proposal dollar values, periods of performance, and technical volume content.

Limitations on Length of Proposal

The Phase I Technical Volume page limits 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.
- **Note:** Do not upload information such as Permanent Resident Cards (Green Cards), birth certificates, Social Security Numbers, or other PII to the DSIP system.

Phase I Work Plan Outline

NOTE: The DAF 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. To do so will necessitate a request for revision, if selected, and may delay contract award.

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, Special 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 special test equipment purchases must, in the CO's opinion, be advantageous to the Government and relate directly to the effort. These toolings or equipment should not be of a type that an offeror would otherwise possess in the normal course of business. These 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. Material costs may include the costs of such items as raw materials, parts, subassemblies, components, and manufacturing supplies.

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 and labor category, if possible. Direct labor hours, labor overhead and/or fringe benefits, and actual hourly rates for each individual are also necessary for the CO to determine whether these hours, fringe rates, and hourly rates are fair and reasonable.

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, Montech, 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 DAF 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) at https://www.sam.gov/, to be eligible for proposal acceptance. Follow instructions located in SAM to obtain a Commercial and Government Entity (CAGE) code and Unique Entity Identifier (UEI) 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.

Please note the FWA Training must 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 DAF will not be responsible for proposals not completely submitted prior to the deadline due to system inaccessibility unless advised by DoD. The DAF will not accept alternative means of submission outside of DSIP, and transmission of proposal materials by way of alternative means will not constitute successful submission on the applicant's part.

AIR FORCE PROPOSAL EVALUATIONS

The DAF will utilize the Phase I proposal evaluation criteria in the DoD 23.A STTR BAA with the factors in descending order of importance.

The DAF will utilize Phase II evaluation criteria in the DoD 23.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.

Automated feedback will be provided for Phase I proposals determined Not Selected. Additional feedback may be provided at the sole discretion of the DAF.
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IMPORTANT: Proposals submitted to the DAF 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 Officer Daniel Brewer, Daniel.Brewer.13@us.af.mil.

AIR FORCE SUBMISSION OF FINAL REPORTS

All final reports will be submitted to the awarding DAF 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

DAF 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 23.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: The DAF 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, including award of Cost-Reimbursement types of contracts. 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 DAF reserves the right to modify the Phase II submission requirements. Should the requirements change, all Phase I awardees will be notified. The DAF also reserves the right to change any administrative procedures at any time to improve management of the DAF STTR Program.

Air Force STTR 23.A Topic Index

Topic Number	Topic Title	Maximum Value	Maximum Duration (in months)	Technical Volume Page Limit
SF23A-T001	Integrated Navigation, Communication, and Authentication	$180,000	9	20
AF23A-T002	Hybrid biological systems/biomaterials for in-body sensing	$180,000	9	20
AF23A-T003	Smart Contact Lens Sensor Integrated with AI to Monitor Physiological Signals in Deployed Extreme Operational Stress Environments	$180,000	9	20

SF23A-T001 TITLE: Integrated Navigation, Communication, and Authentication

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

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

OBJECTIVE: Develop enabling technologies for providing high data rates and precise position, navigation, and timing services with high assurance and reduced hardware/software complexity by leveraging functional synergies of navigation and communication and their hardware/software similarities.

DESCRIPTION: With the growing demand for high communication rate and navigation accuracy, different approaches for integrating the navigation and communication system have been explored for next-generation navigation and communication applications. If successful, a prospective integrated design could provide improved utilization of the spectrum and orbit resources by sharing the spectrum for navigation and communication. Moreover, it would reduce hardware/software complexity and power consumption by sharing radio frequency (RF) front end and signal processing unit, which are common to both communication and navigation. Also relevant is that it would leverage functional synergies of communication and navigation to improve the positioning speed via higher communication rate and alleviate the signal synchronization burden via timing information. However, the key challenge is to meet different requirements, namely high data rate and precise and trustworthy positioning/timing, with a single signaling system. Most previous efforts have explored these requirements in isolation. Navigation and communication functions are implemented independently without deep integration, and the spectrum resources are used separately. Furthermore, the message authentication mechanisms for secure and trustworthy satellite navigation and communication are implemented in isolation. The isolated design inevitably results in a waste of radio resources, increased hardware/software complexity, and degradation of network performance. This topic solicitation seeks a proof of concept to meet all the communication, navigation, and authentication requirements in a single design framework. Signaling solutions that provide: i) high data rates with low transmission power, ii) trustworthy position, navigation, and timing services with reduced hardware/software complexity and power consumption, and iii) reduced spectrum usage, are desirable. Solutions that are backward compatible with the existing navigation system, i.e., providing navigation services with the existing navigation receiver without any modification, are of interest under this call. Signal designs that support various services for users with different data rates, are also of interest. Theoretical performance analysis is highly encouraged as it can provide important guidance and insight for optimum system design.

PHASE I: Identify and explore options for the integration of navigation, communication, and authentication, conduct trade analysis and simulations, define operating concepts, and provide justification for proposed solutions. Integrated solutions should offer potential advantages over state-of-the-art and demonstrate technical feasibility.

PHASE II: Develop prototype hardware and software and demonstrate a proof of concept for trustworthy navigation and communication services. Evaluate the data transmission rate, navigation accuracy, and

authentication error rate in the presence of spoofing attacks to support instantiations and deployments of the proposed concept.

PHASE III DUAL USE APPLICATIONS: Integrate with prospective follow-on transition partners to provide an improved operational capability to a broad range of potential Government and civilian applications such as non-dedicated positioning, navigation, and timing (PNT) services (e.g. through communications systems) as can be derived from the NASA-funded HelioSwarm flight experiment consisted of multi-satellite missions by flying a swarm of nine spacecraft (8 nodes, 1 hub) to make measurements at multiple scales simultaneously, in which a large hub is utilized for transport of the smallsat nodes to the mission orbit and data relay. Government organizations such as Air Force Research Laboratory and Space Systems Command could sponsor a government reference design for PNT over communications flight integration, in collaboration with small business and industry partners. Successful contractor technology demonstrations will inform the technical requirements of future acquisitions by Primes and subcontractors.

REFERENCES:

1. S. Han, Z. Gong, W. Meng, C. Li and X. Gu, "Future Alternative Positioning, Navigation, and Timing Techniques" A Survey, "IEEE Wireless Communications, vol. 23, no. 6, pp. 154-160, December 2016;
2. Zou, Deyue, and Shouchuan Ma. & "Satellite Navigation and Communication Integration Based on Correlation Domain Indefinite Pulse Position Modulation Signal. "Wireless Communications and Mobile Computing 2021;
3. X. Xu, L. Li, M. Zhao, and C. Fan, "A flexible design of waveform for communication and navigation, "IEEE Wireless Communications and Networking Conference (WCNC), 2018;
4. Zou, Deyue, and Shouchuan Ma. "Satellite Navigation and Communication Integration Based on Correlation Domain Indefinite Pulse Position Modulation Signal. "Wireless Communications and Mobile Computing 2021;
5. Yin, Lu, et al. "A novel positioning-communication integrated signal in wireless communication systems. "EEE Wireless Communications Letters, pp. 1353-1356, 2019;
6. Wang, Yu, et al. "Integrated Communication and navigation for ultra-dense LEO satellite networks: vision, challenges and solutions "arXiv preprint arXiv 2105.08985, 2021;
7. Zou, Deyue, Xinyue Li, and Ruofei Ma. "A signal optimization strategy for next-generation navigation and communication integration applications. "Physical Communication, 2022;
8. Wang, Lei, et al. "LEO-augmented GNSS based on communication navigation integrated signal. "Sensors 19.21, 2019;
9. Hein, Guenter W. "Status, perspectives and trends of satellite navigation. "Satellite Navigation 1.1, 2020

KEYWORDS: Communications; navigation; authentication; trustworthy position, navigation, and timing services; reduced hardware and software complexity; low power consumption; reduced spectrum usage

TPOC-1: Khanh Pham
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AF23A-T002 TITLE: Hybrid biological systems/biomaterials for in-body sensing

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

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

OBJECTIVE: The goal of this topic is the development of "soft" implantable, biocompatible and biodegradable sensors that can measure multiple biomarkers of interest continuously, and provide a signal that can be interrogated either with an external device or internally, as part of the implantable device itself.

DESCRIPTION: Implantable sensors are emerging as a promising means to perform a wide variety of diagnostic and therapeutic functions. In these types of applications, the hydrogel-based biocompatible polymer matrix containing photosensitized molecule probes must be properly designed to accurately measure biomarker levels under the skin. The most noticeable example of a flexible micro-sensor was reported by Profusa with Lumee, a tissue implantable device for monitoring the levels of oxygen in the surrounding tissues [1]. Applications of such implantable sensors include monitoring of peripheral artery disease, wound healing, and muscle performance. Recently, implanted sensors were reported for detecting the presence of oral cancers [2], as well as for battery-less recording of deep brain neuropotentials [3]. Research advances in tissue-injectable biopolymer matrix continue to develop for more advanced applications. For example, implantable temperature-sensitive sensors for infection biomarkers such as pH, carbon dioxide and viscosity of synovial fluid were recently developed for early detection of prosthetic joint infections [4]. Overall, with technological advances in biocompatible material development, implantable biosensors will have the potential to improve the management of patient health and quality of life, increasing survival rates while reducing health care costs. To respond to this topic, the performer should design implantable sensors with components that will assemble into soft materials able to interact transiently with analytes of interest and provide a readable signal that allows analytical quantification over time. Soft materials are defined here as made of biological components (proteins, peptides, nucleic acids and the like) in combination with biocompatible and biodegradable polymers that offer an optimal environment for sensing, with no electronics or other hardware required to be implanted. These materials will be in the micro- or nano-size scale in order to be implanted with no compatibility issues and/or major inflammatory reactions. The end deliverable will detect at least two biomarkers of military relevance when implanted in a model system (animal, tissue model, organ-on-chip platform) or in human subjects. The sensors will be active for at least 24 h without any user intervention or regeneration steps to maintain sensor function.

PHASE I: The performer should identify/design: i) biological components or systems that can interact with identified biomarkers and produce a readable signal to sense their physiological levels over time, and ii) biopolymers with properties allowing for implantation into soft body tissues. At the end of the Phase I effort, the performer should provide a detailed plan for building the sensor prototype, test it for selectivity, sensitivity and biodegradability and the models/platforms to be used for these tests. The performer should also provide a detailed assessment of the rationale for their design considering inflammatory response, biofluid access, reader function and biodegradability bioproducts toxicity.

PHASE II: Multiple biological sensing components or systems should be incorporated into the implantable biopolymer formulation allowing for detection of at least two biomarkers of interest. The performer should investigate cross-reactivity and sensitivity of incorporated sensing components and demonstrate that the implantable biosensor can be used for simultaneous and continuous monitoring of at least two biomarkers of interest. The performer should utilize existing or develop new technologies allowing for the sensor's signal interrogation either with an external device or internally, as part of the implantable device itself, with no electronics or other hardware required to be implanted. At the end of Phase II, the performer should demonstrate that the implantable sensor can be used for monitoring physiological level of at least two biomarkers of interest and produce signals that can be remotely detected and converted into biomarker quantifying units.

PHASE III DUAL USE APPLICATIONS: The performer should test the functionality of the implantable sensor using animal models, tissue models or organ-on-chip platforms. The performer may conduct human studies. At the end of Phase III, the performer should demonstrate that the developed sensing device can be implanted into soft body tissues and can be used for continuous monitoring of at least two biomarkers of interest. The implantable device should be active for at least 24 hours, biocompatible (e.g., without production of toxic or immunological response), and biodegradable over time. The performer should assess marker options for medical use in different areas (tissue regeneration, a self-contained theranostics system, wound healing, etc.) and sports medicine (tissue regeneration/injury recovery, etc.).

REFERENCES:

1. http://profusa.com/lumee/;
2. O.K. Hammouda and A.M.M. Allam, "Utilizing implanted antennas to detect the presence of oral cancers," Res. J. Eng. Scien., vol. 3, pp. 22-27, Jul. 2014.;
3. A. Kiourti, C. Lee, J. Chae, and J.L. Volakis, "A wireless fully-passive neural recording device for unobtrusive neuropotential monitoring," IEEE Trans. Biomed. Eng., vol. 63, pp. 131-137, Jan. 2016.;
4. Wijayaratna, U. N.; Kiridena, S. D.; Adams, J. D.; Behrend, C. J.; Anker, J. N. "Synovial Fluid PH Sensor for Early Detection of Prosthetic Hip Infections." Adv. Funct. Mater. 2021, 31 (37), 2104124. https://doi.org/10.1002/adfm.202104124.

KEYWORDS: implantable sensor; biomarkers; biodegradable; continuous sensing

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AF23A-T003 TITLE: Smart Contact Lens Sensor Integrated with AI to Monitor Physiological Signals in Deployed Extreme Operational Stress Environments

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

OBJECTIVE: The objective of this topic is to design contact lenses integrated with sensitive sensors to monitor physiological parameters as an innovative tool for the detection of stress biosignatures in body fluids in extreme operational environments (e.g., the arctic [i.e., extreme cold temperatures], heat, exposure to unknown contaminants, directed energy radiation, etc.).

DESCRIPTION: In recent years, contact lenses as flexible and wearable sensing devices have shown significant progress in identifying potential biomarkers related to human disease. However, there exists a giant leap in creating these contact lenses with sensor chips integrated with unique functionalities to accomplish non-invasive detection of physiological biosignatures. Recent technological advances in material science, microelectronics, artificial intelligence, and digital engineering have enabled contact lenses as promising sensing devices for non-invasive monitoring systems of human performance in stressful operational environments. Despite significant efforts, the use of smart contact lenses remains limited because of their mechanical biocompatibility, detection sensitivity, and challenging integration process. Many characteristics are required for the successful development of smart contact lenses. First, they must maintain a high degree of transparency within the visual field, including the electronic materials for the embedded sensors and circuitry. Second, smart lenses must be comfortable to wear daily without interrupting the wearer's routine mission in stressful environments. This generates several challenges relating to substrate mechanical stiffness, biocompatibility, lens shape, and surface irregularities that, if not controlled, could lead to eye inflammation and irritation. This challenge requires a multidisciplinary approach that leverage many technologies including biomaterials, microfluidics, biosensor circuits, energy supply, data transmission, and display. All these electronic components must be sandwiched within the lens substrate to prevent harming the eye surface, but it also obstructs direct contact with the tear fluid. A potential solution in this case is to use microfluidic channels for tear sampling and transport. Similarly, it is necessary to use flexible and biologically stable electrode materials to display relevant information on smart lenses with wireless communication capabilities and stable power supply. The proposed topic on wearable contact lenses integrated with biosensors can provide real-time noninvasive monitoring of physiological parameters and increase combat effectiveness in Airmen without interrupting or limiting the wearer's motions. The biosensor components as well as the contact lens should be made of a transparent, opaque, flexible, and biocompatible material to be placed around the healthy pupil without obstructing the field of vision. The proposed contact lens designs must overcome the limitations of current contact lens sensors by continuously monitoring multiple analytes, such as the stress biosignatures cortisol and dehydroepiandrosterone (DHEA), without obstructing the user's field of vision.

PHASE I: A transparent sensor platform will be designed and fabricated to detect a panel of biomarkers (e.g., oxygen, glucose, cortisol, lactate, urea, etc.). Sensor components and their connections must be protected from mechanical deformations due to the soft and stretchable nature of the contact lens. The success for the first phase of this project would be to provide a proof-of-concept for the proposed prototype, demonstrating its multi-functional sensing ability with wireless and battery-free operation. The key deliverables are proof of concept data, specific detection of stress biosignatures, and an initial proof of concept prototype. The final report consisting of a detailed description is required to determine if the result of Phase I feasibility technology is currently at an acceptable stage.

PHASE II: The work completed in Phase II should demonstrate the successful operation of a contact lens prototype with integrated sensor components wireless communication capabilities. The biocompatibility data should be conducted using in vitro or in vivo models to demonstrate the safety of the contact lens

without producing toxicity. The smart lens must be comfortable to wear on daily basis without interrupting the routine mission. The contact lens substrate, mechanical stiffness, lens shape, and surface irregularities should be considered very carefully to not produce any inflammation or irritation to the human eye. The deliverable is the functional smart contact lens sensor with a wireless communication capability to transmit information collected from contact lenses to a receiver for analysis.

PHASE III DUAL USE APPLICATIONS: Phase III should demonstrate dual use primarily for military applications in the field. A wearable contact lens integrated with biosensors must provide real-time noninvasive monitoring of physiological parameters (e.g., cortisol, DHEA, oxygen, glucose, lactate, etc.) and increase combat effectiveness in Airmen without interrupting or limiting the wearer's motions or obstructing their vision. The second application is for commercialization to use to detect key biomarkers for diagnostic and clinical purposes.

REFERENCES:

1. 1. S. Lee, I. Jo, S. Kang, B. Jang, J. Moon, J. B. Park, S. Lee, S. Rho, Y. Kim, B. H. Hong, ACS Nano 2017, 11, 5318.;
2. G. Z. Chen, I. S. Chan, L. K. Leung, D. C. Lam, Med. Eng. Phys 2014, 36, 1134.;
3. M. Falk, V. Andoralov, M. Silow, M. D. Toscano, S. Shleev, Anal. Chem. 2013, 85, 6342.;
4. C. Jordan, Building An Electrochemical Contact Lens Biosensor, https://commons.pacificu.edu/work/4c43dcb4-a05a-42a9-ab10-458b6b338467 2016;
5. Olgun, C.-C. Chen, J. L. Volakis, IEEE Antennas Wirel. Propag. Lett. 2011, 10, 262.;
6. Banbury, Linda K. Stress Biomarkers in the Tear Film https://researchportal.scu.edu.au/discovery/delivery/61SCU_INST:ResearchRepository/12671654 60002368?l#1367455280002368

KEYWORDS: Contact lens; Stress biomarkers; Biosensors

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23.A DEFENSE LOGISTICS AGENCY (DLA)
SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAM
Proposal Submission Instructions

INTRODUCTION

The Defense Logistics Agency's (DLA) mission has three lines of effort the DLA Small Business Innovation Program (SBIP) supports. They include supporting the **NUCLEAR ENTERPRISE** by maintaining nuclear systems readiness, qualifying alternate sources of supply, improving the quality of consumable parts, and increasing materiel availability. **FORCE READINESS & LETHALITY** through Improvements to life cycle performance through technological advancement, innovation, and reengineering, mitigate single points-of-failure that threaten the readiness of weapons systems used by our Warfighters. **SUPPLY CHAIN INNOVATION & ASSURANCE** through improved lead times, reduced lifecycle costs, maintaining a secure and resilient supply chain, providing opportunities for the small business industrial base to enhance supply chain operations with technological innovations. Lastly supply chain assurance securing the microelectronics supply chain, development of a domestic supply chain for rare earth elements, the adoptions of industrial base best practices associated with counterfeit risk reduction.

Proposers responding to a topic in this BAA must follow all general instructions provided in the Department of Defense (DoD) STTR Program BAA. DLA 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 DLA Program and these proposal preparation instructions should be directed to:

Defense Logistics Agency
Small Business Innovation Program (SBIP) Office DLA/J68
Email: DLASBIR2@DLA.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. https://www.dodsbirsttr.mil/submissions/login

Technical Volume (Volume 2)

DLA's objective for the Phase I effort is to determine the merit and technical feasibility of the concept. The technical volume is not to exceed twenty pages and must follow the formatting requirements provided in the DoD STTR Program BAA. Any pages submitted beyond the 20-page limit within the Technical Volume (Volume 2) will not be evaluated. If including a letter(s) of support, they should be included in Volume 5, and they will not count towards the 20-page Volume limit. Any technical data/information that should be in the Volume 2 but is contained in other Volumes will not be considered.

Content of the Technical Volume

Refer to the instructions provided in the DoD Program BAA.

Cost Volume (Volume 3)
A list of topics currently eligible for proposal submission is included in these instructions, followed by full topic descriptions. These are the only topics for which proposals will be accepted at this time. Refer to the topic for cost and duration structure. Proposers must utilize the excel cost volume provided during proposal submission on DSIP.

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required 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. More detailed Instructions are contained the DoD BAA Section 5.3. Phase I proposal Instructions section e. Volume 4.

Supporting Documents (Volume 5)
- Contractor Certification Regarding Provision of Prohibited Video Surveillance and Telecommunications Services and Equipment (required),
- Foreign Ownership or Control Disclosure (Proposers must review Attachment 2 in the DoD STTR BAA: Foreign Ownership or Control Disclosure to determine applicability),
- Additional Cost information (optional),
- Letters of Support (optional),
- Any other supporting documents (optional),
- A qualified letter of support is from a relevant commercial or Government Agency procuring organization(s) working with DLA, articulating their pull for the technology (i.e., what DLA need(s) the technology supports and why it is important to fund it), and

possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program.
    - Letters of support shall not be contingent upon award of a subcontract.

The standard formal deliverables for a Phase I are the:

- Plan of Action and Milestones (POAM) with sufficient detail for monthly project tracking.
- Initial Project Summary: one-page, unclassified, non-sensitive, and non-proprietary summation of the project problem statement and intended benefits (must be suitable for public viewing).
- Monthly Status Report. A format will be provided at the PAC.
- The TPOC and PM will determine a meeting schedule at the PAC. Phase I awardees can expect Monthly (or more frequent) Project Reviews.
- Draft Final Report including major accomplishments, business case analysis, commercialization strategy, transition plan with timeline, and proposed path forward for Phase II.
- Final Report including major accomplishments, business case analysis, commercialization strategy and transition plan with timeline, and proposed path forward for Phase II.
- Final Project Summary (one-page, unclassified, non-sensitive and non-proprietary summation of project results, high resolution photos or graphics intended for public viewing)
- Applicable Patent documentation
- Other Deliverables as defined in the Phase I Proposal
- Phase II Proposal is optional at the Phase I Awardee's discretion (as Applicable)

PHASE II PROPOSAL GUIDELINES

Per SBA SBIR/STTR Phase II Proposal guidance, **all** Phase I awardees are permitted to submit a Phase II proposal for evaluation and potential award selection, without formal invitation. Details on the due date, format, content, and submission requirements of the Phase II proposal will be provided by the DLA SBIP PMO on/around the midway point of the Phase I period of performance. Only firms who receive a Phase I award may submit a Phase II proposal.

DLA will evaluate and select Phase II proposals using the same criteria as Phase I evaluation. Funding decisions are based upon the results of work performed under a Phase I award, the Scientific & Technical Merit, Feasibility, and Commercial Potential of the Phase II proposal; Phase I final reports may be reviewed as part of the Phase II evaluation process. The Phase II proposal should include a concise summary of the Phase I effort including the specific technical problem or opportunity addressed and its importance, the objective of the Phase I effort, the type of research conducted, findings or results of this research, and technical feasibility of the proposed technology.

Due to limited funding, DLA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

Phase II Proposals should anticipate a combination of any or all the following deliverables:

- Plan of Action and Milestones (POAM) with sufficient detail for monthly project tracking
- Initial Project Summary: one-page, unclassified, non-sensitive, and non-proprietary summation of the project problem statement and intended benefits (must be suitable for public viewing)
- Monthly Status Report. A format will be provided at the PAC.
- Meeting schedule to be determined by the Technical Point of Contact (TPOC) and PM at the PAC
- Phase II awardees expect Monthly (minimum) Project Reviews (format provided at the PAC)

- Draft Final Report including major accomplishments, commercialization strategy and transition plan and timeline.
- Final Report including major accomplishments, commercialization strategy, transition plan, and timeline.
- Final Project Summary (one-page, unclassified, non-sensitive and non-proprietary summation of project results, non-proprietary high-resolution photos, or graphics intended for public viewing)
- Applicable Patent documentation.
- Other Deliverables as defined in the Phase II Proposal.

TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The DLA SBIR Program does not participate in the Technical and Business Assistance (formally the Discretionary Technical Assistance Program). Contractors should not submit proposals that include Technical and Business Assistance.

EVALUATION AND SELECTION

Use of Support Contractors in the Evaluation Process

Only Government personnel with active non-disclosure agreements will officially evaluate proposals.

Non-Government technical consultants (consultants) to the Government may review and provide support in proposal evaluations during source selection.

Consultants may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. Consultants will not establish final assessments of risk and will not rate or rank offerors' proposals. They are also expressly prohibited from competing for DLA SBIR/STTR awards in the SBIR/STTR topics they review and/or on which they provide comments to the Government.

All consultants are required to comply with procurement integrity laws. Consultants will not have access to proposals or pages of proposals that are properly labeled by the offerors as "FEDONLY." Pursuant to FAR 9.505-4, DLA contracts with these organizations include a clause which requires them to

(1) Protect the offerors' information from unauthorized use or disclosure for as long as it remains proprietary and

(2) Refrain from using the information for any purpose other than that for which it was furnished. In addition, DLA requires the employees of those support contractors that provide technical analysis to the SBIR/STTR Program to execute non-disclosure agreements. These agreements will remain on file with the DLA SBIP PMO.

Non-Government consultants will be authorized access to only those portions of the proposal data and discussions that are necessary to enable them to perform their respective duties. In accomplishing their duties related to the source selection process, employees of the organizations may require access to proprietary information contained in the offerors' proposals.

All proposals will be evaluated in accordance with the evaluation criteria listed in the DoD STTR Program BAA. DLA will evaluate and select Phase I and Phase II proposals using scientific review criteria based upon technical merit and other criteria as discussed in this Announcement document.

- DLA reserves the right to award none, one, or more than one contract under any topic.
- DLA is not responsible for any money expended by the offeror before award of any contract.
- Due to limited funding, DLA reserves the right to limit awards under any topic
- Only proposals considered to be "Highly Acceptable" as determined by DLA will be funded.

Phase I proposals will be evaluated based on the criteria outlined below, including potential benefit to the DLA. 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 its commercialization.

Please note that potential benefit to the DLA will be considered throughout all the evaluation criteria and in the best value trade-off analysis. When combined, the stated evaluation criteria are significantly more important than cost or price.

It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Technical reviewers will base their conclusions only on information contained in the proposal. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be listed in the proposal and will count toward the applicable page limit.

The SBIP PMO will distribute selection and non-selection email notices to all firms who submit a SBIR/STTR proposal to DLA. The email will be distributed to the "Corporate Official" and "Principal Investigator" listed on the proposal coversheet. DLA cannot be responsible for notification to a company that provides incorrect information or changes such information after proposal submission. DLA will distribute the selection and non-selection notifications to all offerors within 90 days of the BAA close date.

DLA will provide written feedback to unsuccessful offerors regarding their proposals on the non-selection notification. Only firms that receive a non-selection notification are eligible for written feedback.

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: DCSO Small Business Innovation Program SBIP.DCSO@dla.mil. This is the DLA Contracting Team workflow email address.

AWARD AND CONTRACT INFORMATION

Typically, the contract period of performance for Phase I should be up to twelve (12) months and the award should not exceed $100,000. However, each topic may have a different threshold. The DLA Contracting Office utilizes a Firm Fixed Price (FFP) Contract for DLA Phase I Projects

The expected budget for Phase II should not exceed $1M unless approved by the DLA Program Manager,

and the duration should not exceed 24 Months. Proposals in excess of $1M will not be considered without written PM approval. The DLA Contracting Office utilizes a Firm Fixed Price Level of Effort (FFP/LOE) Contract for DLA Phase II Projects.

Proposals not conforming to the terms of this Announcement will not be considered. DLA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality as determined by DLA will be funded.

DLA reserves the right to withdraw from negotiations at any time prior to contract award.

Post Award, DLA may terminate any award at any time for any reason to include matters of national security (foreign persons, foreign influence or ownership, inability to clear the firm or personnel for security clearances, or other related issues).

Please read the entire DoD Announcement and DLA instructions carefully prior to submitting your proposal. Please go to https://www.sbir.gov/about/about-sbir#sbir-policy-directive to read the SBIR/STTR Policy Directive issued by the Small Business Administration.

USE OF FOREIGN NATIONALS (also known as Foreign Persons), GREEN CARD HOLDERS AND DUAL CITIZENS

If proposing to use foreign nationals (also known as foreign persons), they must be green card holders, and/or dual citizens. (DLA will not approve any Student or Temporary Visa holders). The offeror must identify the personnel they expect to be involved on this project, the type of visa or work permit under which they are performing, country of origin and level of involvement.

You will be asked to provide additional information during negotiations 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)).

Proposals submitted to export control-restricted topics and/or those with foreign nationals, dual citizens, or green card holders listed will be subject to security review during the contract negotiation process (if selected for award).

DLA reserves the right to vet all uncleared individuals involved in the project, regardless of citizenship, who will have access to Controlled Unclassified Information (CUI) such as export controlled information. If the security review disqualifies a person from participating in the proposed work, the contractor may propose a suitable replacement.

In the event a proposed person and/or firm is found ineligible by the government to perform proposed work, the contracting officer will advise the offeror of any disqualifications but is not required to disclose the underlying rationale.

V. EXPORT CONTROL RESTRICTIONS

The technology within most DLA topics is restricted under export control regulations including the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR). ITAR controls the export and import of listed defense-related material, technical data and services that provide the United States with a critical military advantage. EAR controls military, dual-use and commercial items not listed on the United States Munitions List or any other export control lists. EAR regulates export-controlled items based on user, country, and purpose. The offeror must ensure that their firm complies with all applicable export control regulations. Please refer to the following URLs for

additional information: https://www.pmddtc.state.gov/ and https://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear.

Most DLA SBIR/STTR topics are subject to ITAR and/or EAR. If the topic write-up indicates that the topic is subject to International Traffic in Arms Regulation (ITAR) and/or Export Administration Regulation (EAR), your company may be required to submit a Technology Control Plan (TCP) during the contracting negotiation process.

CLAUSE H-08 PUBLIC RELEASE OF INFORMATION (Publication Approval)
Clause H-08 pertaining to the public release of information is incorporated into all DLA STTR contracts and subcontracts without exception. Any information relative to the work performed by the contractor under DLA STTR contracts must be submitted to DLA for review and approval prior to its release to the public. This mandatory clause also includes the subcontractor who shall provide their submission through the prime contractor for DLA's review for approval.

FLOW-DOWN OF CLAUSES TO SUBCONTRACTORS
The clauses to which the prime contractor and subcontractors are required to comply include but are not limited to the following clauses:

1) DLA clause H-08 (Public Release of Information),
2) DFARS 252.204-7000 (Disclosure of Information),
3) DFARS clause 252.204-7012 (Safeguarding Covered Defense Information and Cyber Incident Reporting), and
4) DFARS clause 252.204-7020 (NIST SP 800-171 DoD Assessment Requirements). Your proposal submission confirms that any proposed subcontract is in accordance with the clauses cited above and any other clauses identified by DLA in any resulting contract.
5) DFARS Clause 252.223-7999 Ensuring Adequate COVID-19 Safety Protocols for Federal Contractors

OWNERSHIP ELIGIBILITY
Prior to award, DLA may request business/corporate documentation to assess ownership eligibility as related to the requirements of STTR Program Eligibility. These documents include, but may not be limited to, the Business License; Articles of Incorporation or Organization; By-Laws/Operating Agreement; Stock Certificates (Voting Stock); Board Meeting Minutes for the previous year; and a list of all board members and officers.

If requested by DLA, the contractor shall provide all necessary documentation for evaluation prior to STTR award. Failure to submit the requested documentation in a timely manner as indicated by DLA may result in the offeror's ineligibility for further consideration for award.

ADDITIONAL INFORMATION

Classified Proposals
Classified proposals **ARE NOT** accepted under the DLA SBIR/STTR Program. The inclusion of classified data in an unclassified proposal is grounds for the Agency to determine the proposal as non-responsive and the proposal not to be evaluated.

Contractors currently working under a classified contract must use the security classification guidance provided under that contract to verify new SBIR/STTR proposals are unclassified prior to submission.

Phase I contracts are not typically awarded for classified work. However, in some instances, work being performed on DLA SBIR/STTR contracts will require security clearances. If a DLA SBIR/STTR contract develops into or identifies classified work, the offeror must have a facility clearance, appropriate personnel clearances to perform the classified work and coordinate the DD254 with the Contract Officer and the service owning the classified data.

For more information on facility and personnel clearance procedures and requirements, please visit the Defense Counterintelligence and Security Agency Web site at: https://www.dcsa.mil.

Use of Acronyms
Acronyms should be spelled out the first time they are used within the technical volume (Volume 2), the technical abstract, and the anticipated benefits/potential commercial applications of the research or development sections. This will help avoid confusion when proposals are evaluated by technical reviewers.

Communication
All communication from the DLA SBIR/STTR PMO will originate from the DLASBIR2@DLA.mil email address. Please white list this address in your company's spam filters to ensure timely receipt of communications from our office.

All attachments sent via email require encryption. The firm will have to purchase ECA certificates to send and receive encrypted email if they do not have a CAC or PIV issued. The cost is approximately $100 per year per user. This will be a CMMC requirement for all future contracts.

ORGANIZATIONAL CONFLICTS OF INTEREST (OCI)

The basic OCI rules for Contractors which support development and oversight of SBIR/STTR topics are covered in FAR 9.5 as follows (the Offeror is responsible for compliance):

(1) the Contractor's objectivity and judgment are not biased because of its present or planned interests which relate to work under this contract.

(2) the Contractor does not obtain unfair competitive advantage by virtue of its access to non-public information regarding the Government's program plans and actual or anticipated resources; and

(3) the Contractor does not obtain unfair competitive advantage by virtue of its access to proprietary information belonging to others.

All applicable rules under the FAR Section 9.5 apply.

If you, or another employee in your company, developed or assisted in the development of any SBIR/STTR requirement or topic, please be advised that your company may have an OCI. Your company could be precluded from an award under this BAA if your proposal contains anything directly relating to the development of the requirement or topic. Before submitting your proposal, please examine any potential OCI issues that may exist with your company to include subcontractors and understand that if any exist, your company may be required to submit an acceptable OCI mitigation plan prior to award.

PHASE III GUIDELINES & INSTRUCTIONS

Phase III is any proposal that "Derives From", "Extends" or completes a transition from a Phase I or II project. Phase III proposals will be accepted after the completion of Phase I and or Phase II projects.

There is no specific funding associated with Phase III, except Phase III is not allowed to use SBIR/STTR coded funding. Any other type of funding is allowed.

Phase III proposal Submission. Phase III proposals are emailed directly to DLASBIR2@dla.mil. The PMO team will set up evaluations and coordinate the funding and contracting actions depending on the outcome of the evaluations. A Phase III proposal should follow the same format as Phase II for the content, and format. There are, however, no limitations to the amount of funding requested, or the period of performance. All other guidelines apply. More specific Instructions may be available when a firm submits a Phase III proposal.

DLA STTR 23.A Topic Index

DLA23A-003 TITLE: Innovation in High Temperature Resistant Thermal Protection System (TPS) Materials, Manufacturing, and Resilient Supply Chains for Hypersonics TPS and Related Defense Applications

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

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

OBJECTIVE: High temperature resistant Thermal Protection System (TPS) materials and structures, including their means of supply, are critical to the success of new hypersonic weapons and related U.S. defense modernization priorities. Key to their success is increased domestic production capacity, affordability, and supply chain resiliency. Hypersonics TPS applications of particular interest include boost glide vehicle acerage, leading edge, nosetip, and control surfaces as well as similar materials and supply chains of importance to the production rocket motors and other re-entry systems. Supply chain resisancy concerns include foreign reliance, single point of failure supply, obsolesence, long-lead times, and low manufacturing yields).

The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies of related materials consistently to our Department of Defense (DoD) customers and other DoD stakeholders. DLA continually investigates diverse technologies for new or improved materials, more efficient means of their production, and more competitive domestic supply chains which would lead to the higher levels of innovation in current and future weapon systems combined with benefits to other commercial and government technology applications.

Advanced technology demonstrations for increasing production capacity, affordability and supply chain resiliency for high temperature resistant TPS and related materials and processing are of high interest to DoD. These areas of materials and manufacturing technologies provide potential opportunities toward achieving breakthrough advances for national defense. Proposed efforts funded under this topic may encompass diverse TPS materials and processing at any level that will result in increasing production capacity, affordablity, and supply chain resiliency.

Research and Development (R&D) efforts selected under this topic shall demonstrate and involve a degree of risk where the technical feasibility of the proposed work has not been fully established. Further, proposed efforts must be judged to be at a Technology and/or Manufacturing Readiness Level (TRL/MRL) 6 or less, but greater than TRL/MRL 3 to receive funding consideration.
TRL 3. (Analytical and Experimental Critical Function and/or Characteristic Proof of Concept)
TRL 6. (System/Subsystem Model or Prototype Demonstration in a Relevant Environment)

DESCRIPTION: DLA R&D is looking for domestic capabilities and capacity that demonstrates new or improved high temperature resistant TPS materials, processing, and supply chains that increase domestic defense industrial base production capacity, affordability, and supply chain resiliency for hypersonic systems and other defense programs that depend on similar materials (e.g., other conventional weapons, strategic programs, and space systems).

R&D tasks include identifying, developing, and demonstrating new and/or improved high temperature resistant TPS materials and production processes that support this topic area's objecitives for increasing production capacity, affordablity, and supply chain resilieancy. Related areas of interest include materials, processing and fabrication of TPS components and structures as well as their various consitutent materials and processes (e.g., fiber reinforcements and their precursors, woven textiles and complex preforms, matrix precursors and prepreg, rapid densificiation, heat treating, additive manufacturing, production automation of weaving and prepreg application, and oxidation resistant coatings).

PHASE I: PHASE I: Not to exceed a duration of 6 months and cost of $100,000.
Determine, insofar as possible, the scientific, technical, and commercial feasibility of the TPS concept. Include a plan to demonstrate the innovative TPS materials process and/or discrete TPS parts or structures manufacturing and address implementation approaches for near term insertion into the manufacturing of relavant DoD hypersonic systems and/or related subsystems, components, parts, or related material supply chains. Collboration with a qualifying Research Institution (RI) is required for Small Business Technology Transfer (STTR) projects. Collboartion with a relavant DoD Component organzation (e.g., DoD lab and/or defense system program office) and one or more relavant DoD weapon system supply chain participants or other suitable organization is highly desirable.

PHASE II: Not to exceed a duration of 24 months and cost of $1,000,000.
The expectation is to develop a solution to the System/Subsystem Model or Prototype Demonstration in a Relevant Environment level, (TRL 6).

Validate the feasibility of the innovative process by demonstrating its use in the production, testing, and integration of items, and/or materials and processes, for DLA and key DoD stakeholders. Validation would include, but is not be limited to, prototype quantities, data analysis, laboratory tests, system simulations, operation in test-beds, or operation in a demonstration system. A partnership with a current or potential supplier to DoD or other suitable partner is highly desirable. Identify commercial benefit or application opportunities of the innovation. Innovative processes should be developed with the intent to readily transition to production in support of DoD and its supply chains

PHASE III DUAL USE APPLICATIONS: TPS technology transition via successful demonstration of a new material, processing or fabriaction technology. This demonstration should show near-term TPS application to one or more DoD systems, subsystems, components, or their related material supply chains. This demonstration should also verify the potential for enhancement of increased TPS producton capacity, affordablity, and supply chain resilancy.

Private Sector Commercial Potential: TPS materials and manufacturing improvements, including development of domestic manufacturing capabilities, increased capacity, and affordability, have a direct applicability to diverse defense system technologies. Material manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, space, and related defense technologies. Competitive material manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Advancements in high temperature resistant materials, processing, and supply chain resiliency will benefit the defense industrial base and key weapon systement development, production, and sustainablity, as well as afford spin-off opportunities to civilian and other commercial sectors that depend on associated technogies and their innovatoins.

REFERENCES:

1. Affordable Hypersonic Missiles for Long-Range Precision Strike
https://www.jhuapl.edu/content/techdigest/pdf/V20-N03/20-03-White.pdf

2. Increasing Production Is Important for Hypersonics, Defense Official Says: https://www.defense.gov/News/News-Stories/Article/Article/2927403/increasing-production-is-important-for-hypersonics-defense-official-says/

KEYWORDS: Hypersonics, Thermal Protection Systems (TPS), aeroshell, leading edge, control surfaces, nose tips, high temperature resistant materials (e.g., carbon/carbon, ceramics, ablative phenolics, composites, metals and alloys); materials and processing (e.g., fiber reinforcement, matrix precursors, woven textiles and preforms, prepreg, rapid densificiation, heat treating, additive manufacturing, manufacturing automation, and oxidation resistant coatings); and structures fabrication.

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