# DEPARTMENT OF DEFENSE
# SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
# SBIR 20.2 Program Broad Agency Announcement (BAA)

**May 6, 2020:** DoD BAA issued for pre-release
**June 3, 2020:** DoD begins accepting proposals
**July 2, 2020:** Deadline for receipt of proposals no later than **12:00 p.m. ET**

Participating DoD Components:

- Department of the Army
- Department of the Navy
- Chemical and Biological Defense (CBD)
- Defense Health Agency (DHA)
- Defense Logistics Agency (DLA)
- Defense Threat Reduction Agency (DTRA)
- Missile Defense Agency (MDA)
- Office of the Secretary of Defense (OSD)
- Strategic Capabilities Office (SCO)
- United States Special Operations Command (USSOCOM)

**IMPORTANT**

**Deadline for Receipt:** Proposals must be **completely** submitted no later than **12:00 p.m.** ET, July 2, 2020. Proposals submitted after 12:00 p.m. will not be evaluated.

**Classified proposals will not be accepted under the DoD SBIR 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. The DSIP is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposers submitting through this site for the first time will be asked to register. It is recommended that firms register at https://www.dodsbirsttr.mil/submissions as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process.

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

**SBIR/STTR Updates and Notices:** To be notified of SBIR/STTR opportunities and to receive e-mail updates on the DoD SBIR and STTR Programs, you are invited to subscribe to our Listserv by emailing DoDSBIRSupport@reisystems.com.

**Help Desk:** If you have questions about the Defense Department's SBIR or STTR Programs, please call the DoD SBIR/STTR Help Desk at 1-703-214-1333, or email to DoDSBIRSupport@reisystems.com.

# Table of Contents

# 1.0 INTRODUCTION

The Army, Navy, CBD, DHA, DLA, DTRA, MDA, SCO, and USSOCOM, hereafter referred to as DoD Components, invite small business firms to submit proposals under this BAA for the Small Business Innovation Research (SBIR) Program. Firms with the capability to conduct research and development (R&D) in any of the defense-related topic areas described in Section 12.0 and to commercialize the results of that R&D are encouraged to participate.

**This BAA is for Phase I proposals only** unless the Component is participating in the **Direct to Phase II Program**. Army, Navy, DLA, OSD, SCO, and USSOCOM are offering Direct to Phase II topics for the SBIR 20.2 BAA – see the Component-specific instructions for more information.

A separate BAA will not be issued requesting Phase II proposals, and unsolicited proposals will not be accepted. All firms that receive a Phase I award originating from this BAA will be eligible to participate in 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 firm submits their Phase II proposal prior to the dates provided by the individual Components, it may be rejected without evaluation.

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

# 2.0 PROGRAM DESCRIPTION

## 2.1 Objectives

The objectives of the DoD SBIR 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.

## RT&L Technology Focus Area Definitions

| Focus Area | Description |
|---|---|
| **5G** | Technologies enabling the 5G spectrum to increase speed over current networks, to be more resilient and less susceptible to attacks, and to improve military communication and situational awareness. |
| **Artificial Intelligence (AI)/ Machine Learning (ML)** | Systems that perceive, learn, decide, and act on their own. Machine-learning systems with the ability to explain their rationale, characterize their strengths and weaknesses, and convey understanding of how they will behave in the future. |
| **Autonomy** | Technology that can deliver value by mitigating operational challenges such as: rapid decision making; high heterogeneity and/or volume of data; intermittent communications; high complexity of coordinated action; danger to mission; and high persistence and endurance. |
| **Biotechnology** | Biotechnology is any technological application that harnesses cellular and biomolecular processes. Most current biotech research focuses on agent detection, vaccines, and treatment. Future advances in biotechnology will improve the protection of both the general public and military personnel from biological agents, among numerous other potential applications. |

| | |
|---|---|
| **Cybersecurity** | Prevention of damage to, protection of, and restoration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communications, including information contained therein, to ensure its availability, integrity, authentication, confidentiality, and nonrepudiation. |
| **Directed Energy (DE)** | Technologies related to production of a beam of concentrated electromagnetic energy, atomic, or subatomic particles. |
| **Hypersonics** | Innovative concepts or technologies that enable, or directly support, weapons or aircraft that fly at or near hypersonic speeds and/or innovation that allows for enhancing defensive capability against such systems. |
| **Microelectronics** | Critical microcircuits used in covered systems, custom-designed, custom-manufactured, or tailored for specific military application, system, or environment. |
| **Networked Command, Control, and Communications (C3)** | Fully networked command control and communications including: command and control (C2) interfaces, architectures, and techniques (e.g., common software interfaces and functional architectures and improved C2 processing/decision making techniques); communications terminals (e.g, software-defined radio (SDRs)/apertures with multiple networks on the same band and multi-functional systems); and apertures and networking technologies (e.g., leveraging/managing a diverse set of links across multiple band and software defined networking/ network slicing). |
| **Nuclear** | Technologies supporting the nuclear triad-including nuclear command, control, and communications, and supporting infrastructure. Modernization of the nuclear force includes developing options to counter competitors' coercive strategies, predicated on the threatened use of nuclear or strategic non-nuclear attacks. |
| **Quantum Science** | Technologies related to matter and energy on the atomic and subatomic level. Areas of interest: clocks and sensors; networks; computing enabling technologies (e.g., low temperature amplifiers, cryogenics, superconducting circuits, photon detectors); communications (i.e., sending/receiving individual photons); and manufacturing improvements. |
| **Space** | Technologies supporting space, or applied to a space environment. |
| **General Warfighting Requirements (GWR)** | Warfighting requirements not meeting the descriptions above; may be categorized into Reliance 21 areas of interest. |

The DoD SBIR Program follows the policies and practices of the Small Business Administration (SBA) SBIR Policy Directive updated on May 2, 2019. 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 Policy Directive is available at: https://www.sbir.gov/sites/default/files/SBIR-STTR_Policy_Directive_2019.pdf.

## 2.2 Three Phase Program

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

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

Under Phase III, the Proposer is required to obtain funding from either the private sector, a non-SBIR 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. SBIR Phase III refers to work that derives from, extends, or completes an effort made under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Phase III work is typically oriented towards commercialization of SBIR 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:

### 3.1 Performance Benchmarks for Progress toward Commercialization

In accordance with the SBA SBIR-STTR Policy Directive Sec 6(a)(7), DoD established a threshold for the application of a benchmark where it is applied only to Phase I applicants that have received more than twenty (20) awards over the prior five (5) fiscal years as determined by the Small Business Administration. The ratio of Phase II awards received to Phase I awards received during this period must be at least 0.25. Additional information on performance benchmarking for Phase I applicants can be found at https://www.sbir.gov/performance-benchmarks.

### 3.2 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.

### 3.3 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 firm.

### 3.4 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.

### 3.5 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.

### 3.6 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.

### 3.7 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.

### 3.8 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 SBIR Program training related to Fraud, Waste and Abuse is available at: https://www.sbir.gov/tutorials/fraud-waste-abuse/tutorial-1. See Section 4.18 for reporting Fraud, Waste and Abuse.

### 3.9 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 SBIR awards.

### 3.9 HBCU/MI - Historically Black Colleges and Universities and Minority Institutions

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.

### 3.11 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).

### 3.12 Principal Investigator

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

For both Phase I and Phase II, the primary employment of the principal investigator must be with the small business firm 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. This precludes full-time employment with another organization. Occasionally, deviations from this requirement may occur, and must be approved in writing by the contracting officer after consultation with the agency SBIR/STTR Program Manager/Coordinator. Further, a small business firm or research institution may replace the principal investigator on an SBIR/STTR Phase I or Phase II award, subject to approval in writing by the contracting officer.

### 3.13 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.

### 3.14 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/.

### 3.15 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.

### 3.16 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.

### 3.17 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 DoDD 3216.02 "Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research," as well as other applicable federal and state law and regulations, and DoD component guidance. Proposers must be cognizant of and abide by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as they regard vulnerable populations (DoDD 3216.02), recruitment of military research subjects (DoDD 3216.02), and informed consent and surrogate consent (10 U.S.C. § 980) and chemical and biological agent research (DoDD 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 DoDD 3216.02 for definitions of these terms and more information about the applicability of DoDI 3216.02 to research involving human subjects.

### 3.18 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.

### 3.19 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).

### 3.20 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.)

### 3.21 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.

### 3.22 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.

### 3.23 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 that:

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

### 4.2 Proposer Eligibility and Performance Requirements

a. Each proposer must qualify as a small business concern as defined by 13 C.F.R §§ 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 3.15 of this BAA). Proposers must meet eligibility requirements for Small Business Ownership and Control (see 13 CFR § 121.702 and Section 4.4 of this BAA).
b. A minimum of <u>two-thirds</u> of the research and/or analytical work in Phase I must be conducted by the proposing firm. For Phase II, a minimum of one-half (50%) of the research and/or analytical work must be performed by the proposing firm. The percentage of work is measured by both direct and indirect costs.
c. For both Phase I and II, the <u>primary employment</u> of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than <u>one-half</u> of the principal investigator's time is spent with the small business. Primary employment with a small business concern precludes full-time employment at another organization.
d. For both Phase I and Phase II, all research or research and development work must be performed by the small business concern and its subcontractors in the United States.
e. **Benchmarks.** Proposers with prior SBIR/STTR awards must meet two benchmark requirements for Progress towards Commercialization as determined by the Small Business Administration (SBA) on June 1 each year.

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

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

    Consequence of failure to meet the benchmarks:

    - SBA will identify and notify Agencies on June 1st of each year the list of companies which fail to meet minimum performance requirements. These companies will not be eligible to submit a proposal for a Phase I award for a period of one year from that date.
    - Because this requirement only affects a company's eligibility for new Phase I awards, a company that fails to meet minimum performance requirements may continue working on its current ongoing SBIR/STTR awards and may apply for and receive new Phase II and

Phase III awards.

- To provide companies with advance warning, SBA notifies companies on April 1st if they are failing the benchmarks. If a company believes that the information used was not complete or accurate, it may provide feedback through the SBA Company Registry at www.sbir.gov.
- In addition, SBA has posted a Guide to SBIR/STTR Program Eligibility to help small businesses understand program eligibility requirements, determine if they will be eligible at the time of award, and accurately complete necessary certifications.
- The benchmark information on the companies will not be available to the public.
- More detail is available at https://www.sbir.gov/performance-benchmarks.

### 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.

### 4.4 Majority Ownership in Part

Majority ownership in part by multiple venture capital, hedge fund, and private equity firms: Small businesses that are owned in majority part by multiple venture capital operating companies (VCOCs), hedge funds, or private equity funds are ineligible to submit applications or receive awards for opportunities in this BAA. Please check Component instructions for further information.

### 4.5 Conflicts of Interest

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

### 4.6 Classified Proposals

Classified proposals will not be accepted under the DoD SBIR Program. If topics will require classified work during Phase II, the proposing firm must have a facility clearance in order to perform the Phase II work. For more information on facility and personnel clearance procedures and requirements, please visit the Defense Security Service Web site at: http://www.dss.mil/index.html.

### 4.7 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 3.12).

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. Proposers should clearly segregate research activities involving human subjects from other research and development activities in their proposal.

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

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

### 4.8 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 3.11).

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.**

### 4.9 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.

### 4.10 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.

### 4.11 Pre-Award and Post Award BAA Protests

Interested parties have the right to protest as prescribed in FAR 33.106(b) and FAR 52.233-2. For purposes of pre-award protests related to the terms of this BAA, protests should be served to the Contracting Officer (listed below). 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 below (pre-award ONLY) or DoD Component POC (selection/award decision ONLY) within one day of filing with the GAO. Protests of small business status of a selected firm may also be made to the Small Business Administration.

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

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

**4.12 Phase I Award Information**

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

a. **Number of Phase I Awards**. The number of Phase I awards will be consistent with the Component's RDT&E budget. No Phase I contracts will be awarded until evaluation of all qualified proposals for a specific topic is completed.
b. **Type of Funding Agreement**. Each Phase I proposal selected for award will be funded under negotiated contracts or purchase orders and will include a reasonable fee or profit consistent with normal profit margins provided to profit-making firms for R/R&D work. Firm-Fixed-Price, Firm-Fixed-Price Level of Effort, Labor Hour, Time & Material, or Cost-Plus-Fixed-Fee type contracts can be negotiated and are at the discretion of the Component Contracting Officer.
c. **Dollar Value**. The Phase I contract value varies among the DoD Components; it is therefore important for proposing firms to review Component-specific instructions for the Component to which they are applying for specific instructions regarding award size.
d. **Timing.** The SBA SBIR 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 SBIR BAA closes and the award of a Phase I contract is approximately four months. Normally proposing firms will be notified of selection or non-selection status for a Phase I award within 90 days of the closing date for this BAA.

**4.13 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.

**4.14 Questions about this BAA and BAA Topics**

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

(1) **Help Desk**. The DoD SBIR/STTR Help Desk is prepared to address general questions about this BAA, the proposal preparation and electronic submission process and other program-

related areas. The Help Desk may be contacted from 9:00 a.m. to 6:00 p.m. ET Monday through Friday at:

- Phone: 1-703-214-1333
- E-mail: DoDSBIRSupport@reisystems.com

(2) **Web sites**. The Defense SBIR/STTR Innovation Portal (DSIP) Web site at https://www.dodsbirsttr.mil/submissions/login has information on the DoD SBIR/STTR Program, including:

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

(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, you are invited to subscribe to our Listserv by emailing DoDSBIRSupport@reisystems.com.

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

c. **Direct Contact with Topic Authors**. From **May 6, 2020 to June 2, 2020**, this BAA is issued for Pre-Release with the names of the topic authors and their phone numbers and e-mail addresses. During the pre- release period, proposing firms have an opportunity to contact topic authors by telephone or e-mail to ask technical questions about specific BAA topics. Questions should be limited to specific information related to improving the understanding of a particular topic's requirements. Proposing firms may not ask for advice or guidance on solution approach and you may not submit additional material to the topic author. If information provided during an exchange with the topic author is deemed necessary for proposal preparation, that information will be made available to all parties through Topic Q&A (formerly SITIS). After this period questions must be asked through Topic Q&A as described below.

d. **Topic Q&A (formerly SITIS)**. Once DoD begins accepting proposals on **June 3, 2020** no further direct contact between proposers and topic authors is allowed unless the Topic Author is responding to a question submitted during the Pre-release period. However, proposers may submit written questions through Topic Q&A at https://www.dodsbirsttr.mil/submissions/login. In Topic Q&A, the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing.

Questions 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, will not receive a response. Proposing firms may locate the topic to which they want to submit a technical question by using the Topic Search feature on this Web site. 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 **May 6, 2020** and closes to new questions on **June 18, 2020 at 12:00 PM ET**. Once the BAA closes to proposal submission, no communication of any kind with the topic author or through Topic Q&A regarding your submitted proposal is allowed.

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

### 4.15 Registrations and Certifications

Proposing firms must be registered in the Defense SBIR/STTR Innovation Portal (DSIP) at: https://www.dodsbirsttr.mil/submissions/ in order to prepare and submit proposals.

Before the DoD Components can award a contract, proposing firms must be registered in the System for Award Management (SAM). If you were previously registered in CCR, your information has been transferred to SAM. However, it is in the firm's interest to visit SAM and ensure that all of the firm's data is up to date from SAM and other databases to avoid delay in award. SAM replaced the Central Contractor Registration (CCR), Online Representations and Certifications Application (ORCA), and the Excluded Parties List System (EPLS). SAM allows firms interested in conducting business with the federal government to provide basic information on business capabilities and financial information. To register, visit www.sam.gov.

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

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

### 4.16 Promotional Materials

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

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

**IMPORTANT** -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work (see Section 3.3) 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 False Statements

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

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

### 4.19 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: http://www.dcaa.mil and click on "Guidance" and then click on "Audit Process Overview Information for Contractors," and also at: http://www.dcaa.mil and click on "Checklists and Tools" and then click on "Pre-award Accounting System Adequacy Checklist."

### 4.20 State and Other Assistance Available

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

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

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

### 4.21 Discretionary Technical and Business Assistance (TABA)

DoD is not mandating the use of TABA pending further SBA guidance and establishment of a limit on the amount of technical and business assistance services that may be received or purchased by a small business concern that has received multiple Phase II SBIR or STTR awards for a fiscal year. However, proposers should carefully review individual component instructions to determine if TABA is being offered and follow specific proposal requirements for requesting TABA funding.

## 5.0 PHASE I PROPOSAL

### 5.1 Introduction

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

Since the guidance on allowable content may vary by Component, it is the proposing firm's responsibility to consult the Component-specific instructions for detailed guidance.

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
- Volume 6: Fraud, Waste and Abuse Training

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

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

Signatures are not required on the electronic forms at the time of submission. If the proposal is selected for award, the DoD Component program will contact the proposer for signatures at the time of award.

### 5.2 Summary of Component Programs

The tables below are provided for your convenience. Information provided in the Component instructions take precedence over any figures listed below. Please refer to the Component instructions for the topic of interest prior to proposal submission.

| DoD Component | Cost | Duration | Phase I Option | Technical and Business Assistance |
|---|---|---|---|---|
| **Army** | Base NTE $111,500 +<br>Phase I Option NTE $56,000 | 6 Month Base +<br>4 Month Phase I Option | Required | $5,000 |
| **Army Direct to Phase II** | Base NTE $1,100,000 | 24 Months | Not Applicable | $10,000 |
| **Navy** | Base NTE $140,000 +<br>Phase I Option NTE $100,000 | 6 Month Base +<br>6 Month Phase I Option | Required | $6,500 |
| **Navy Direct to Phase II** | Base NTE $1,000,000<br>Option one NTE $500,000 | 24 Month Base +<br>12 Month Option | Phase II Option Required | $25,000 |
| **CBD** | Base $167,500 | 6 Month Base | Not Applicable | Not Available |
| **DHA** | Base NTE $250,000 | 6 Month Base | Not Applicable | Not Available |
| **DLA** | Base: $100,000 | 9 Month Base | Not Applicable | $5,000 |
| **DTRA** | Base $167,500 | 7 Month Base | Not Applicable | $6,500 |
| **MDA** | Base $150,000 | 6 Month Base | Not Applicable | $5,000 |
| **OSD Direct to Phase II** | Base $1,000,000<br>Option $500,000 | 12 month Base<br>6 Month Option | Not Applicable | Not Available |
| **SCO Direct to Phase II** | Base $1,500,000 | 24 Months | Not Applicable | $5,000 |
| **USSOCOM** | Base $150,000 | 6 Month Base | Not Applicable | $6,500 |
| **USSOCOM Direct to Phase II** | Base NTE $1,245,00 | Typically 18 Month | Not Applicable | $50,000 |

| DoD Component | Volume 5 – Supporting Documents | Volume 6 – Fraud, Waste & Abuse | Technical Volume Page Limits |
|---|---|---|---|
| **Army** | Not Accepted | Not Accepted | 20 pages |
| **Army Direct to Phase II** | Not Accepted | Not Accepted | 38 pages |
| **Navy** | Accepted but Not Evaluated | Not Accepted | 10 pages |
| **Navy Direct to Phase II** | Accepted but Not Evaluated | Not Accepted | 50 pages |
| **CBD** | | | 20 pages |
| **DHA** | Not Accepted | Not Accepted | 20 pages |
| **DHA Direct to Ph II** | Not Accepted | Not Accepted | 60 pages |
| **DLA** | Required | Accepted | 20 pages |
| **DLA Direct to Phase II** | Accepted | Accepted | 60 pages |
| **DTRA** | Required | Accepted | 20 pages |
| **MDA** | Accepted | Required | 15 pages |
| **OSD Direct to Phase II** | Not Accepted | Not Accepted | 30 pages |

| | | | |
|---|---|---|---|
| **SCO Direct to Phase II** | Accepted | | 15 pages |
| **USSOCOM** | 15 page PowerPoint | Accepted but Not Evaluated | 5 pages |
| **USSOCOM Direct to Phase II** | 15 page PowerPoint | Accepted but Not Evaluated | 10 pages |

### 5.3 Marking Proprietary Proposal Information

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

a. Mark the first page of each Volume of the proposal submission with the following legend:

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

b. 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.

### 5.4 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 of no more than 200 words that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. **Do not include proprietary or classified information in the Proposal Cover Sheet**. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released on the Internet. Once the Cover Sheet is saved, the system will assign a proposal number. You may modify the cover sheet as often as necessary until the BAA closes.

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

(1) **Type of file**: The Technical Volume must be a single Portable Document Format (PDF) file, including graphics. Perform a virus check before uploading the Technical Volume file. If a virus is detected, it may cause rejection of the proposal. **Do 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 firm's responsibility to verify that the Technical Volume does not exceed the page limit after upload to DSIP. Please refer to Component-specific instructions for how a technical volume is handled if the stated page count is exceeded. Some Components will reject the entire technical proposal if the proposal exceeds the stated page count.

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

**human and/or animal use are encouraged to separate these tasks in the technical proposal and cost proposal in order to avoid potential delay of contract award.**

(4) **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The technical volume must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following:

a. Short description,
b. Client for which work was performed (including individual to be contacted and phone number), and
c. Date of completion.

(5) **Relationship with Future Research or Research and Development**

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

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

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

(8) **Foreign Citizens.** Identify any foreign citizens or individuals holding dual citizenship expected to be involved on this project as a direct employee, subcontractor, or consultant. For these individuals, please specify their country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Proposers frequently assume that individuals with dual citizenship or a work permit will be permitted to work on an SBIR project and do not report them. This is not necessarily the case and a proposal will be rejected if the requested information is not provided. Therefore, firms should report any and all individuals expected to be involved on this project that are considered a foreign national as defined in Section 3.5 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 SBIR 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 university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be identified and described according to the Cost Breakdown Guidance. A minimum of two-thirds 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. SBIR efforts may include subcontracts with Federal Laboratories and Federally Funded Research and Development Centers (FFRDCs). A waiver is no longer required for the use of federal laboratories and FFRDCs; however, proposers must certify their use of such facilities on the Cover Sheet of the proposal.

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

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

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

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

Complete the Cost Volume by using the on-line cost volume form on the Defense SBIR/STTR Innovation Portal (DSIP). Some items in the Cost Breakdown Guidance may not apply to the proposed project. If that is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow us to understand how you plan to use the requested funds if a contract is awarded.

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

(2) While special tooling and test equipment and material cost may be included under Phases I,

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

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

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

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

(6) All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal. Enter this information in the Explanatory Material section of the on-line cost proposal form. The Supporting Documents Volume (Volume 5) 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 http://www.dcaa.mil. Click on "Guidance" and then click on "Audit Process Overview Information for Contractors."

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

The Company Commercialization Report is the fourth volume of a complete proposal package. The Company Commercialization Report is prepared through the Defense SBIR/STTR Innovation Portal (DSIP) (https://www.dodsbirsttr.mil/submissions/). A Company Commercialization Report is required even if the proposing firm has not previously received SBIR or STTR awards. All Firms are required to complete the Business Certification, Firm Commercialization Point of Contact, and Commercialization Narrative sections of the Company Commercialization Report. For firms that have received SBIR and/or STTR awards, follow the instructions on the Defense SBIR/STTR Innovation Portal (DSIP)and enter the quantitative commercialization results of your firm's prior Phase II projects. Include the items listed below as well as other information relative to your firm's commercialization track record.

(1) Sales revenue from new products and non-R&D services resulting from Phase II technology;

(2) Additional investment from sources other than the federal SBIR/STTR Program in activities that further the development and/or commercialization of Phase II technology;

(3) The number of patents resulting from the contractor's participation in the SBIR/STTR Program;

(4) Growth in number of firm employees; and

(5) Whether the firm has completed an initial public offering of stock (IPO) resulting, in part, from a Phase II project.

All prior DoD and non-DoD Phase II projects must be reported in the Prior Awards Addendum, regardless of whether the project has any commercialization to date.

The Web site will compare these results to the historical averages for the DoD SBIR Program to calculate a Commercialization Achievement Index (CAI) value. Only firms with four or more Phase II projects that were awarded at least two years prior to this BAA will receive a CAI score; otherwise the CAI is not applicable (see the Company Commercialization Report section of the Defense SBIR/STTR Innovation Portal (DSIP)for more details). Firms with a CAI at the 20th percentile or below will be rated no higher than "Marginal" for this factor. This report shall only be prepared once and submitted with all your proposals for this BAA. A report showing that a firm has received no prior Phase II awards will not affect the firm's ability to obtain an SBIR award.

Additional explanatory material relating to the firm's record of commercializing its prior SBIR or STTR projects may be included in the Commercialization Track Record Narrative section of the Company Commercialization Report. Examples of the additional information include: commercialization successes in government or private sector markets that are not fully captured in the quantitative results (e.g. commercialization resulting from your firm's prior Phase I projects); any mitigating factors that could account for low commercialization; and recent changes in the firm's organization or personnel designed to increase the firm's commercialization success.

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

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

Documents that are acceptable and may be included in Volume 5 are:

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

Refer to the Component-specific instructions for Volume 5 requirements.

g. **Fraud, Waste and Abuse Training (Volume 6)**

Refer to the Component-specific instructions for the Fraud, Waste and Abuse Training (Volume 6) requirements.

## 6.0 PHASE I EVALUATION CRITERIA

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

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

Cost reasonableness and realism shall also be considered to the extent appropriate.

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

## 7.0 PHASE II PROPOSAL

### 7.1 Introduction

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

### 7.2 Proposal Provisions

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

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

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

### 7.3 Commercialization Strategy

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

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

The commercialization strategy must also include a schedule showing the anticipated quantitative commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its Company Commercialization Report (see Section 5.4.e) at least annually. For information on formatting, page count and other details, please refer to the Component-specific instructions.

## 8.0 PHASE II EVALUATION CRITERIA

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

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

Cost reasonableness and realism shall also be considered to the extent appropriate.

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

## 9.0 PHASE II ENHANCEMENT POLICY

To further encourage the transition of SBIR 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 SBIR funding if the company can match the additional SBIR funds with non-SBIR funds from DoD acquisition programs or the private sector.

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

## 10.0 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. Additionally, each Department has developed criteria and processes to identify projects with the potential for rapid transition to Phase III and that are expected to meet high priority needs of their Department. A project's inclusion in the CRP is by invitation and at the discretion of the Departments. CRP participants may receive a variety of assistance services and/or opportunities to facilitate the transition of their projects. Participation in the CRP may also include modifications to existing Phase II contracts with additional non-SBIR funding, as well as additional SBIR funding beyond the normal SBIR funding guidelines, to enhance ongoing projects with expanded research, development, test, or evaluation to accelerate transition and commercialization. Additional reporting on CRP participants and results achieved is required.

## 11.0 CONTRACTUAL REQUIREMENTS

### 11.1 Other Contract Requirements

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

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

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.
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. **Publication Approval**. Government review and approval will be required prior to any dissemination or publication, except within and between the Contractor and any subcontractors, of classified and non-fundamental information developed under this contract or contained in the reports to be furnished pursuant to this contract.
s. **Animal Welfare**. Contracts involving research, development, test, evaluation, or training on vertebrate animals will incorporate DFARS clause 252.235-7002.
t. **Protection of Human Subjects**. Effective 29 July 2009, contracts that include or may include research involving human subjects in accordance with 32 CFR Part 219, DoD Directive 3216.02 and 10 U.S.C. 980, including research that meets exemption criteria under 32 CFR 219.101(b), will incorporate DFARS clause 252.235-7004.
u. **E-Verify**. Contracts exceeding the simplified acquisition threshold may include the FAR clause 52.222-54 “Employment Eligibility Verification” unless exempted by the conditions listed at FAR 22.1803.
v. **ITAR**. In accordance with DFARS 225.7901-4, Export Control Contract Clauses, the clause found at DFARS 252.225-7048, Export-Controlled Items (June 2013), must be included in all BAAs/solicitations and contracts. Therefore, all awards resulting from this BAA will include DFARS 252.225-7048. Full text of the clause may be found at https://www.govinfo.gov/content/pkg/CFR-2013-title48-vol3/pdf/CFR-2013-title48-vol3-sec252-225-7048.pdf.

w. **Cybersecurity**. Any Small Business Concern receiving an SBIR award is required to provide adequate security on all covered contractor information systems. Specific security requirements are listed in DFARS 252.204.7012, and compliance is mandatory.

### 11.2 Commercialization Updates in Phase II

If, after completion of Phase I, the contractor is awarded a Phase II contract, the contractor shall be required to periodically update the following commercialization results of the Phase II project through the Web site at https://www.dodsbirsttr.mil/submissions/:

a. Sales revenue from new products and non-R&D services resulting from the Phase II technology;
b. Additional investment from sources other than the federal SBIR/STTR Program in activities that further the development and/or commercialization of the Phase II technology;
c. Whether the Phase II technology has been used in a fielded DoD system or acquisition program and, if so, which system or program;
d. The number of patents resulting from the contractor's participation in the SBIR/STTR Program;
e. Growth in number of firm employees; and
f. Whether the firm has completed an initial public offering of stock (IPO) resulting, in part, from the Phase II project.

These updates on the project will be required one year after the start of Phase II, at the completion of Phase II, and subsequently when the contractor submits a new SBIR or STTR proposal to DoD. Firms that do not submit a new proposal to DoD will be asked to provide updates on an annual basis after the completion of Phase II.

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

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

### 11.4 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.

### 11.5 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a period of five years to allow the awardee to pursue a patent. See also Invention Reporting in Section 11.6.

### 11.6 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 unlimited rights in the SBIR data. During the license period, the Government may not release or disclose SBIR 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."

If a proposer 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. The contract cannot be awarded until assertions have been approved.

### 11.7 Invention Reporting

SBIR 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.

### 11.8 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 at http://www.dtic.mil/dtic/submit/guidance_on_submitting_docs_to_dtic.html. In addition, monthly status and progress reports may be required by the DoD Component.

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

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

*(2)* For each unclassified report, the company submitting the report should fill in Block 12 (Distribution/Availability Statement) of the SF 298, "Report Documentation Page," with the following statement: "Distribution authorized to U.S. Government only; Proprietary Information, (Date of Determination). Other requests for this document shall be referred to the Component SBIR Program Office." *Note: Data developed under a SBIR contract is subject to SBIR Data Rights which allow for protection under DFARS 252.227-7018 Class Deviation 2020-O0007 (see Section 11.5, Technical Data Rights). The sponsoring DoD activity, after reviewing the company's entry in Block 12, has final responsibility for assigning a distribution statement.*

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

(3) Block 14 (Abstract) of the SF 298, "Report Documentation Page" must include as the first sentence, "Report developed under SBIR 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 "SBIR 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)
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 SBIR Data Rights protected under DFARS 252.227-7018 Class Deviation 2020-O0007.

**ARMY**
**20.2 Small Business Innovation Research (SBIR)**
**Proposal Submission Instructions**

## INTRODUCTION

The U.S. Army Combat Capabilities Development Command (CCDC) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Website: https://www.armysbir.army.mil/.

Broad Agency Announcement (BAA), topic, and general questions regarding the SBIR Program should be addressed according to the DOD Program BAA. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the BAA. To obtain answers to technical questions during the formal BAA period, visit https://www.dodsbirsttr.mil/submissions/. Specific questions pertaining to the Army SBIR Program should be submitted to:

Monroe Harden
Acting Program Manager, Army SBIR
usarmy.apg.ccdc.mbx.sbir-program-managers-helpdesk@mail.mil
U.S. Army Combat Capabilities Development Command
6662 Gunner Circle
Aberdeen Proving Ground, MD 21005-1322
TEL: 866-570-7247

The Army participates in three DOD SBIR BAAs each year. Proposals not conforming to the terms of this BAA will not be considered. Only Government personnel will evaluate proposals with the exception of technical personnel from Irving Burton Associates and ICON who will provide Advisory and Assistance Services to the Army and technical analysis in the evaluation of proposals submitted against Army topic numbers:

- A20-136 "Automated Encounter Documentation and Data Driven Decision Support Systems" (Irving Burton Associates)
- A20-137 "To Develop and Demonstrate an Advanced Combat Would Care Technology that Prevents Sepsis from Infected Traumatized Tissue" (ICON)

The individuals from Irving Burton Associates and ICON 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. These institutions are expressly prohibited from competing for SBIR awards and from scoring or ranking of proposals or recommending the selection of a source. In accomplishing their duties related to the selection processes, the aforementioned institutions may require access to proprietary information contained in the offerors' proposals. Therefore, pursuant to FAR 9.505-4, the institutions must execute an agreement that states that they will (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. These agreements will remain on file with the Army SBIR program management office at the address above.

**PHASE I PROPOSAL SUBMISSION**

SBIR Phase I proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. **Please note that the Army will not be accepting a Volume Five (Supporting Documents), nor a Volume Six (Fraud, Waste and Abuse) as noted at the DOD SBIR website.** The Technical Volume .pdf document has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments. Small businesses submitting a Phase I Proposal must use the DOD SBIR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, Cost Volume, and how to upload the Technical Volume, and the Company Commercialization Report. For general inquiries or problems with proposal electronic submission, contact the DOD SBIR Help Desk at 703-214-1333.

The small business will also need to register at the Army SBIR Small Business website: https://sbir.army.mil/SmallBusiness/ in order to receive information regarding proposal status/debriefings, summary reports, impact/transition stories, and Phase III plans. **PLEASE NOTE**: If this is your first time submitting an Army SBIR proposal, you will not be able to register your firm at the Army SBIR Small Business website until after all of the proposals have been downloaded and we have transferred your company information to the Army Small Business website. This can take up to one week after the end of the proposal submission period.

Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent in other sections of the proposal as these will count toward the 20-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report are excluded from the 20-page limit. **Army Phase I proposals submitted containing a Technical Volume .pdf document containing over 20 pages will be deemed NON-COMPLIANT and will not be evaluated. It is the responsibility of the Small Business to ensure that once the proposal is submitted and uploaded into the system that the technical volume .pdf document complies with the 20 page limit.**

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DOD Program BAA.

20.2 Phase I Key Dates

| | |
|---|---|
| BAA closes, proposals due | 2 Jul 2020, 12:00 pm ET |
| Phase I Evaluations | 7 Jul 2020 – 29 Sep 2020 |
| Phase I Selections Announced | 30 Sep 2020 |
| Phase I Award Goal | 30 Nov 2020* |

**Subject to the Congressional Budget process*

**PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL**

The Army implements the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent, in other sections of the proposal as these will count toward the 20 page limit.

**PHASE I COST VOLUME**

A firm fixed price or cost plus fixed fee Phase I Cost Volume with maximum dollar amount of **$167,500** must be submitted in detail online. Proposers that participate in this BAA must complete a Phase I Cost Volume not to exceed a maximum dollar amount of **$111,500** for the six months base period and a Phase I Option Cost Volume not to exceed a maximum dollar amount of **$56,000** for the four months option period. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Volume. The Cost Volume DOES NOT count toward the 20-page Phase I proposal limitation when submitted via the submission site's on-line form. When submitting the Cost Volume, complete the Cost Volume form on the DOD Submission site, versus submitting it within the body of the uploaded proposal.

**PHASE II PROPOSAL SUBMISSION**

Only Small Businesses that have been awarded a Phase I contract for a specific topic can submit a Phase II proposal for that topic. Small businesses submitting a Phase II Proposal must use the DOD SBIR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Cost Volume, and how to upload the Technical Volume, and the Company Commercialization Report. For general inquiries or problems with proposal electronic submission, contact the DOD Help Desk at 703-214-1333.

Army SBIR has four cycles in each FY for Phase II submission. A single Phase II proposal can be submitted by a Phase I awardee within one, and only one, of four submission cycles and must be submitted between 4 to 17 months from the Phase I contract award date. Any proposals that are not submitted within these four submission cycles and before 4 months or after 17 months from the contract award date will not be evaluated. The submission window opens at 0001hrs (12:01 AM) eastern time on the first day and closes at 2359 hrs (11:59 PM) eastern time on the last day. Any subsequent Phase II proposal (i.e., a second Phase II subsequent to the initial Phase II effort) shall be initiated by the Government Technical Point of Contact for the initial Phase II effort and must be approved by Army SBIR PM in advance.

The next available four Phase II submission cycles following the announcement of selections for the 20.1 BAA are:

2021(b) 1 Mar – 30 Mar 2021
2021(c) 15 Jun - 14 Jul 2021
2021(d) 2 Aug – 31 Aug 2021
2022(a) 15 Oct – 14 Nov 2021

**PLEASE NOTE**: Do not start entering your Phase II Proposal to the DOD Submission Website before the start date as any proposals started before the published start date and not submitted by the published end date will not be evaluated.

For other submission cycles see the schedule below, and always check with the Army SBIR Program Managers Office helpdesk for the exact dates.

| SUBMISSION CYCLES | TIMEFRAME |
|---|---|
| Cycle One | 30 calendar days starting on or about 15 October* |
| Cycle Two | 30 calendar days starting on or about 1 March* |
| Cycle Three | 30 calendar days starting on or about 15 June* |
| Cycle Four | 30 calendar days starting on or about 1 August* |

*Submission cycles will open on the date listed unless it falls on a weekend or a Federal Holiday. In those cases, it will open on the next available business day.

Army SBIR Phase II Proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and the Company Commercialization Report. The Technical Volume .pdf document has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes), data assertions and any attachments. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 38 page limit. As with the Phase I proposals, it is the proposing firm's responsibility to verify that the Technical Volume .pdf document does not exceed the page limit after upload to the DOD SBIR/STTR Submission site.

Only the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report are excluded from the 38-page Technical Volume.

**Army Phase II Proposals submitted containing a Technical Volume .pdf document over 38 pages will be deemed NON-COMPLIANT and will not be evaluated.**

Army Phase II Cost Volumes must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of **$1,100,000.** During contract negotiation, the contracting officer may require a Cost Volume for year one and year two. The proposal cost volumes must be submitted using the Cost Volume format (accessible electronically on the DOD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the first year prior to extending funding for the second year.

Small businesses submitting a proposal are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal.

DOD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DOD Program BAA very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the BAA.

**BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS**

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

**FOREIGN NATIONALS**

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.5 of this BAA for definitions of "lawful permanent resident" and "protected individual"] as key personnel, they must be clearly identified. **For foreign nationals, you must provide 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. Please ensure no Privacy Act information is included in this submittal.**

**OZONE CHEMICALS**

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

**CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)**

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase I (**$111,500 maximum**), Phase I Option (**$56,000 maximum**), and Phase II (**$1,100,000 maximum**), under "CMRA Compliance" in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://www.ecmra.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

(1) Contract number, including task and delivery order number;
(2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
(3) Estimated direct labor hours (including sub-contractors);
(4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
(5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
(6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
(7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

**DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA) (FORMERLY KNOWN AS DISCRETIONARY TECHNICAL ASSISTANCE)**

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed nine Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

**For more information go to**: https://www.armysbir.army.mil, then click the "SBIR" tab, and then click on Transition Assistance/Technical Assistance.

This technical and business assistance to SBIR awardees to assist in:

- Making better technical decisions on SBIR projects
- Solving technical problems that arise during SBIR projects;
- Minimizing technical risks associated with SBIR projects; and
- Developing and commercializing new commercial products and processes resulting from such projects including intellectual property protections.

Army may provide up to $5,000 of SBIR funds for the technical assistance described above for each Phase I award, and $10,000 per Phase II project to these vendors for direct support to SBIR awardees.

Alternatively, a SBIR firm may directly acquire the technical assistance services described above and not through the vendor selected by the Components. Firms must request this authority from the agency and clearly identify the need for assistance (purpose and objective of required assistance), provide details on the provider of the assistance (name and point of contact for performers) and why the proposed TABA providers are uniquely skilled to conduct the work (specific experience in providing the assistance proposed), and the cost of the required assistance (costs and hours proposed or other details on arrangement). This information must be included in the Explanatory Material section of the firm's cost proposal specifically identified as "Discretionary Technical and Business Assistance."

If the awardee demonstrates this requirement sufficiently, the agency shall permit the awardee to acquire such technical assistance itself, in an amount up to $5,000 for each Phase I award and $10,000 for each Phase II project, as an allowable cost of the SBIR award. The per year amount will be in addition to the award and is not subject to any profit or fee by the requesting (SBIR) firm and is inclusive of all indirect rates.

The TABA provider may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g. research partner or research institution).

Failure to include the required information in the Phase I and/or Phase II proposal will result in the request for discretionary technical and business assistance being disapproved. Requests for TABA funding outside of the Phase I or Phase II proposal submission will not be considered. If the firm is approved for TABA from a source other than that provided by the agency, the firm may not be eligible for the technical assistance services normally provided by those organizations. Small business concerns that receive technical or business assistance as described in this section are required to submit a description of the assistance provided, and the benefits and results achieved. Contact the Army SBIR Program Office for any other considerations.

NOTE: The Small Business Administration (SBA) is currently developing regulations governing TABA. All regulatory guidance produced by SBA will apply to any SBIR contracts where TABA is utilized.

It should also be noted that if approved for discretionary technical and business assistance from an outside source, the firm will not be eligible for the Army's Technical Assistance Advocate support. All details of the TABA agency and what services they will provide must be listed in the technical proposal under "consultants". The request for TABA must include details on what qualifies the TABA firm to provide the services that you are requesting, the firm name, a point of contact for the firm, and a web site for the firm. List all services that the firm will provide and why they are uniquely qualified to provide these services. The award of TABA funds is not automatic and must be approved by the Army SBIR Program Manager. The maximum TABA dollar amount that can be requested in a Phase I Army SBIR proposal is $5,000. The maximum TABA dollar amount that can be requested in a Phase II Army SBIR proposal is $5,000 per year (for a total of $10,000 for two years).

**COMMERCIALIZATION READINESS PROGRAM (CRP)**

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

**NON-PROPRIETARY SUMMARY REPORTS**

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DOD and/or non-DOD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at:
https://sbir.army.mil/SmallBusiness/ and is due within 30 days of the contract end date.

**ARMY SBIR PROGRAM COORDINATORS (PCs) for Army SBIR PHASE 20.2**

| Participating Organizations | Program Coordinator | Phone |
|---|---|---|
| Army Futures Command (AFC) | Casey Perley | 716-574-6311 |
| Armaments Center (AC) | Ben Call<br>Sheila Speroni | 973-724-6275<br>973-724-6935 |

| | | |
|---|---|---|
| Aviation and Missile Center (AvMC-A) | Dawn Gratz | 256-842-3272 |
| Aviation and Missile Center (AvMC-M) | Dawn Gratz | 256-842-3272 |
| Army Research Laboratory (ARL) | Francis Rush<br>Nicole Fox | 919-549-4347<br>919-549-4395 |
| Army Test & Evaluation Command (ATEC) | Kendra Raab | 443-861-9344 |
| Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) | Lauren Marzocca | 410-395-4665 |
| Chemical Biological Center (CBC) | Martha Weeks | 410-436-5391 |
| Ground Vehicle Systems Center (GVSC) | George Pappageorge | 586-282-4915 |
| JPEO Armaments and Ammunition | Vincent Matrisciano | 973-724-2765 |
| JPEO Chemical, Biological, Radiological, and Nuclear Defense (CBRND) | Jacqueline Yearby-Wade | 410-417-3596 |
| Medical Research and Development Command (MRDC) | James Myers | 301-619-7377 |
| PEO Command, Control and Communications Tactical (PEO C3T) | Meisi Amaral | 443-395-6725 |
| PEO Intelligence, Electronic Warfare & Sensors (PEO IEW&S) | Michael Voit | 443-861-7851 |
| PEO Soldier | Mary Harwood | 703-704-0211 |
| Soldier Center | Cathy Polito | 508-206-3497 |
| Space and Missile Defense Command (SMDC) | Jason Calvert | 256-955-5630 |

## ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) Submit two copies of the approved scientific or technical report delivered under the contract to the Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at https://discover.dtic.mil/.

## PROTEST PROCEDURES

Refer to the DOD Program Announcement for procedures to protest the Broad Agency Announcement.

As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to:

Monroe Harden
Acting Program Manager
Army Small Business Innovation Research (SBIR)

Phone: 866-570-7247
Email: usarmy.apg.ccdc.mbx.sbir-program-managers-helpdesk@mail.mil

These protests will then be forwarded to the appropriate contracting officer based on the sponsoring organization for the topic.

**DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST**

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DOD requirements specified in the BAA. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase I effort (up to **$111,500** with up to a six-month duration) AND an optional effort (up to **$56,000** for an up to four-month period to provide interim Phase II funding).

2. The proposal is limited to only **ONE** Army BAA topic.

3. The technical content of the proposal, including the Option, includes the items identified in Section 5.4 of the BAA.

4. SBIR Phase I Proposals have four (4) sections: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume .pdf document has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments. However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal submission as **THESE WILL COUNT AGAINST THE 20-PAGE LIMIT**. Any information that details work involved that should be in the technical volume but is inserted into other sections of the proposal will count against the page count. ONLY the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report are excluded from the Technical Volume .pdf 20-page limit. Army Phase I proposals submitted with a Technical Volume .pdf document of over 20-pages will be deemed **NON-COMPLIANT** and will not be evaluated.

5. The Cost Volume has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army requires that small businesses complete the Cost Volume form on the DOD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

10. If applicable, Foreign Nationals are to be identified in the proposal.

## ARMY

## ARMY SBIR 20.2 Topic Index

| | |
|---|---|
| A20-133 | Innovative Technologies for Precision Timing of Onboard Munition Navigation Systems |
| A20-134 | Innovative and Intelligent Standoff Detection Algorithm |
| A20-135 | Low-Cost Gamma Dose Rate Technology for Military Operations |
| A20-136 | Automated Encounter Documentation and Data Driven Decision Support Systems |
| A20-137 | To Develop and Demonstrate an Advanced Combat Wound Care Technology that Prevents Sepsis from Infected Traumatized Tissue |
| A20-138 | Distributed Coded Computing for Content Management at the Tactical Edge |
| A20-139 | Software Defined Everything (SDx) and 5G/6G Cellular Design Prototype for Tactical Radios |
| A20-140 | High Performance Optical Fibers for 100-Watts Infrared Lasers |
| A20-141 | C4ISR/EW Modular Open Suite of Standards (CMOSS)-based Common Data Link (CDL) Radio Transceiver |
| A20-142 | Federated Intelligence, Surveillance, Reconnaissance (ISR) Collection Management Using Machine Learning (ML) |
| A20-143 | A Novel Non-Uniformity Correction (NUC) Approach for Night Vision Cameras |
| A20-144 | Aerostat Payload Protection (APP) System |
| A20-145 | Active Noise Reduction HGU-56P Aviator Helmet |
| A20-146 | Low Voltage Cable Reflectometer Built in Test Module |
| A20-147 | Light-weight Internal-combustion High-power, Transformative, Novel, Individual New Generator (LIGHTNING) |
| A20-148 | Flight Test Execution Team Pre-Mission Training Tool |
| A20-149 | High-Power Tapered Amplifier Laser Diode Array With Active Phase Control Feedback Loop for Future High Energy Laser Weapons |
| A20-150 | Photonic Crystal Surface Emitting Semiconductor Laser |

A20-101 TITLE: Continuous Flow Recrystallization of Energetic Nitramines

RT&L FOCUS AREA(S): General Warfighting
TECHNOLOGY AREA(S): Materials

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design, develop and demonstrate a continuous process for direct recrystallization of energetic materials.

DESCRIPTION: Energetic materials are dual-use materials used in private industry, recreational sport, and military applications. Energetic materials are extremely dangerous to handle. Unfortunately the manufacturing processes used today are decades-old using antiquated equipment. This has resulted in catastrophic events leading to injury and death over the years. The design and engineering capabilities available today, along with innovative technologies that were not available decades ago, offer a unique opportunity for the implementation of safer and sustainable manufacturing processes for energetics. The main steps include the reaction, filtration, and recrystallization while extraction and distillation processes are also utilized depending on the material. These steps typically include an operator interfacing with sometimes dangerous intermediates and products. The main reaction can be done in batch or continuous reactors. Development of continuous flow synthetic approaches applied to energetic materials have demonstrated several advantages including reduced waste, material in process, process control and product quality. In order to fully realize the potential of continuous flow synthesis it needs to be paired with complementary continuous flow technologies including filtration, recrystallization, extraction, and distillation. Continuous flow recrystallization presents one of the largest challenges and opportunities in continuous flow preparation of nitramines including RDX and HMX. The pharmaceutical industry has demonstrated use of continuous flow recrystallization to result in improved purity, particle size control and particle size distribution. This topic desires continuous flow recrystallization strategies for direct recrystallization to each of the RDX/HMX class sizes (eliminating grinding steps) with tighter particle size, greater process control and improved process waste profiles while retaining the desired polymorph for each.

PHASE I: The small business will investigate innovative strategies for lab-scale continuous flow recrystallization of RDX and HMX with tunable particle size distribution within the range specified for various class sizes and their respective desired polymorph. This lab-scale work will develop models based off of experimental work to better understand process kinetics and viability. The phase I output will be a prototype process for energetic material recrystallization that results in a tunable system for the direct production of Class 1-5 nitramines with their desired polymorph. This prototype process will result in a 20% tighter particle size distribution, eliminated operator exposure and developed strategies for inline process monitoring. While initial process development may be on surrogate compounds, the final prototype and evaluation must be on either RDX or HMX. A Phase II effort must be on the energetic materials.

PHASE II: Development and demonstration of a pilot scale process for continuous nitramine recrystallization. The process models generated in Phase I should be validated, optimized for affordability and robustness, and developed into a physical pilot process. This pilot scale process should produce final product at a rate of at least 1 g/min. The demonstration should exhibit polymorph and particle size control to each of the class sizes and be transition-able to manufacturing environments. It should show reduced particle size distribution, operator exposure, hazardous waste generation, and greater process control. A 20 g sample of each class size must be shipped to CCDC-Armaments Center for further evaluation of product quality. Phase II will conclude with a full process design and transition plan.

PHASE III DUAL USE APPLICATIONS: The process developed in Phase II should be scalable to production capacity. This capability will allow greater flexibility in meeting warfighter needs for nitramine-based end items in times of high demand with lower infrastructure costs than large scale batch recrystallization process equipment. It will also result in greater control of nitramine explosive properties (due to tighter control of particle size distribution) for improved end item reliability.

REFERENCES:

1. K.A. Powell, A.N. Saleemi, C.D. Rielly, Z.K. Nagy. "Periodic steady-state flow crystallization of a pharmaceutical drug using MSMPR operation." Chemical Engineering and Processing: Process Intensification, Volume 97, November 2015, pp 195-212
2. P.B. Palde, T.F. Jamison. "Safe and Efficient Tetrazole Synthesis in a Continuous-Flow Microreactor." Angewandte Chemie International Edition, Volume 50, 15, April 2011, pp 3525-3528.
3. "DETAIL SPECIFICATION RDX (CYCLOTRIMETHYLENETRINITRAMINE)." MIL-DTL-398D. 1996.
4. S. Lawton, G. Steel, P. Shering, L. Zhao, I. Laird, X.W. Ni. "Continuous Crystallization of Pharmaceuticals Using a Continuous Oscillatory Baffled Crystallizer." Org. Process Res. Dev., Volume 13, October 2009, pp 1357-1363


KEYWORDS: Continuous Flow, Recrystallization, Nitramines, Process Analytical Technology


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A20-102 TITLE: Deep Neural Network Learning Based Tools for Embedded Systems Under Side Channel Attacks

RT&L FOCUS AREA(S): Cybersecurity, AI/ML
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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 Army Combat Capabilities Development Command (CCDC) Armament Center leads the Army for cyber secured weapons, sensors and systems. CCDC sponsored a series of new generations of embedded systems and communication systems development for weapons. The current efforts focus on the capabilities of using deep learning technologies to enhance both hardware and software in relevant dense urban environments. One key aspect of these efforts is to enhance weapons to defend against side-channel attacks (SCAs).

DESCRIPTION: The current efforts focus on the capabilities of using deep learning technologies to enhance both hardware and software in relevant dense urban environments. One key aspect of these efforts is to enhance weapons to defend against cyber attacks; AI/ML techniques to identify and counter SCAs are of particular interest under this SBIR [1-9].

PHASE I: Government expects that basic investigations can be accomplished during Phase I. While deep learning neural network outperformed existing approaches in SCAs, there are several standing questions that require further investigations. 1) What are the meanings of the activation functions and weights correspondent to the keys and architectures under SCAs? 2) How to extract the features or group of features correspondent to the different components in one system architecture? 3) How to assemble/refine a neural network if we have trained neural network models for general components (i.e. different type of memory architectures)? To fully understand and utilize this powerful technique, the offeror should:

- Investigate the anatomy of the neural network.
- Identify the neural network models for basic components in architectures.
- Build and refine deep learning neural network using basic neural network models.
- Compare TA, ML-based approaches with the proposed deep learning neural network.

It is anticipated that the Phase I study will be unclassified.

PHASE II: Software/Hardware Implementations: during this phase, the Government expects the models/software modules developed in Phase I to be integrated into the existing sensors, weapons, and communication systems. We also expect the offeror to investigate plug-and-play hardware implementation that can upload the existing deep learning software. As an integrated component, this new hardware shall be inserted onto the existing sensors, weapons and communication system to perform real time cybersecurity.

It is anticipated that this Phase will be executed at the SECRET level.

PHASE III DUAL USE APPLICATIONS: The government expect the offeror to provide software products based on deep learning SCAs, and hardware products with our deep learning software upload to perform real time guardiancies in cyber security for existing CCDC systems. These products will have military engineer/soldier friendly interfaces to assist training and reconfigurations thereof.

REFERENCES:


1. L. Lerman, R. Poussier, G. Bontempi, O. Markowitch, and F. Standaert, “Template Attacks vs. Machine Learning Revisited (and the Curse of Dimensionality in Side-Channel Analysis),” in Constructive Side-Channel Analysis and Secure Design COSADE 2015, Berlin, Germany, 2015. Revised Selected Papers, 2015, pp. 20–33.
2. Chari, S., Rao, J.R., Rohatgi, P., “Template attacks.,” In: Kaliski Jr., B.S., Ko¸c, C¸.K., Paar, C. (eds.) CHES 2002. LNCS, vol. 2523, pp. 13–28. Springer, Heidelberg (2002)
3. Schindler, W., Lemke, K., Paar, C. “A stochastic model for differential side channel cryptanalysis,” In: Rao, J.R., Sunar, B. (eds.) CHES 2005. LNCS, vol. 3659, pp. 30–46. Springer, Heidelberg (2005)
4. G. Hospodar, B. Gierlichs, E. De Mulder, I. Verbauwhede, and J. Vandewalle, “Machine learning in side-channel analysis: a first study,” Journal of Cryptographic Engineering, vol. 1, pp. 293–302, 2011.
5. Alia Levina, Daria Sleptsova, Oleg Zaitsev, “Side-channel attacks and machine learning approach,” 2016 18th Conference of Open Innovations Association and Seminar on Information Security and Protection of Information Technology (FRUCT-ISPIT).
6. Liran Lerman, Gianluca Bontempi, and Olivier Markowitch, “Side channel attack:; B. Liu, K. Chen, M. Seo, J. Roveda, R. Lysecky. Evaluation of the Complexity of Automated Trace Alignment using Novel Power Obfuscation Methods, ACM Great Lakes Symposium on VLSI (GLSVLSI), 2018.
7. http://colah.github.io/posts/2015-08-Understanding-LSTMs/


KEYWORDS: Deep Neural Network, Artificial Intelligence, Machine Learning, Hardware, Software

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A20-103 TITLE: Beyond Li-Ion Batteries in Electric Vehicles (EV)

RT&L FOCUS AREA(S): General Warfighting
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Develop the next generation energy storage device for future U.S. Army vehicle platforms, to include hybrids and fully electric vehicles.

DESCRIPTION: In the next generation combat vehicle power generation, energy storage, energy recharge, and energy distribution capabilities will be critically important. Full or partial electrification of a vehicle will enable significant improvements in offensive capabilities, agility & maneuverability, extended operational duration, on-board and exportable power, and reduced signatures for vehicles and mobility systems.

To support the creation of a Highly Electrified Platform (HEP), there is a need for new energy storage technologies. The HEP will have extremely high energy demands that will require the vehicle to store several Megawatts of energy to ensure full system functionality in all operational environments across the range of military operations, from training to counter-insurgency to full scale war. This program of effort seeks to identify technology that:

- Provides, at a minimum, a specific energy of 400 watts per kilogram;
- Is capable of recharge at a rate of >2C; and,
- Maintains the same safety and reliability standards as today's Li-Ion batteries.

Awards made under this topic will be for a maximum of $50,000 with a three-month period of performance. The Phase I Option period amounts and durations are not changed.

PHASE I: Determine technical feasibility of battery reaching above standards. Develop preliminary storage technology design, model key elements, and identify subcomponents that demonstrate clear path towards meeting requisite minimum standards with a robust safety profile. Phase I deliverables include a design review including expected device performance, and a final report including Phase II plans.

Awardees selected for this topic will receive a maximum of $50,000 and have a period of performance of three months. Awardees also have the ability to voluntarily participate in an Army Application Lab cohort program. Companies will kick off the SBIR on location, meeting with end users, getting access to relevant equipment, and talking with key stakeholders. Virtual office hours, to be taken advantage of as desired, will be held weekly throughout the 12 week period of performance. Midway through there will be a virtual touch point with stakeholders to answer questions that may have arisen during the company's concept design week preparations. The final week of the program will involve an in-person outbrief to key stakeholders and AAL. While the cohort programming will be provided free of charge, participating companies must travel and participate out of company internal operating budgets. Proposers that plan to participate in the cohort (if awarded a Phase I) are encouraged to include travel costs for two cohort trips, within the continental US, of 2-3 days each for the in person programming. Details will be provided to awardees under this topic at Phase I award.

PHASE II: Develop a prototype of the battery to the specifications determined in Phase I design study. Conduct a formal risk assessment of the cell and thermal monitoring solutions for the transportation, storage and use of the battery in operational environments. Phase II deliverables include delivery of a prototype for further Army evaluation, as well as quarterly and final reports detailing design and performance analysis of the prototype.

Awardee(s) of this topic will have the ability to voluntarily participate in quarterly soldier touch-points, a 1-2 day trip within the continental US. Touch point will be provided free of charge, however participating companies must travel and participate out of company internal operating budgets. Soldier touch point details will be provided to awardee(s) under this topic at Phase II award.

PHASE III DUAL USE APPLICATIONS: Develop a manufacturing ready product design, capable of integration with at least one Army vehicle platform, and demonstrate technology integration as part of a vehicle system. Low rate production will occur as required. Potential commercial uses include electric commercial vehicles, trucks, and trains; and mass transportation infrastructure.

REFERENCES:

1. K. Xu, “Electrolytes and interphases in Li-Ion batteries and beyond,” Chemical Reviews, 114, 23, October 2014.
2. J. M. Tarascon, “Key Challenges in future Li-Battery research,” Philosophical Transactions: Mathematical, Physical and Engineering Sciences, Volume 368, No. 1923, p. 3227-3241, July 2010.
3. M. Braga, N. Grundish, A. Murchison, and J. Goodenough, “Alternative strategy for a safe rechargeable battery,” Energy & Environmental Science, Issue 1, 2017.
4. D. Stefano, et. al, “Superionic Diffusion through Frustrated Energy Landscape,” Chem, Volume 5, Issue, 9, p. 2450-2460 July 2019: https://doi.org/10.1016/j.chempr.2019.07.001
5. “Batteries: Beyond Lithium Ion,” Scientific American Custom Media, https://www.scientificamerican.com/custom-media/pictet/batteries-beyond-lithium/
6. j. Provoost, “Beyond the lithium-ion battery,” Physics World, https://physicsworld.com/a/beyond-the-lithium-ion-battery/


KEYWORDS: Battery; Energy Storage, Next Generation Battery; Beyond Li-Ion


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A20-104 TITLE: Wireless Power transfer

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Develop methods for high efficiency, long range wireless power transfer

DESCRIPTION: The Army is increasingly relying on expeditionary electric power -- from soldier borne equipment and novel UAS platforms, to life support and communication systems in command posts, and the desire to electrify combat vehicles. The Army's transition to greater reliance on electric power, and the increased likelihood of fighting dispersed on the future battlefield requires an overhaul of our electricity generating, transmission, and storage process.

In particular, innovations in wireless recharging capabilities for the growing commercial electric vehicle market has sparked interest in the way the Army will conduct future resupply convoys. Currently battlefield electricity is powered by diesel powered generators. Studies show that 52% of all US military casualties in Iraq and Afghanistan occurred during attacks on land based resupply missions. Additionally, dispersed elements may not be able to be resupply by traditional convoys in combat. While concurrent efforts to develop unmanned resupply vehicles are also underway, the Army is hoping to leverage wireless power transfer technology to significantly reduce the need for fuel deliveries.

The Army requires long range wireless power transfer that could include (but is not limited to):

- continuous wireless power transfer from point of generation to end user at a distance of greater than 3.5 meters
- variable transfer capacity to fulfill requirements at multiple echelons
- non-interference transfer methods which are secure from enemy interference
- ability to transfer power between moving transmitters and/or receivers
- has a robust safety profile

PHASE I: Provide proof of concept for wireless power transfer technology and capability estimates. This should also highlight any related safety risks at higher transmission capacities if any exist. Proposals are evaluated based on scalability, transfer capacity, modularity, and usability. that demonstrate clear path towards meeting requisite minimum standards with a robust safety profile. Phase I deliverables include a design review, and a final report including Phase II plans. Solutions will be chosen based on a holistic constellation of features including distance of transmission and safety profile especially in areas with personnel, electronic systems and munitions.

Awardee(s) of this topic will have the ability to voluntarily participate in quarterly soldier touch-points, a 1-2 day trip within the continental US. Touch point will be provided free of charge, however participating companies must travel and participate out of the company's internal operating budgets. Soldier touch point details will be provided to awardee(s) under this topic at Phase I award.

PHASE II: Develop and manufacture a functional prototype of wireless power transfer technology. Prototypes are required to have safety testing completed and available to highlight risks and mitigation techniques. Proposals are evaluated based on scalability, transfer capacity, risks of operation, and usability.Solutions will be chosen based on the same constellation of features as in Phase I, in addition to portability.

Awardee(s) of this topic will have the ability to voluntarily participate in quarterly soldier touch-points, a 1-2 day trip within the continetal US. Touch point will be provided free of charge to participating companies, however companies must travel and participate out of the company's internal operating budgets. Soldier touch point details will be provided to awardee(s) under this topic at Phase II award.

PHASE III DUAL USE APPLICATIONS: Perform power transfer operations with scenarios consistent with military operating environment and tactics. Potential commercialization use cases include wireless area charging of personal electronics devices, powering electronics during movement, and wireless power grids.

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KEYWORDS: wireless power transfer; WPT; recharge; wireless; electricity transmission

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A20-105 TITLE: Direct Wall Shear Stress Measurement for Rotor Blades

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Directly measure mean and fluctuating shear stress on a rotor blade.

DESCRIPTION: Aerodynamic loads on rotor blades are driven in large part by the dynamics of the boundary layer. Each point of the blade undergoes large variations in aerodynamic regimes throughout its operation; including tangential speed variations along the span, variation of both mean and fluctuating angles of attack as a result of the setting of collective and cyclic controls, as well as variation in the magnitude of the oncoming flow speed throughout the rotation in forward flight. All of these factors influence the behavior of the boundary layer and ultimately lead to the overall aerodynamic performance of a vertical lift vehicle platform.

Numerical calculation of these loads from high-fidelity computation fluid dynamics models is possible, but validation of sufficiently complex models is difficult without the ability to directly measure surface pressure and shear stress at various locations on the rotor blade system. Direct point-wise sensing of these quantities would permit model validation, as well as insight into the boundary layer physics. Many boundary layer models are developed from investigations that do not include the full complexity of the actual flows (i.e. 2D vs 3D, swept wing vs rotation, Mach and Reynolds number mismatches, etc.) and thus suffer from empiricism and questionable applicability to the vehicle system. Capturing the behavior of the boundary layer subject to all the relevant physical mechanisms has potential to significantly advance fundamental understanding of the unsteady boundary layer physics, which in turn will permit more advanced vehicle/rotor system designs.

Historically, hot-film anemometry and oil-film interferometry have been used as wall-shear stress measurements, but suffer from directionality, bandwidth, and the need to infer wall-shear stress behavior rather than sense it directly. A sensor capable of conducting these measurements will need to meet several challenges associated with operation in this domain: the sensor must 1) be able to be installed in rotor blades with realistic geometries, to include thin/narrow airfoils, 2) operate reliably while undergoing dynamic motion (e.g. pitch, rotation), 3) have sufficient bandwidth, dynamic range, directional sensitivity, and spatial resolution to capture relevant boundary layer physics (both mean and fluctuating quantities), and 4) provide a means for accurate readout during rotational operation of the rotor blade system. Current MEMS-based or photonics-based sensing modalities, while capable of direct wall-shear stress measurement in a steady environment, need additional development to address all of the above-mentioned challenges.

PHASE I: Perform an analysis of the required sensor performance metrics for implementation on a current full-scale vertical lift vehicle platform. The analysis should consider the challenges listed in the description, considering the boundary layer physics (both mean and fluctuating quantities) on a rotor blade for a full-scale vertical-lift vehicle, the effect of dynamic motion (e.g. pitch and rotation), methodologies for data readout from the rotating environment, and form factors capable of being integrated on realistic geometries without necessitating compromise of the rotor blade structure.

Provide a conceptual design of a wall shear stress sensor that addresses the operational environment; including form factor, acceleration compensation, readout connectivity, and overall integration with the rotor blade system.

Phase I will conclude with a viable sensor design for development in Phase II.

PHASE II: Develop a working shear stress sensor prototype that meets the identified requirements and demonstrate operation in a relevant environment. This phase should demonstrate and characterize all aspects of the measurement system, to include: 1) sensing element, 2) transducer, 3) measurement signal routing, and 4) all necessary electronics for useful signal output, such that the sensor can be directly utilized in conjunction with typical COTS data acquisition systems.

PHASE III DUAL USE APPLICATIONS: Refine prototype designed in Phase II for technology transfer for commercial and military applications, to include university laboratories, DoD laboratories and research centers, NASA vertical- lift research efforts and helicopter and wind-turbine manufacturers. Successful implementation of this measurement technology will enable future design and performance analysis of vertical lift systems capable of increased performance (range, endurance, efficiency, safety, etc.).

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KEYWORDS: wall shear stress, rotor blade, vertical lift, boundary layer physics

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A20-106 TITLE: Electronically-Tunable, Low Loss Microwave Thin-film Ferroelectric Phase-Shifter

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Design and development of low-loss and high-speed passive, analog, electronically-tunable microwave phase-shifter based on tunable thin-film ferroelectric (FE) materials for application in military and commercial communications systems operating in the frequency range of 1 - 12 GHz.

DESCRIPTION: Electronically-scanned antenna (ESA) systems based on phased-arrays are attractive for radar and on-the-move (OTM) communication systems providing advantages such as high-scan speeds, low control power, long-term reliability, high accuracy, and adaptive beam-forming [1,2]. These traits are advantageous, especially in the increasingly congested communications environments of modern warfare, where fast-changing operational environments require increasingly adaptive communication systems. Similarly, the demand for low-cost, high-frequency phase shifters is expected to increase in the commercial market to meet the growing demand for state-of-the-art transceivers designed for 5G communication. The congestion in the frequency spectrum, the need for highly power efficient operation, and the dangers of mutual interference are driving commercial networks to the exploitation of very agile narrow beams and dynamic null steering, mainly at base stations. Commercial vehicles such as boats and aircraft will have radar applications requiring steered beams. Military communication networks will have even greater requirements to mitigate the threats of detection, jamming, and interception in addition to the dangers of friendly interference. Furthermore, mobile military networks will not depend on stationary base stations, so they will require the dynamic steering of narrow beams at each network station. Military radars will be operating in this frequency range and will also require agile beam steering. A barrier to the use of phased array antennas in these applications is the system cost of the large number of phase shifters. Passive ESAs are composed of a large number of individual antenna elements, and are capable of electronically-controlled beam-forming and beam-steering by controlling the relative phase of the signal fed to each antenna element. The key component to passive ESAs is the electronically-tunable phase-shifter that adjusts the phase-angle of the signal arriving at an individual antenna element. In order to meet performance and cost requirements, high-performance phase-shifter components are needed that are both lightweight and compact, and the total phase variation needs to be 360 degrees to control an ESA with moderate bandwidth. Electronic phase-shifters tend to incur high insertion loss requiring active amplification; however, low-loss passive phase shifters are attractive since they are lower cost and require low power. Additionally, analog phase-shifters offer accurate phase control with continuously adjustable phase-shift, in contrast to digital phase-shifters that provide a discrete set of phase states controlled by phase-bits, and thus require a lower number of control voltages reducing the control-complexity [3]. Recent advances in the growth of tunable dielectrics and control of their domains demonstrate high intrinsic material Q values greater than 1000 [4-6] while maintaining high voltage tunabilities. These advances point to significant advances in affordable system capability due to the increased performance of tunable phase-shifters with high device Q values.

PHASE I: Ferroelectric material with intrinsic material Q's over 1000 is within the current state-of-the-art [4-6]. Phase I of this topic will require the demonstration that the proposing company can grow and characterize high quality FE thin films with high intrinsic material Q and electronic tunability of 10:1 within an operating range of +/- 100 V and within the frequency range of 1-12 GHz. Design a FE phase shifter device structure using this material and show, by analysis or simulation, its feasibility for an electronically tuned phase shifter capable of continuous phase shift of 360 degrees in the frequency range of 1-12 GHz with low insertion loss (<6 dB) and tuning speeds of 0.5 microseconds. Develop and maintain contact with ARL (Army Research Laboratory) researchers for advice on materials measurement and application. Provide materials sample to ARL researchers for confirmation.

PHASE II: Develop a synergistic model that couples predictive materials design with phase shifter design and performance. Characterize the frequency dependent dielectric properties of the FE thin films, including permittivity, tunability, and dielectric loss, using basic test devices. Establish and demonstrate the low loss integration of the thin film FE material with the device structure and optimize the insertion loss and tunability. If the FE material will be metallized, demonstrate Q's greater than 200 in MIM structures with 10:1 tunability with +/- 100 V tuning voltage. If the FE material will be used in a different device structure, demonstrate the low loss performance over the same tuning range. Demonstrate a phase shifter device capable of the metrics outlined above. Optimize the coupled device and FE material insertion loss and tunability, and a flat differential phase shift over the frequency range. Fully fabricate phase shifter prototypes ready for evaluation. Electrically characterize the phase shifter properties including S11 and S21 measurements over the frequency range. Deliver sample devices to the designated government laboratory for assessment and validation. Optimize the materials and device fabrication process for commercial scalability, considering the use of buffer layer or virtual substrate techniques for integration. Make contacts with communications and radar systems development offices such as CCDC C5ISR Center (Combat Capabilities Development Command Communications-Electronics Research, Development and Engineering Center)and industry systems providers to determine specific design parameters for a customer base. Develop a full commercialization plan to exploit these opportunities.

PHASE III DUAL USE APPLICATIONS: Develop components and circuits capable of meeting selected customer specifications for phase shifter circuits for applications in tactical radio and commercial wireless system handsets and radio systems. Describe specific military applications where the new technology will enable solution of specific problems. Provide a firm technology transition pathway for their developments (for example establish a production line for the fabrication of these circuits and components, produce the individual components for sale, or establish a licensing relationship with a company with a production capability). The path to commercialization is expected to first address radar and communications requirements for military and commercial systems, but is expected to expand into other wireless and electronic systems applications. Recommended transition paths are for mobile vehicular radio links via the Program Executive Office Command and Control or radars for the Program Executive Office Intelligence, Electronic Warfare, and Sensors. Significantly lowering the cost of the phased array antenna will bring the capability to use phased array systems to a much wider variety of military platforms, and therefore a greater market base. Commercial radio links and radars would be of interest to companies such as Lockheed Martin, Boeing, or Raytheon. Emerging 5G market will be explored for opportunities for further commercialization.

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KEYWORDS: phase shifter, electronically tunable, ferroelectric, thin film

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A20-107 TITLE: Automated Imagery Annotation and Segmentation for Military Tactical Objects

RT&L FOCUS AREA(S): Network, AI/ML
TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop and demonstrate a capability to automatically generate image annotation and segmentation data from Full Motion Video (FMV) of complex military tactical objects.

DESCRIPTION: There is a growing need to expedite the manual image annotation and segmentation process that precedes the development of algorithm development for vision-based sensor systems. Annotation (defining regions within an image) and segmentation (labeling pixels within an image) are data prerequisites to the development of computer vison-aided Automatic Target Recognition (ATR) algorithms, Machine Learning (ML), and Artificial Intelligence (AI) capabilities. Prior to the development of algorithms associated with ATR/ML/AI, FMV with new content of interest must be meticulously annotated and segmented by a human-in-the-loop so that the algorithms "understand" the FMV content. This is an extremely expensive, labor intensive task which is recognized as the single greatest bottleneck hindering algorithm development, ML, and AI. This effort will significantly reduce the level-of-effort required to manually annotate and segment tactically relevant information in FMV. Tactical military objects offer unique, additional challenges that commercial annotation and segmentation products do not address. Commercial applications of computer vision-based autonomous systems designed for object detection are focused on autonomous vehicle technology, which emphasizes a totally different application space. For example, most tactical objects are designed to blend into the surrounding environment, void of textual content, objects of interest appear in unexpected location/positions, and dissimilar in appearance to the objects which commercial products tend to focus on (i.e. text, persons, cars).

Many advances have occurred in the area of automated annotation and segmentation of FMV for the commercial industry due to requirements of self-driving automobiles. While similarities exist, annotation and segmentation for military tactical objects emphasize a different application space. Although the application space is different, the advances in state of- the-art deep learning models for optical flow computation and semantic segmentation in the commercial sector suggests a strong possibility of success in performing autonomous annotation and segmentation with sufficient accuracy (>95%) for military applications.

Typical annotation by an individual varies, but statistical studies indicate an average annotation time of 35 seconds per image for a given annotator. With the use of existing semi-automated tools and various methods, an average time of approximately 7 seconds is achievable with an accuracy of no greater than 70%, which is too low for military applications.

The optimal solution must be able to automatically analyze high-resolution FMV of military tactical objects and accurately produce XML metadata files that accurately annotate and segment the object's tactically relevant "features" which are used by ATR/ML/AIs algorithms operating on similar content of interest. Annotation / segmentation must support algorithms designed to confidently and consistently report attributes such as object classification, identification, and tactically relevant "features" such as the number of wheels, dimensions, track indicators, barrel length, antenna type/configuration, armament, camouflage, and other object attributes discernable by Electro-optical and Infrared imaging sensors. The capability must output XML data products which are consumable in many system architectures. The delivered capability should offer the user options to tailor the focus system's processing to specific attributes sought by the algorithm developer. It may be acceptable to preload the system with known attributes of the objects within the FMV file and the geospatial environment which the FMV was captured.

Prioritized requirements for this capability include: 1) autonomously annotate and segment military tactical objects within FMV files, 2) extract target features from the object which enable ATR/ML/AI development, and 3) minimize the amount of time a person must invest to the pre/post process the FMV.

PHASE I: The research effort shall explore technologies for automated image segmentation and annotation. Investigate and determine the characteristics of the solution that meets the requirements. Using a standard data set (Pascal VOC) of 10,000 images, create a semiautomated solution that meets the requirements: 1) 6 second average annotation time per image; 2) 95 percent average annotation accuracy across entire 10,000 image dataset; 3) resulting annotated images must enable ATR/ML/AI engines to identify "cropped" objects with 5% or less non-object content; 4) segmentation objective must indicate specified target feature 95% of the time that the attributes are resident in any image frame of FMV; 5) output data products in XML format metadata files that accurately annotate and segment the object's tactically relevant "features" which are used by ATR/ML/AIs algorithms. The primary deliverable is a detailed design and analysis documentation demonstrating a proposed system that meets the requirements and a demonstration of the research including software components, capabilities, and methods to be used to achieve the solution. Develop documentation for a proposal for the solution for Phase II consideration.

PHASE II: Phase II research should demonstrate the solution required to enable the capability. The focus of the demonstration must be the solution's ability to achieve the requirements specified in Phase I using three different standard datasets, each with a minimum of 10,000 images. Additionally, research to design, develop, and integrate a fully automated (no human-in-the-loop) solution to meet the requirements specified in Phase I. Demonstrate the fully automated solution (no human-in-the loop) that meets the requirements using three different standard datasets, each with a minimum of 10,000 images.

Deliver 1 semi-automated and 1 fully automated prototype to ARL for testing to validate that the fully automated system is capable of meeting the specified performance, including each of the primary requirements, updated documentation to specify all hardware, software, and firmware subsystems that defines the entire solution. The system must be able to meet all system performance specifications.

PHASE III DUAL USE APPLICATIONS: Further develop the platform into a fully functional product that can reliably perform fully automated (no human-in-the-loop) image annotation and segmentation, output data in the prescribed format, and provide the user effective options to precondition the system to produce a tailored output. In Phase III, given 10,000 images from FMV of five different tactical targets, the Phase III system must be able to collectively demonstrate the requirements specified in Phase II, with a repeatability rate of 99% or better when exposed to different FMV image data sets of the same target. Commercial applications include the medical field for accurately screening patients for diseases such as cancer.

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KEYWORDS: Image annotation and segmentation, machine vision, ATR, machine learning, artificial intelligence

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A20-108 TITLE: Multi-Solution Precision Location Determination System to be Operational in a Global Positioning System (GPS) Denied Environment for Static, Dynamic and Autonomous Systems under Test

RT&L FOCUS AREA(S): Cybersecurity, network
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Design and create a system that can provide precision location information on static, dynamic and autonomous systems under test within a GPS denied environment.

DESCRIPTION: Threats to GPS signals availability has created new GPS receiver designs with are intended to operate in a GPS denied environment to provide both timing and precise location data to the user equipment or as a part of a larger system relying on these data feeds for systems functionality. As the requirements to test GPS receivers designed to operate in a GPS denied environment increase, there is a need to have precision location data of the system under test to be used to determine effectiveness of the new GPS receiver designs in these environments. As most of the position location systems in use rely on using the GPS signals in space for determination of their position, there is a need to have a means to provide the precise location of the GPS systems under test on static, dynamic and autonomous moving platforms without having to rely on the GPS signals, using other means to determine precision location data on static and moving platforms. This effort will develop a capability that could be used in testing to ensure that true location data can be used as a baseline to the new GPS receiver systems in determining their ability to correctly determine location within the GPS denied environment.

PHASE I: Develop a method of determining precision location data not reliant on using the GPS signals as a means for determination. The method will be able to be used in a test range environment that allows for position location updates at a one second interval and able to be integrated on a dynamic moving platform and autonomous moving platforms. Accuracy of the data solution should be equal to that of the positon of a GPS receiver operating in a non-denied environment with full view of the GPS satellite constellation view.

PHASE II: Develop and demonstrate a prototype system operating in a GPS enabled environment and after successful demonstration, operate within a GPS denied environment with dynamic platforms and varied operating conditions.

PHASE III DUAL USE APPLICATIONS: This system could be used in a broad range of military and civilian Command, Control, Communication and Intelligence (C3I) applications where precision location determination is required in areas of potential GPS signals denial, or as a supplement to GPS signals determined location data. The prototype configuration will be matured into a stand-alone, portable, system that is deployable and operable by test support personnel and demonstrated in a realistic field-test environment.

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4. N/A

KEYWORDS: precision location determination, GPS denied environment, autonomous, moving platforms, testing.

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A20-109 TITLE: Environmentally Adaptive Free-Space Optical Communication

RT&L FOCUS AREA(S): network
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an approach to free-space optical communication (FSOC) that adapts to environmental conditions based on an estimate of current conditions impacting optical propagation (optical turbulence, extinction, jitter, etc.), via direct or indirect measurements, to improve communication performance.

DESCRIPTION: The military and commercial sectors have increasing needs for high-speed data transmission over long atmospheric paths. Due to their high directivity and high oscillation frequency, optical beams can transmit data over free space much faster than radio and microwave frequencies. Over the past couple of decades, there have been significant advances in optical source and receiver technology to reduce source power requirements, extend link distances, and increase link margins. Unfortunately, optical beams are much more susceptible to weather, clouds, turbulent fluctuations in the air's refractive index, and spatial motion in transmit and receive platforms [1].

Still, a FSOC system on a mobile platform will likely need to operate over a very broad range of conditions, e.g., link distance, geographic location, and time of day. In the past few years, there have been significant improvements in modeling environmental factors that affect the transmission of optical beams through the open air. This is especially true for the lower atmosphere in the boundary layer [2,3]. If environmental information, such as GPS coordinates, time of day, and meteorological measurements are available in real time, and the models can calculate optical turbulence parameters quickly, the FSOC system could adapt itself to improve its performance. This would provide additional resilience beyond that provided by the margin of the link power budget without resorting to a secondary radio frequency (RF) channel.

The end goal of this SBIR topic is to develop (Phase I and II) and demonstrate (Phase III) an approach to adapting a FSOC only system within engineering constraints combined with sufficient environmental modeling for a diverse range of geographic sites, times of day, and link paths in the atmosphere. A Phase I effort will develop a concept for adapting a FSOC system and identify the required model and input data. A Phase II effort would involve developing a fast modeling code and demonstrating the FSOC adaptation concept in computer simulation. Conducting laboratory or outdoor field experiments would be a plus. A Phase III effort would demonstrate the full prototype adaptive FSOC system in the field at multiple sites in day and night times.

PHASE I: Devise an initial approach to adapting a FSOC system (beam properties, wavelength, encoding, etc.). Identify a set of inputs needed to drive that adaptation and likely sources of the basic data (sensors, databases, etc.). This step will ensure that the developed approach is ready for a Phase II effort.

PHASE II: Using the results from Phase I, with validation and uncertainty estimates for phase II, finalize the FSOC design and demonstrate its use in extensive computer simulations. The simulations should be done with an emphasis on determining which parameters and inputs contribute most to improving system performance. Conduct relevant experiments, either in a laboratory or the open air, to validate correlation of computer simulations with empirical results. The correlation must include an estimate of uncertainty of the computer simulations for a variety of parameters and inputs. This step shall ensure that the developed approach is ready for a Phase III effort. In this manner, the FSOC prototype will provide initial validation of an optical communications performance.

PHASE III DUAL USE APPLICATIONS: Military application: Demonstrating the developed approach in a field environment at distances greater than 1 km with a moving transmitter or receiver platform. This step shall ensure that the developed approach is ready for realistic operations. The FSOC prototype will be used in field conditions to provide effectiveness predictions of optical communications in a variety of combat environmental conditions.

Commercial Application: The successfully demonstrated FSOC approach could be applied to commercial aircraft, vehicles, and trains where high speed data transmission is required.

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KEYWORDS: communication, lasers, meteorology, sensing


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A20-110 TITLE: Localized High Bandwidth Wireless Secure Mesh Network

RT&L FOCUS AREA(S): network
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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: Provide an equipment centralized network solution that allows the digitization of RF spectrum into packetized IF to transport massive amounts of data.

DESCRIPTION: The RF spectrum from any antenna source on the White Sands Missile Range shall be digitized, transported to, and faithfully reconstructed at a centralized operations facility. The architecture must allow for the ability to move ground modems and processing equipment away from antennas so that they can be shared among multiple antennas, allowing the ability for multiple grounds sites to access and work with the same data.

PHASE I: End product for Phase I should be a fully vetted design of a High Bandwidth Wireless Secure Mesh Network with an architecture that allows for the ability to move ground modems and processing equipment away from antennas so that they can be shared among multiple antennas, allowing the ability for multiple grounds sites to access and work with the same data.

PHASE II: End product for Phase II shall be a prototype that interfaces existing COTS technologies which generates a concentrated invisible beam of light which has properties similar to a laser but with incoherent output (safer and better for distance) than a laser. The beam does not spread out like typical light but stays in a close formation like a laser with billions of pulses of light in a single second which are detectable at high bandwidths greater than 10Gbps. Adding additional wavelengths to the beam is easy due to the design flexibility which will increase the bandwidth to 40Gbps and possibly over 100Gbps on a single beam. Multiple detectors filter out and separate the channels.

PHASE III DUAL USE APPLICATIONS: Fully automated networking system solution allowing for digitization of RF spectrum into packetized IF, subsequently allowing the secure transportation of massive amounts of data. Bandwidths greater than 10Gbps are desired, with a 40Gbps threshold and over 100Gbps objective on a single beam.

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KEYWORDS: High Bandwidth, Mesh, Wireless, Secure, Network, Localized,


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A20-111 TITLE: Non-Destructive Evaluation of Bonded Interface of Cold Spray Additive Repair

RT&L FOCUS AREA(S): General Warfighting
TECHNOLOGY AREA(S): Air Platform

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 section 3.5 of 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 purpose of this effort is to provide a non-destructive evaluation (NDE) inspection process to verify the cold spray bond line, ensuring good adhesion to the aviation component.

DESCRIPTION: It is the intent for the offeror to demonstrate acceptable cold spray material properties with non-destructive evaluation (NDE) method development identifying degraded cold spray bulk material properties and/or adhesion to a substrate. Qualified performers must demonstrate that they have a cold spray capability (in-house or partnership with a company). Samples must be provided containing intentional defects created by this carefully controlled cold spray bonding capability, and the NDE techniques to be developed must detect at least 90% of the defects.

The existing NDE method of fluorescent penetrant inspection (FPI) only evaluates the surface. The requirement is for sub-surface NDE of the cold spray bonded interface for use in structural flight critical safety item (CSI) restoration. Since bulk material properties of the cold sprayed coating may influence bond condition, NDE methods must also determine acceptable bulk material properties of the cold spray coating. NDE methods shall be explored and a solution provided to characterize these conditions. There is a need for developing a nondestructive examination method that will determine if the interface bond is intact without destroying the part. This is critical for flight safety on Army aviation components. Defects within the deposit can be the weak areas allowing for fatigue crack initiation and growth. These defects need to be ascertained so the cold spray deposit onto the substrate has acceptable strength, elongation, fatigue resistant, and other characteristics to ensure it will give the same life expectancy as the original component. It is desired that the NDE capability will be developed from this SBIR to ensure that the cold spray interface bond line is not compromised when it is applied and when it is returned to the depot for overhaul to ensure continued flight safe operation after overhaul.

Pre- and post-process with possible in-situ NDE development of the cold spray process shall be accomplished on cold sprayed coupons prior and after testing specifically ensuring no cracks, excessive porosity or contaminants, and good adhesion (25,000 psi). Use of cold spray process parameter adjustment or introduction of contaminants to establish a non-acceptable cold spray deposit is expected during research and development of the NDE method. Various NDE methods may include eddy current, ultrasonic, computed tomography (CT) radiology, or other techniques. The cold spray powder and process used should be sufficient to establish structural integrity on aluminum and magnesium substrates (Aluminum (Al) 7049 forged, Magnesium (MG) forged AZ80A, and Mg ZE41A) during the NDE development.

Typical acceptable cold spray deposit are adherent to the substrate material, showing a uniform continuous surface free from blisters, voids, spalling, chipping, flaking, cracking, lumps (berries), loosely adherent spattered particles, and other objectionable imperfections. Microscopic examination of the cold spray does not exhibit any cracks, excessive or massive oxides or porosity when examined at a minimum magnification of 100X per ASTM E3, E407, and E1920. Oxide and porosity content are usually less than 2 percent when viewed at 100X minimum per ASTM E2109. Acceptable bond strength is near the 25000 pounds per square inch per plug bond testing. No de-bonds or delamination are to be present in the cold spray bond line. Hardness minimum is 70 Vickers minimum on as deposited 6061 cold spray powder. The CCDC AvMC Aviation Engineering Directorate (AED) has tapped Army Research Laboratory's (ARL) cold spray research, however ARL recommended NDE process assessment of properties using frictional sliding (presented at cold spray action team (CSAT)) does not establish sub-surface evaluation at the degree of resolution needed in aviation CSI components. The success criteria is ability to detect degraded interface bond to an acceptable probability of detection (POD).

PHASE I: Develop NDE method(s) to determine an acceptable cold spray interface bond during the cold spray process, inclusive of cold spray coating bulk material properties. The innovation desired of phase I is to give the Army aviation the capability to detect subsurface (internal) cold spray flaws from the smallest critical size, interface delamination, bulk properties in thin, medium thick, and thick deposits. The offeror shall be able to inspect subsurface (internal) flaws for any linear size indications. (Note- current critical size visibly detectable on surface inspection via NDE method(s).)

Comparison example of external surface inspection criteria (using NDE method fluorescent penetrant inspection (FPI)) on critical safety items (CSI) requires detection of cracks and corrosion (any linearity size visually detectable) and thru-wall indications (any linearity size visually detectable), of which no indications are allowed. Using NDE surface method FPI, non-CSI parts (lower quality) may allow indications of up to 0.010 inch in diameter of porosity/cold shuts/shrinkage/inclusions.

The effort shall require cold spray of coupons with NDE development pre- and post-evaluation and in-situ of subsurface (internal). The cold spray ranges from the thin coatings (deposits) (0.010 -0.050 inch thick coatings), medium thick coatings (deposits) (0.1 – 0.5 inch thick coatings), and thick coatings (deposits) (0.5 – 1 inch thick coatings). This NDE developed method(s) should include the capability to detect the cold spray interface bond line for any linearity size delamination, cracks, porosity, contaminants, and weak cold spray bonded interface resulting from cold spray parameters (e.g. critical velocity, pressures, gas flow, etc.) while providing quantitative material condition results. The offeror will be required to develop detection methods for subsurface (internal) flaws in the thin and medium coatings, linear or diameter. If successful on the thin and medium thick coatings, then the thick coatings will be attempted as well.

Metrics for phase I include for thin (0.010-0.050 inch) and medium thick (0.1-0.5 inch) coatings (evaluation based on NDE with performance testing via coupon testing (ASTM E8, E466, R.R. Moore (bend/rotate)):

- Demonstrate NDE method(s) capability to detect flaws (cracks, delamination, porosity, contaminants, weak bond interface).
- Demonstrate NDE method(s) smallest critical size of flaws detectable (cracks, delamination, porosity, contaminants, weak bond interface). (Critical indication flaw size should equate (similar) to a visual discernment on external surface for indications less than 0.010 inch linear or diameter using FPI method )
- Demonstrate NDE method(s) capability to inspect bulk properties of the cold spray (densities, acoustics, etc. that are not influenced by interfaces (boundaries).
- Upon successful demonstration of thin and medium thick coatings, then thick coatings (0.5-1 inch) shall be demonstrated in subparagraphs a. through c.

For NDE detection development it is expected that an unacceptable cold spray process will require seeding of faults (parameter adjustment, contaminant introduction, etc.). The material characterization of the cold spray shall be accomplished during the research effort and be inclusive of failure mechanisms, residual stress, microstructure, microhardness, mechanical properties, etc. The deliverable of the project includes recommendation of inspection equipment and NDE method(s) along with substantiated results. All research and development processes shall be documented and reported for potential replication. NDE methods with greatest promise shall be highlighted and recommended for Phase II demonstration.

PHASE II: Deliverable will be the design, development, and fabrication of a prototype NDE method(s) from phase I to include motion control, data acquisition system, data reduction (software), used to detect sub-surface cold spray interface bond and bulk material properties characterization during research and development of statistically sound repeatable results for aerospace application of the cold spray process. The success criteria will be an established probability of detection (POD) 90 % with 95% confidence. The offeror shall develop a NDE method to along with the examination of the cold spray interface bond. This phase II will assess, describe, and develop a NDE method that will establish the ability to detect a particular defect, (delamination, crack, porosity, contaminants, weak cold spray bonded interface) along with identifying the size, orientation, and location of the defect. Typical four options that constitute the probability matrix of include:

- An item is flawed and the NDE method detects it (True Positive).
- No flaw exists and the NDE method indicates a flow present (False Positive).
- An item is flawed and the NDE method does not detect it (False Negative).
- No flaw exists and the NDE method has no indication of a flaw (True Negative).

Probability of detection (POD) studies such as this SBIR is requiring for development is to be done, possibly by plotting the accumulation of flaws detected by a newly developed NDE method against the flaw size of all flaws “detected” (or that produce a response over some threshold). Ideally all flaws over some critical size will be detected and flaws smaller than that are not “detected”. A common tool used for POD is the POD curve, probability of detection versus flaw height.

A demo system will be developed incorporating the NDE method including all data processing methods developed in Phase I and Phase II.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of Phases I and II, the actual NDE method will be implemented in a cold spray additive repair process for actual Army aviation components. The demo system built in Phase II will be modified and adapted for inspection of selected prototype part geometries. Finally, the cold spray repaired prototype components will undergo full scale fatigue testing as required by Aviation Engineering Directorate (AED) using the NDE demo system for inspection and quantifying degraded cold spray properties and adhesion. Upon successful completion of any further testing required (i.e. corrosion, etc.), a maintenance engineering order will be established allowing repair and overhaul production.

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5. ASTM B557, Standard Test Methods for Tension Testing Wrought and Cast Aluminum-and Magnesium-Alloy Products
6. ASTM E18, Standard Test Methods for Rockwell Hardness of Metallic Materials
7. ASTM E407, Standard Practice for Microetching Metals and Alloys
8. ASTM E2248, Standard Test Method for Impact Testing of Miniaturized Charpy V-Notch Specimens
9. ASTM E466, Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials
10. ASTM C633, Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings
11. ASTM E1097, Standard Guide for Determination of Various Elements by Direct Current Plasma Atomic Emission Spectrometry
12. ASTM E1920, Standard Guide for Metallographic Preparation of Thermal Sprayed Coatings
13. ASTM E 2109; MIL-STD-3021, Manufacturing Process Standard Materials Deposition, Cold Spray

KEYWORDS: Cold Spray, Nondestructive Evaluation (NDE), eddy current, ultrasonic, computed tomography

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A20-112 TITLE: Compact, High Performance Engines for Air Launched Effects UAS

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate low volume, high performance engine systems to power Air Launched Effects (ALE) unmanned aerial systems (UAS) for increased operational capability.

DESCRIPTION: Tactical requirements for ALE unmanned aerial systems are exceeding current capabilities for performance (payload, range/endurance), low noise capability, reliability, maintainability, and supportability. Mission requirements such as extended range/endurance, increased power, low altitude operation without detection, and high reliability are becoming paramount. These requirements are not currently fully realized with conventional rotary, internal combustion, or turbine-based propulsion. Electrical power requirements for advanced payloads is also increasing, which adds weight to the air vehicle. Current UAS conventional engines tend to be noisy, which can limit UAS operational capabilities. Various advanced engine concepts offer the potential for significantly increased power to weight/volume ratio. The objective of this topic is to develop advanced, small engines (approximately 10-30 horsepower) which can fit in a defined installation envelope while having low noise characteristics and low specific fuel consumption (threshold 1.2 lb/hp-hr, objective 0.6 lb/hp-hr). The threshold size for the installation envelope is no larger than 13 inch height by 10 inch width by 21 inch length, while the objective size is 10 inch height by 10 inch width by 21 inch length. The output shaft should be aligned parallel to the length axis. Specific power goals for proposed engines (including the weight of all ancillaries required for operation such as control systems, cooling systems, gearbox (if required to meet output speed below), etc.) are .5 hp/lb threshold and 1.5 hp/lb objective. Reliability goals for proposed engines includes mean time between overhaul (1000 hours threshold, 2000 hour objective) and mean time between essential function failure (1000 hours threshold, 2000 hour objective). Additional key capabilities include the ability of the engine to operate off of heavy-fuel (JP-8, diesel, and alternative fuels) and ability to provide power to electrical payloads (1 kW). Output shaft design speed should be 4000-7000 rpm.

PHASE I: During Phase I effort, all major components of proposed engine concepts should be, as a minimum, designed and validated via either modeling or subscale testing to substantiate the ability to provide adequate power for propulsion, fuel consumption for endurance, as well as meeting reliability, specific power, and volume goals.

PHASE II: Phase II will fully develop, fabricate, and demonstrate a demonstrator engine system in a ground test environment.

PHASE III DUAL USE APPLICATIONS: Phase III options should include endurance testing and integration of the enhanced propulsion system into an ALE UAS airframe and demonstrate the performance of the system with flight testing in an ALE mission environment.

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KEYWORDS: unmanned aerial system, propulsion system, heavy fuel engine, power to weight ratio, fuel efficiency, low noise

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A20-113 TITLE: Optical Based Health Usage and Monitoring System (HUMS)

RT&L FOCUS AREA(S): network
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Develop a Health and Usage Management System utilizing fiber optic inputs and sensors for operational data recording and analysis that will improve flight safety, mission readiness, and effectiveness.

DESCRIPTION: The Army is seeking novel approaches to developing a Health and Usage Management Systems (HUMS) that has the ability to collect data from a number of fiber optic sources that measure strain, pressure, temperature, and acceleration from critical components on the vehicle. Typical HUMS systems receive inputs from the airframe, engines, and avionics and analyzes the data in real time to provide updates on the state of the vehicle. Data trends such as an increase in vibration on a specific component can be used to identify the beginning of a catastrophic failure and provide the pilot with the information, preventing loss of the vehicle. Fiber optic based sensing and data collection has the advantage of being significantly lighter than more traditional measurement methods, immune to EMI from other sources, passive such that an RF signal is not emitted from the vehicle, and enables highly multiplexed sensing such that >40 measurements can be made on a single channel. With the increasing use of composite structures, the ability to detect and interpret fatigue failure and cracking in addition to vibration measurements is highly desired. Due to the flexibility of optical fiber systems, it is strongly encouraged that the developed system supports additional measurements and measurement locations on the vehicle. It is also strongly encouraged that offerers demonstrate a relationship with a successful military systems integrator as part of the transition plan.

The fiber optic HUMS will need to be tested in accordance with MIL-STD-810G specifications for environmental robustness. It will need to receive inputs from up to several sensing locations:

- Total volume of sensors: > 500 sensors, across >12 parallel optical fibers
- Simultaneous and concurrent detection across all sensors
- Absolute wavelength accuracy with traceable on-board referencing
- Continuous dynamic range (loss budget) of >20 dB per channel
- Flexible acquisition rates 2 – 5kHz
- Survivability and operation at vibrations up to 5 G rms, 15Hz to 2000Hz, per 514.7C-VI from MIL-STD-810G
- Long term operating temperatures of -30 to 85C, Storage temperatures of -50 to 125C, short term in-spec operating temperatures of -50 to 120 C,

PHASE I: Design a flight qualifiable the architecture for a HUMS system meeting the above specifications that receives inputs from fiber optic strain, temperature, and vibration sensors. Phase I should also demonstrate the flight readiness of key optical components and electrical designs in accordance with MIL-STD 810G specifications.

Paper study and some hardware.

PHASE II: Develop the architecture designed during Phase I into a testable HUMS system. Upon completion of the Phase II a prototype HUMS should be delivered to the Army for further testing.

PHASE III DUAL USE APPLICATIONS: The HUMS system developed during this effort has applications on similar civilian airframes that face many of the same challenges as their military counterparts. Once the system is developed it will be transitioned to the Project Management Offices for all airframes. The technology developed here would have significant bearing on the commercial airline industry as well.

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KEYWORDS: Health and Usage Monitoring (HUMS), Sensors,

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A20-114 TITLE: 3-D Microfabrication for In-Plane Optical MEMS Inertial Sensors

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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: MEMS inertial sensors using electromechanical readout approaches have achieved tactical grade performance in small inexpensive form factors. The objective of this effort is to demonstrate three-dimensional microfabrication approaches to achieve micro-optical inertial sensors capable of going beyond tactical grade while maintaining the form factors typical of current MEMS sensors.

DESCRIPTION: Army missile systems are continuing to become smaller and less expensive. In addition, these systems face ever increasing threats to GPS availability. These factors are driving advancement in small and inexpensive, yet high-performance, inertial sensor technology. MEMS technology has demonstrated small form factors for relatively inexpensive inertial components that are suitable for tactical grade operation. However, as missile systems decrease in size and must operate for extended periods of time in GPS-denied environments, future small inertial sensors must demonstrate increasingly higher levels of performance.

MEMS inertial sensors utilizing electrostatic, piezoelectric, and magnetic proof mass displacement readout approaches have achieved success in both commercial- and defense-related applications. However, there is a desire for improved performance suitable for navigation-grade applications. This program proposes the development of technology that could yield the next generation Micro-Electro Mechanical Systems (MEMS) navigation-grade inertial sensor. The majority of MEMS inertial sensors utilize electromechanical readout of the motion of a micromachined proof mass. It is anticipated that these “traditional” MEMS pickoff techniques (capacitive, magnetic, piezoelectric, etc.) will not be able to achieve the required performance levels. Optical readout of mechanical displacements has demonstrated high levels of resolution in macro-scale applications including precision movement and placement systems. In addition, optical techniques are common in high performance inertial sensors such as fiber optic gyros and ring laser gyros. Incorporating optical readout approaches into MEMS acceleration devices may yield sufficient resolution to achieve navigation-grade performance.

However, the integration of micro-optical components within MEMS devices suffers from multiple issues. Hybrid integration of micro-optical components is commonplace for electro-optic devices such as tunable lasers, modulators, detector arrays, and other complex optical systems. However, for MEMS components with released microstructures, the required microassembly processes suffer from the need to perform component alignment, place and contain adhesives, and attach components to movable structures. In addition, hybrid microassembly is not amenable to wafer-scale processing, leading to difficulties in controlling final component cost. Monolithic integration of micro-optical components within MEMS inertial sensors addresses these issues by providing benefits such as self-alignment and wafer-level fabrication. However, the fabrication of micro-optical components, such as lenses, mirrors, and beam splitters, directly within MEMS components has been limited primarily to the creation of out-of-plane features. These features can be used to realize out-of-place optical MEMS inertial sensors through approaches such as wafer stacking. However, there are few options for fabricating in-plane micro-optical features that can realize in-plane MEMS inertial sensors.

The goal of this program is to develop approaches to realize in-plane MEMS inertial sensors that utilize monolithically fabricated micro-optical components for precise proof mass position sensing, thereby enabling high levels of inertial sensor performance without increasing potential form factors and costs. 3-D microfabrication approaches can include such items as sidewall micromachining to achieve vertical high-quality micro optical surfaces, multi-level waveguide fabrication approaches to guide light between sources, detectors, and various micro-optical surfaces on the MEMS structure, self-assembled structures to create micro-optical functionality after chip fabrication, amongst other techniques. The performance goals for this effort are 1) range $\geq \pm 60$ g, 2) Bias Instability $\leq 20$ μg, 3) Scale factor stability $\leq 50$ ppm, 4) Volume $< 5$ $in^3$.

PHASE I: Conduct a design study with detailed fabrication and model development for each component of an in-plane optical MEMS inertial sensor. Predict in-plane optical surface quality for the selected 3-D microfabrication processes. Estimate optical MEMS inertial sensor performance based on potential optical quality. Perform proof-of-principle experiments to investigate 3D microfabrication process performance.

PHASE II: Develop and deliver a functional prototype MEMS inertial sensor with a 3D microfabricated optical pickoff. Characterize the resolution of proof mass displacement measurement. Characterize inertial sensor performance specifications.

PHASE III DUAL USE APPLICATIONS: Deliver a fully functional MEMS inertial sensor with a 3D microfabricated optical pickoff. Additionally, documentation verifying inertial sensor performance characteristics shall be included with each device delivered. Reported inertial performance characteristics should include scale factor, scale factor error, and bias instability. Measures of angle random walk and velocity random walk shall be included in the inertial sensor performance characteristics for gyroscopes and accelerometers respectively. The inertial sensor technology developed in this effort can be applied to commercial aviation, aerospace, and maritime guidance systems. The optical pickoff technology developed in this effort can also be applied to non-inertial microsystems such as telecommunication integrated optics modules, active alignment systems in microassembly approaches, and nanopositioning devices.

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KEYWORDS: MEMS, Optical Inertial Sensor, Displacement Measuring Interferometry

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A20-115 TITLE: Using Artificial Intelligence to Optimize Missile Sustainment Trade-offs

RT&L FOCUS AREA(S): AI/ML
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of 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 methods to use artificial intelligence (AI), machine learning, and real-time computational intelligence to optimize Army logistics and sustainment simulations and predictions for both legacy and future Army missile systems.

DESCRIPTION: The CCDC AvMC Logistics Engineering Lab (LogLab) developed a sustainment simulation capability for Army aviation using a government-owned software tool called System of Systems Analysis Tool (SoSAT). Multiple PM's use this capability to conduct analysis and provide input for major acquisition documents. The LogLab is looking to upgrade the simulation capabilities of the software tool using artificial intelligence and machine learning to optimize logistics outcomes for CCDC AvMC customers like Hypersonics. Artificial intelligence would determine strategies of sparing, costs, supply chain locations, maintenance staffing, maintenance levels, scheduled maintenance times, to best measure and optimize sustainment options and logistics support for Army missile systems. Identify missile platform life cycle metrics, such as Materiel Availability (Am), Operational Availability (Ao), sparing, cost, maintenance man-hours, and other KSA's, to be optimized by AI. Provide to a logistics engineer knobs to turn to see effects on metrics such as system reliability, system availability, system downtime, administrative delay time, maintenance man-hours, manpower, and OPTEMPO. Additionally, consider a Material Availability (Am) model to also include full life-cycle and fleet-wide sustainment concerns such as fielding schedules, recaps, resets, demils, software and hardware upgrades, modernizations, etc.

SoSAT is a government-owned software package and will be provided. Notional and/or representative Army missile reliability and supply data will be used. The size of the dataset will also be representative of actual datasets used and expected to be used by future Hypersonics systems -- a typical 30-year Army sustainment model is approximately 25GB, and multiple models could be combined, yielding datasets in the range of 100-200GB. Any AI solution will need to run on US-government network computers and will be export controlled.

PHASE I: Perform a design study to determine how to use artificial intelligence, machine learning, and real-time computational intelligence to optimize sustainment and logistics support. Deliver a final design of AI's capabilities, a simulation model of Army missile assets (including systems of systems), and a demonstration of an AI-infused logistics model capable of making intelligent trade-off decisions to meet specified PM threshold and objective sustainment metrics -- specifically, downtime and readiness levels as calculated by Army missile systems, using inputs such as failure rates, ALDT, repair times, and maintenance man hours. A successful design will be able to optimize support, minimizing missile system downtime and maximizing system availability, using logistics inputs (component failure rates, repair part shipping times, repair times, maintenance man hours and maintainer staffing). Designed AI must be capable of handling, learning from, living in, and analyzing datasets upwards of 200GB in size. Designed

AI must also show a 75% reduction in results data processing time over current methods, a 10% reduction in data input, import, and formatting time over current methods, and a 30% reduction in output dataset size. Test method to determine success for above metrics will be accomplished through analysis.

PHASE II: Deliver and implement a working prototype of an AI-infused logistics model (as designed in Phase I) capable of deep learning and making intelligent trade-off decisions to meet specified PM threshold and objective sustainment metrics. The model will also provide the capability to measure the impacts of technology insertions, obsolescence, reset, and other significant events in the entire Army missile platform's life cycle, and to optimize such downtime and upgrade scheduling over that typical life cycle. Prototype AI must be capable of handling datasets upwards of 200GB in size. Prototype AI must be able to learn from baseline sustainment datasets, learn from excursion datasets on the fly, and apply learned behaviors. Prototype AI must show a 100% reduction in results data processing time over current methods, a 20% decrease in data input, import, and formatting time over current methods, and a 50% reduction in output dataset size. Test method to determine success for above metrics will be accomplished through demonstration. Mission profiles and operations in the model will be based on notional Army missile concept of operations (CONOPS).

PHASE III DUAL USE APPLICATIONS: Deliver a polished and complete working AI-infused logistics sustainment model making intelligent trade-off decisions to meet specified PM threshold and objective sustainment metrics to all Army PM's and for current and future Army missile platforms. The final product should model and optimize logistics and sustainment at multiple levels of fidelity from battalions to component parts, from components to systems of systems, from individual missions to entire life cycles, use advanced web and cloud services to compute and be hardware-independent, may include an asynchronous mobile application to view and sort results, handle upwards of 1TB of data, and be hosted or otherwise available to all CAC-enabled personnel. Test method to determine success for above metrics will be accomplished through operations.

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KEYWORDS: artificial intelligence, logistics, simulation, modeling and simulation, sustainment, availability, reliability, maintainability, supportability, software development, machine learning, neural networks, real-time computational intelligence, data science,


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A20-116 TITLE: Distributed Beamforming for Non-Developmental Waveforms

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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: To facilitate the adoption of resilient communications within the Army by developing the capability to apply distributed beamforming techniques to non-developmental waveforms for cost effective communication systems with greater range and power-efficiency and lower detectability then current communications technologies.

DESCRIPTION: The US Army C5ISR Center is interested in the development of technology to enable the application of distributed beamforming communications techniques to non-developmental waveforms. Distributed beamforming techniques have matured significantly over the past decade, but currently rely on unique waveforms often with costly computational and hardware requirements. The ability to apply distributed beamforming techniques to non-developmental waveforms can greatly facilitate integration of the technology into tactical communications architectures.

Distributed beamforming using dismounted soldier radios can emulate an antenna array and obtain power and/or directivity gains which are proportional to the number of dismounted radios, and be used to deliver a common message to a mounted receiver or possibly another collection of dismounted soldiers. Benefits of distributed beamforming include energy efficiency, improved communication range (or an equivalent lowering in detection range with respect to an adversary), interference rejection, and possibly the ability to spatially multiplex streams of data if desired.

The C5ISR Center particularly seeks techniques, which can be used for squad level communications. The Army squad must be able to communicate with a separated parent vehicle in poor visibility or over restrictive terrain in a manner which reduces vulnerability to enemy interception/detection (LPI/LPD) and enhances Anti-Jam (AJ) capabilities in congested/contested environments.

The US Army SBIR office and C5ISR Center are requesting information related to distributed beamforming methods designed for dismounted soldiers where each soldier has a radio and omnidirectional antenna, and where each soldier acts as a node in the distributed dismounted beamforming system. The dismounted soldiers must be able to communicate, in a cooperative manner, with a radio mounted on a vehicle, where the mounted radio may use multiple antennas. The capability must demonstrate AJ/LPI/LPD characteristics while operating in a congested/contested environment. Waveforms in consideration for this effort should be non-developmental in nature. The ability to update existing tactical radios with this capability via software/firmware update is highly desirable. The approach should maximize portability and backwards compatibility to tactical radio systems which will support widespread implementation and reduce overall cost. Consideration will be given to government owned and government purpose waveforms. The Joint Tactical Networking Center (JTNC) DoD Information Repository and JTNC Tactical Communications Marketplace, both available at https://www.public.navy.mil/jtnc/Pages/home.aspx, are resources to gain access to these waveforms.

The proposal should contain information regarding the beamforming (or diversity) implementation, and specifically how LPI and LPD are improved by the beamforming methods. Furthermore, the proposal should contain any information regarding the characteristics of the beamforming methods that facilitate improved resistance to intentional and non-intentional interference, both from enemy and friendly forces in congested/contested environments.

Typical concepts of operation would include forward dismounted reach-back to a vehicular platform that may or may not be under condition of enemy electronic warfare (EW) attack (electronic support (ES) and electronic attack (EA)), support for route clearing operations that might use a Counter Remote Controlled Improvised Explosive EW (CREW) device to block enemy communications, and tactical dismounted operations in dense urban terrain typical of building search and clearing, which are assumed to be highly congested/contested environments.

The system must provide up-echelon communications to at least 5000m to a reach back node that is mounted or dismounted. The solution must also provide communications, AJ, LPI, and LPD capabilities when the reach-back distance is lower than 5000m. Frequency Bands of interest are VHF, UHF, L-Band, and S-Band. Real time voice, push-to-talk (PTT), and data demonstration is expected as a part of this effort. Open standard and non-proprietary interfaces shall be available for connection of audio and data connection ports.

Data rates will be available to support transfer of voice and position location information. Solutions which provide additional data rates which support file transfer and streaming video services are also of interest.

PHASE I: The Phase I effort shall include a feasibility study of the incorporation of distributed beamforming methods to non-developmental waveforms to include frequency offset and time/phase synchronization as well as the impacts of other waveform aspects such as modulation and coding. Additionally an overall consideration of system architecture feasibility incorporating the various individual blocks (modulation, synchronization, demodulation, etc.) should be included.

An analysis of the theoretical limits of the various technical approaches shall be presented in addition to any practical limitations for the approaches. Analysis should be reinforced with simulation of the approaches. The Phase I effort will identify the optimal approach and provide a recommendation for Phase II implementation. The Phase I deliverable will be a report documenting the results of the feasibility study and simulation software with short exemplary use-cases for the simulation software allowing reproduction of some key simulation results from the report.

PHASE II: The Phase II effort shall implement and demonstrate the operation of a TRL 5/6 prototype distributed beamforming system using a non-developmental waveform(s). The prototype systems shall incorporate the techniques researched in Phase I. The prototype shall be delivered to the government with an associated user manual and a report documenting the results of the Phase II effort.

The system is expected to be evaluated and demonstrated at the Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, and Reconnaissance (C5ISR) Center Ground Activity in Ft. Dix, NJ. The demonstration shall include full beamforming with a minimum of 4-nodes. The system architecture should be scalable and support team sizes of at least 11-nodes. It is further desirable to support squad-to-squad beamforming without a dedicated base station. The Army is interested in performance in unobstructed line of sight (LOS), restricted, and urban terrains under benign and contested electromagnetic environments.

The Phase II effort shall include an operationally relevant field demonstration of the prototype systems, which demonstrates at least real-time transfer of voice/PTT and position location information (PLI) data. Demonstration of higher throughput applications is desirable. The test environment shall be a GFE provided test facility.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will focus on reducing the size, weight, and power of the Phase II prototype, maturing the prototypes to TRL 6/7 for integrating into the appropriate Army Program of Record. The technology developed under Phase II may also be modified and transitioned to the commercial cellular industry for appropriate use in 5G (or other) systems. The capability proposed in this SBIR is beneficial to commercial uses for first responders in disaster relief communications where critical communications infrastructures are unavailable. Distributed beamforming of small teams increases the reach-back communications distances; especially in challenging environments with path obstructions such as buildings or foliage.

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KEYWORDS: Communications, distributed beamforming, cooperative beamforming, collaborative beamforming, synchronization, radiation pattern, near-field, far-field, space-time, electronic warfare, interference mitigation


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A20-117 TITLE: Lens Antennas for Resilient Satellite Communications (SATCOM) on Ground Tactical Vehicles

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop and demonstrate a vehicular mounted, On the Move (OTM) lens antenna capable of satellite communications with Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geosynchronous Earth Orbit (GEO) constellations simultaneously.

DESCRIPTION: The Army must leverage emerging LEO and MEO satellite service for tactical communication to remain competitive with foreign adversaries. The Army intends to integrate this capability into the existing Army GEO SATCOM terminals, to provide resilient transport links for multiple networks simultaneously.

As the technology development organization for the U.S. Army Futures Command (AFC), the Command, Control, Communication, Computers, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) Center, provides research, development and engineering support for Army satellite communications. In this role, STCD is seeking to partner with a small business to develop a new satellite antenna capability of supporting communications diversity on the battlefield. The focus is on providing an affordable technology that has the potential to meet performance requirements to close multiple simultaneous connections to geosynchronous and other Wideband SATCOM systems, typically at X, Ku, and Ka bands. The antenna technology is required to meet Size, Weight and Power (SWaP) requirements for integration on a ground tactical vehicle. The antenna technology will be required to support tracking for LEO, MEO and GEO satellites.

The antenna must present an innovative path forward for cost reduction that will contribute to an affordable resilient next generation tactical terminal with multi-beam capability. The multi-beam antenna technology should be capable of supporting multi-megabit per second connections to multiple satellites simultaneously in different types of orbit, and be easily deployed. The technology is meant to be deployed on a ground tactical vehicle and should use commercial processes to drive affordability. This capability when complete will support added resiliency for the U.S. Army and Multi-Domain Operations (MDO) mission threads in a contested environment which aligns directly with Army Modernization Priorities, Long Range Precision Fires, Next Generation Combat Vehicle and Army Network.

Historically, parabolic dish antennas have been the chosen architecture for Tactical SATCOM systems. These systems make up the majority of the Army's tactical vehicle inventory. Parabolic dish antennas offer a low cost solution, with antenna performance that meets military requirements for Effective Isotropic Radiated Power (EIRP), Receive Gain / Temperature (G/T), and SWaP. However, these systems are limited in providing multi-beam and multi-band solutions necessary for an integrated LEO, MEO, GEO SATCOM capability.

A second type of antenna, heavily used for Military SATCOM are phased arrays. These antennas offer multi-beam and multi-band solutions, but are often challenged with the total cost and field-of-regard (i.e. performance at low elevation angles) which is critical for performance on tactical vehicles. A new generation of Army tactical terminals is necessary to meet existing military performance requirements and provide a multi-beam, multi-band SATCOM capable solution, with the broad field-of-regard critical for Army tactical vehicles, at a cost the Army can afford.

Lens antennas offer a host of new architectures, from which to build a multi-band, multi-beam terminal. Lenses, similar to dishes, passively focus Electro Magnetic (EM) waves which greatly reduces antenna cost. Further, lens technology offers 3-dimensional way to collect electromagnetic waves, and therefore provide the field-of-regard critical for Army tactical vehicles.

PHASE I: Develop an initial design of a SATCOM lens antenna and terminal, meeting the Government performance requirements for Tactical SATCOM OTM (available from Government TPOC, upon request). The initial design should evaluate the full SATCOM terminal system, and utilize modeling and simulation to support the design.

PHASE II: Develop functional prototype SATCOM lens antenna and terminal. Demonstrate SATCOM connectivity over LEO, MEO, and GEO satellites, in a laboratory setting.

PHASE III DUAL USE APPLICATIONS: Package the potential solution for a field based test. Demonstrate SATCOM connectivity over LEO, MEO, and GEO satellites, in a field environment. Engage commercial partners to use the product in this field test alongside military operation.

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KEYWORDS: Communications, Printable nanocomposite inks, lens, Wideband SATCOM, Additive manufacturing, antennas

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A20-118 TITLE: Novel, Low SWaP-C Unattended Ground Sensors for Relevant SA in A2AD Environments

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop and demonstrate novel, very small, inexpensive radio frequency (RF) sensors that can be distributed in mass quantity over an operational zone to gather relevant Situational Awareness (SA) data on millimeter wave signals.

DESCRIPTION: The US Army Combat Capabilities Development Command (CCDC) C5ISR Center is interested in experimenting with low-cost, very small Size, Weight, and Power (SWaP) unattended ground sensors (UGS) to maintain situational awareness (SA) within a signal dense (e.g. urban centers) and contested (e.g. limited air superiority) area of operations that require a ubiquity of sensors not achievable by conventional means.

The UGS would be readily distributed within an area of interest to provide the ability to sense the Cyber-Electromagnetic Environment (C-EME), allowing for the acquisition of data required to achieve Cyberspace Situational Understanding (CYBER SU) and improve network survivability. The collected sensor data would support multiple objectives, to include environment mapping, specific signal of interest detection and geo-referencing, and battle damage assessment. In addition, the UGS could be deployed hundreds of miles forward of a Forward Line of Troops (FLOT) from platforms such as high altitude (i.e. >60K feet) balloons to support acquisition of target data for long-range precision fires.

The sensors could leverage emerging Internet of Things (IoT) protocols (or comparable performing waveforms) for data retrieval. Sensors will at a minimum contain the following core functionality: GPS, CPU, non-volatile memory storage, data retrieval waveform and Tx/Rx chain, power management system (to include battery), accelerometer (optional, but highly desirable), and compass (optional, but desirable). Given the small size, weight, power, and cost objectives, it is envisioned that such sensors would only perform a single specific sensing objective. However, the design would ideally allow for the rapid integration of various different types specific EM signals or other modalities (i.e. seismic) of interest within the core sensor package.

C5ISR Center is seeking to partner with a small business to develop UGS that can affordably be distributed in mass quantities. The partner should analyze and describe trades involved in the various size, weight, power, cost, and longevity envelopes.

Other Design Considerations:

- Given the small size, weight, power, and cost objectives, it is not envisioned that sensors will be able to communicate and collaborate with each other. However, this is not prohibited.
- A persistent connection between the data aggregation system and the sensor field cannot be assumed. The data aggregation system may only be present within range of the sensor field for a transient amount of time.

PHASE I: Develop an understanding of the key technical challenges that exist to support this concept. Identify components and build models (to include power budgets) of the very low cost, highly distributable unattended sensors described above. Conduct trade off studies on the use of existing IoT protocols, or comparable data retrieval waveforms. Work with the government to determine initial desired EM signal for the sensor to detect. Deliver a technical report of Phase I results.

PHASE II: Develop baseline UGS prototypes and demonstrate the sensor with a relevant representative environment. Demonstrate the use of identified data retrieval waveforms to collect data from the UGS as selected from Phase I studies. Deliver multiple prototypes, in sufficient quantity, for C5ISR Center to fully vet the operational concept and performance of such a capability.

PHASE III DUAL USE APPLICATIONS: Advance the UGS sensor to TRL 7/8 and MRL 8. Modify the baseline UGS prototype design and develop variants that collect on additional EM signals and provide other functions such as seismic and chemical, biological, radiological and nuclear (CBRN) monitoring.

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KEYWORDS: Network/C3I, Long-Range Precision Fires, Battlefield Internet of Things (IoT), Unattended Ground Sensors


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A20-119 TITLE: Efficient Near Field Charge Transfer Mediated Infrared Detectors

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a scalable and low cost novel charge transfer hetero-interface architecture for high quantum efficiency infrared (IR) detector technology operating at near room temperature with response cutoff wavelengths of 5 and/or 10 micron IR radiation.

DESCRIPTION: Infrared imaging systems have been an important capability for the U.S. Army to ensure day and night situational awareness. In future conflicts, it would be necessary to deploy imaging capability to squad and individual Soldiers. While Longwave Infrared (LWIR) uncooled thermal imaging capability is gradually becoming available to Soldiers, these cameras do not offer flexibility in F/#, sensitivity, frame-rates, or range. High performance Midwave Infrared (MWIR) and LWIR quantum detector based imaging systems can solve many of these issues. However, the cooling requirements, Size, Weight and Power (SWaP) and high cost of production prevents high performance systems at the Soldier level and smaller platforms. Traditional approaches to increase operating temperature in MWIR and LWIR detectors that can operate near room temperature have been unsuccessful. A new approach whereby photon to electron transduction that take advantage of efficient charge transfer across a hetero-interface to separate electron-hole pairs is needed.

A recent body of research1-3 in two-dimensional materials has demonstrated promising new optoelectronic devices based on near-field coupling via interface charge transfer. More studies are needed to understand the hetero-interfaces. The underlying concept in these studies is to implement mechanisms similar to Förster or Drexel energy transfer for electron or hole collection leading to very efficient processes. These studies also show promise to increase the operating temperature. For example, energy transfer across van-der-waals hybrids of graphene and transition metal di-chalcogenides may occur via simultaneous two-way electron transfer via exchange interaction or near-field non-radiative energy transfer mechanisms such as dipole-dipole coupling. It should be noted that these studies have been mostly focused on detection of near infrared radiation. There has not been any major work in the longer wavelengths.

This topic aims to understand and develop MWIR (2-5 micron) and/or LWIR (8-12 micron) detector technology that can operate near room temperature by implementing and testing the efficacy of the above-stated ideas. The goal is to demonstrate operating temperatures of greater than 250K (MWIR) and 150K (LWIR) with quantum efficiencies better than 60% in both bands. Solutions are being sought for novel innovative concepts to develop either or both bands.

PHASE I: Develop a theoretical model and optimize the optical and electronic charge transfer processes in the chosen hetero-interface structure. Understand the underpinning processes to increase the charge transfer efficiency, interface traps and loss mechanisms. Demonstrate the concept and feasibility of the proposed approach by fabricating single detectors and conducting appropriate materials and detector characterization. Demonstrate proof-of-principle to achieve the above-stated goals.

PHASE II: Based on the Phase I results, perform further development and improvement leading to demonstration of a small array (32 x 32 or larger), test device characteristics in a fan out configuration and deliver to the Government. Conduct a full trade study analysis of the array to establish the case for scalability to larger arrays. Integrate the appropriate array with available Commercial-off-the-Shelf (COTS) ROIC, and build prototype for final delivery of one unit to the Government for laboratory testing.

PHASE III DUAL USE APPLICATIONS: Develop a manufacturing and commercialization plan by partnering with an established IR camera manufacturing firm. Address any shortcomings in the camera design to meet military applications and requirements. These may include applications such as helmet-mounted, weapon-mounted, and Tier I and II UAS for Intelligence, Surveillance, and Reconnaissance (ISR).

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KEYWORDS: MWIR, LWIR, Infrared, Detectors, Focal Plane Arrays, High Operating Temperature

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A20-120 TITLE: Very Small Pixel Uncooled Longwave Read-Out Integrated Circuit for Enhanced Sensor SWAP and Range Performance

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a read-out integrated circuit (ROIC) for use on an uncooled longwave infrared (LWIR) bolometer focal plane array (FPA) based sensor having a pixel pitch of 6–8.5 microns. This will enable lower size, weight, and power (SWaP), higher resolution uncooled LWIR sensors for Soldier borne and vehicle mounted applications.

DESCRIPTION: The Army makes extensive use of uncooled bolometer sensors throughout its air, ground, and Soldier portfolios. In nearly all cases there is a SWaP concern, and for many applications it is paramount. A way to increase sensor performance for a given SWaP is to decrease the pixel pitch. The current standard pitch is 12 µm. DoD and industry investments are being made to improve pixel design to enable small pixels, but currently no ROICs exist to take advantage of these investments.
As the pixel gets smaller, it becomes more of a challenge to fit appropriate ROIC circuitry within the available space. To overcome this hurdle, hybrid or fully digital circuit architectures may need to be used, perhaps in conjunction with novel physical architectures and fabrication techniques. However, the most desirable approaches will include as many as possible of the following features:

- ≥ 120 Hz full-frame frame rate, preferably ≥ 240 Hz; windowing to even higher frame rates
- Very low power, suitable for small autonomous platform or Soldier-borne applications
- Resolution of ≥1280×1024 pixels
- Bolometer-limited noise performance (ROIC does not significantly degrade noise performance of bolometer)
- Low-cost fabrication techniques and processes
- Very high intra-scene temperature dynamic range

PHASE I: The proposer shall design and model a small pixel ROIC for uncooled LWIR bolometer sensor applications that supports as many of the desired features listed above as possible.

PHASE II: The proposer shall fabricate a small pixel ROIC based on phase I results. At a minimum, results from a device verification test (DVT) for fabricated ROIC wafers must be presented. Collaboration with one or more bolometer manufacturer during this phase is highly encouraged to ensure that the ROIC will support realistic bolometers (e.g. physical form factor, pixel resistivity, etc).

PHASE III DUAL USE APPLICATIONS: With an industry partner, determine an appropriate transition or upgrade path to an Army or DoD customer. Deliver prototype camera systems with 1280×1024 or better resolution for investigation of a variety of problems of commercial and military relevance to the Army where high performance is required in a low SWaP-C package. It is expected that the proposer will partner with one or more bolometer manufacturer during this phase to fabricate appropriate bolometers on the ROIC and build of camera.

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KEYWORDS: ROIC, readout integrated circuit, uncooled LWIR, bolometer, thermal, infrared


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A20-121 TITLE: Polarimetric Modeling and Visualization

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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 models and visualization tools for multi-modal polarimetric imagery to enhance detection, recognition and identification.

DESCRIPTION: Polarization imaging provides improvements in Detection, Recognition, and Identification (DRI) of objects through contrast enhancements and clutter suppression. The polarimetric data sets are multi-modal and include polarization magnitude, orientation, and conventional intensity information. The physics behind polarimetric signatures is complex and is dependent on the material properties of the scene elements, the shape and the surface characteristics of the objects in the scene, the look angle of the sensor, the relative position of any illumination sources, the relative temperatures of the objects in the scene and the background, and background conditions including weather, cloud cover and the presence and temperature of objects in line of sight of the imaged field of view. Although a first principle model that includes all of these considerations would provide a means to analyze situations and mission parameters in which the enhancement from polarization sensing is optimized, an accurate physics-based model is not practicable. Instead, we seek a hybrid empirical/physical model based on physical modeling and enough testing to develop empirical detection models that can be used to set the mission parameters. Visualization tools are needed to assist a human observer in rapidly detecting and identifying threats in a scene. What is needed is the modeling to predict what should be happening and the visualization tools to achieve successful DRI.

The proposer shall collect or acquire infrared polarimetric data (short-wave, mid-wave, or long-wave) under a variety of conditions and use this data for model development. Detection performance must be quantified through established published metrics. The empirical detection model would ultimately be used for some or all elements of the DRI process and may be implemented into a mission planning tool. The proposer shall develop visualization tools by exploiting the multi-modal nature of polarimetric imaging and thus improve DRI.

PHASE I: Develop and design empirical/physical process for optimizing multi-modal polarimetric image collection with a limited set of parameters. A complete set of parameters will be identified and the subset for Phase I development delineated. Analysis to demonstrate the efficacy of the model is sufficient for a Phase I demonstration. A path for algorithm improvement in Phase II will be established.

PHASE II: Execute the plan developed in Phase I and continue algorithm development. The complete set of mission parameters will be included in the model. A user interface will be developed to facilitate easy input of the parameters. Sufficiently large data sets for development and test will be collected. The algorithms will be implemented on a real-time computing platform and demonstrated.

PHASE III DUAL USE APPLICATIONS: Provide a validated approach for predicting polarimetric camera performance for a variety of military applications and programs. For military applications, this technology will contribute to route clearance, countermine operations, drone-based ISR, and missile seekers.

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KEYWORDS: infrared, polarimetric imaging, image enhancement, machine learning, artificial intelligence


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A20-122 TITLE: Infrared Transparent Adhesive

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an optical adhesive that is transparent in the Mid-Wave Infrared (MWIR) (3-5 µm) and Long-Wave Infrared (LWIR) (8-12 µm) wavebands.

DESCRIPTION: The U.S. Army develops advance optical sensor components and systems to enhance the situational awareness, survivability, and lethality of the Soldier. To complement these advancements in sensor technology, the Army is seeking novel optical adhesives to facilitate the fabrication of the next generation of sensors. Currently, there is no commercially available adhesive suitably transparent (>0.95) in the MWIR and LWIR. This limits the fabrication methods of imaging systems that operate in these bands. An IR transparent adhesive will allow for the fabrication of unique optical elements, new methods of bonding focal plane arrays to read-out circuits, and development of novel structures such as metalens and structured coatings. An adhesive that meets the metrics of MWIR and LWIR transparency of >0.95 through a film of 0.5 mm, has a reactive index between 2 and 3, maintains a bond through 100 temperatures cycles of -55° to 125° F, and has maximum tensile stress of greater than 20 N/mm2, would find many applications in the Army modernization process. Including the fabrication of imaging systems for the Next Generation Combat Vehicle (NGCV), Future of Vertical Lift (FVL), and Soldier Lethality.

PHASE I: The proposer shall complete a conceptual design of and modeling of an optical adhesive that is transparent in the MWIR and LWIR. This shall include a molecular level design and then modeling of IR transmission.

PHASE II: Using the results of Phase I, synthesize and test an adhesive to meet the performance metrics. For a ZnS to ZnS and a ZnS to Al bond the adhesive should have a maximum tensile stress of greater than 20 N/mm2, refractive index of 2.2, persist over 100 temperature cycles of -55° to 125° F, and have an average transparency of 0.95 across the MWIR and LWIR for a 0.5 mm film. At the end of phase two the adhesive will delivered to the U.S. Army CCDC C5ISR Center for further testing.

PHASE III DUAL USE APPLICATIONS: Transition applicable materials to a production environment with the support of an industry partner as, needed. The finalized adhesive that meets the appropriate performance metrics can be transitioned to applications such as Soldier Borne Sensor (SBS), Individual Vision Augmentation System (IVAS), and dual band sensor systems in support of the Army modernization priorities such as an the Next Generation Combat Vehicle, Future Vertical Lift, and Soldier Lethality. Commercially, this technology will be widely applied in devices that use infrared imaging such as thermal mapping, scientific research, and medical imaging.

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KEYWORDS: Adhesive, Broadband IR, Imaging, Sensors, Manufacturing

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A20-123 TITLE: CdZnTe Substrate Screening

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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: This topic seeks the development of a non-destructive technique to unambiguously identify those subsurface defects within the CdZnTe substrate which cause large defects in the epitaxial HgCdTe film. This non-destructive technique shall be able to be scaled up to a manufacturing capability for rapid low cost screening of large CdZnTe substrates before HgCdTe epitaxial film growth is initiated.

DESCRIPTION: HgCdTe infrared detector array technology has improved significantly over the last decade. Single element mm sized detectors made from bulk HgCdTe crystals in the 1960s have been transformed today through research into arrays having more than one million elements with each element measuring below 20 micrometers. This has resulted in DoD infrared systems having much greater sensitivity at a much larger field of view. One major drawback to such large arrays, however, is the yield of such arrays is dramatically reduced by large defects in the HgCdTe film which cause many adjacent HgCdTe detectors to be defective with high noise and lower signal. Recent research has identified the cause of some of these large defects as arising from an imperfect CdZnTe substrate surface. Even after addressing this issue, however, large HgCdTe epitaxial film defects are still driving down the yield of large arrays making their costs rise to prohibitive levels for some applications. New non-destructive technologies are sought which will identify defects below the surface of the single crystal CdZnTe substrate which cause large, yield limiting defects in the HgCdTe films. This technique should be able to be rapidly applied to 7cm × 7.5cm and larger substrates in a manufacturing setting.

PHASE I: Demonstrate correlation between defects identified in the subsurface region of the CdZnTe substrate and large defects in the epitaxial HgCdTe film grown on the same substrate. This correlation shall be shown for a minimum of six defects on at least two different substrates. The HgCdTe films shall be at least five micrometers thick. The composition of the HgCdTe films shall be chosen to represent that composition typically grown which requires large format focal plane arrays. The films shall be grown by a state-of-the-art HgCdTe foundry producing state-of-the-art large HgCdTe arrays.

PHASE II: Modify the subsurface CdZnTe defect detection system to allow for non-destructive rapid inspection of substrates at least 7cm × 7.5 cm in size within the two year period of performance. Demonstrate prototype system on several 7cm × 7.5 cm films with large defects in the films. The prototype system shall demonstrate good correlation between the defects found in the CdZnTe subsurface and large defects seen on the HgCdTe film on the same substrate.

PHASE III DUAL USE APPLICATIONS: Transition operation of a single wafer non-destructive system to HgCdTe foundry operators. Provide supporting documentation for its operation and maintenance. Correlation of subsurface CdZnTe defects with large HgCdTe defects shall be greater than 90%. Time to non-destructively screen a 7cm × 7.5 cm CdZnTe substrate shall be less than 1 hour. Yield of large HgCdTe arrays shall be demonstrated to increase at least 25% after using this non-destructive inspection system in the HgCdTe foundry. Deliver a lot of substrates and large arrays for verification testing to demonstrate quality, consistency and reproducibility of this inspection method.

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KEYWORDS: Infrared detectors, CdZnTe substrates, HgCdTe epitaxy



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A20-124 TITLE: No burden / low burden biological air sampler

RT&L FOCUS AREA(S): Biotech
TECHNOLOGY AREA(S): Chem Bio Defense

OBJECTIVE: To develop a passive biological air sampler that integrates into current Personal Protective Equipment (PPE) ensembles. It should be easily deployed and tested in all / many current fieldable biological detection platforms.

DESCRIPTION: Novel technology is needed to overcome the shortcomings associated with this lack of portability and burdensome logistical train associated with biological air samplers. Innovative sampling solutions are sought that integrate with limited burden into or onto personal protective equipment (PPE) while eliminating the need for an externally powered air sampler, maintenance, and the overall logistic burden associated with processing the sample matrix from deployment to use in fielded biological detectors. Potential solutions may include novel media (e.g., gels or adsorbent fabrics), passive concentrating technology, or integrated into / onto current fielded respiratory systems. The goal is to develop a lower maintenance, lower profile, and lighter weight biological air sample matrix add on / passive flow device for end user exposure surveillance. Current technology turnaround time to gather actionable knowledge of the presence of a biological in the air is far too long. This technology developed would reduce that time and reduce the burden of actively gathering an air sample. Potential operational uses may include prolonged entry into immediately dangerous to life and health (IDLH) atmospheres or unknown CBRN environments.

PHASE I: Design and develop passive, IPE integrated biological sampling technology / matrices that are effective in passively capturing particles present in the air and offer significant improvements in the logistical burden associated with the current air sampling technologies. Demonstrate feasibility in application, integration in COTS prep kits and archive capable and ability to have biological material capture in/on the material. Identify key performance efficiency parameters and test criteria relevant to use and follow on testing with one biological test platform. Establish test set up and procedures to assess and validate proposed approach. Fabricate physical model and conduct bench top testing to characterize the performance of the proposed solution(s) to include but not limited to the following, where applicable to the proposed technology: adsorption capacity, efficiency of capture rate, and use in diagnostic platform detailing limitations (if any), logistic requirements, inhibition by-products, and efficiency under relevant temperature/humidity conditions.

PHASE II: Refine and optimize Phase I model to capture protein/toxin and bacteria capacity and performance. Perform follow-on bench top evaluations to verify improvements made to the basic enabling technology. Modify test setup and improve test procedures as required. Develop functional prototype by incorporating enabling technology into a suitable test bed (e.g., M50 mask or UIPE ensemble). This technology should be non-invasive to any PPE and capable of being donned / doffed while fully protected. Characterize test bed performance under an operational relevant range of external environmental (temperature/humidity) conditions. Based on results obtained, implement necessary refinements to the scalable test bed model.

In preparation for Phase III, transfer functional prototype to CCDC CBC for independent benchtop verification and validation. Training of Government personnel will be provided by the performer in the proper use of the prototype. Performer will offer test support including addressing technical issues.

PHASE III DUAL USE APPLICATIONS: Fully integrate solution into a full-scale, fully-functional prototype. Demonstrate ability of the technology to be incorporated into an end user donned ensemble through modification of an existing systems. Expand applications to other commercial detectors.

Transfer fully-functional prototype to CCDC CBC for independent verification and validation in aerosol chamber. Training of Government personnel will be provided by the performer in the proper use of the prototype. Performer will offer test support including addressing technical issues.

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KEYWORDS: Biological Sampler, Passive, Integrated, Low burden

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A20-125 TITLE: Indicator Chemicals for In-theater Inkjet Assay Production

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Chem Bio Defense

OBJECTIVE: Develop, demonstrate, validate, and produce indicator reagents to enable on-demand, in-theater printing of low-user-burden chemical and biological threat detection and identification assays on COTS inkjet printers.

DESCRIPTION: Low-burden, inexpensive, and eye-readable assays such as M8 paper, litmus paper, and assays for protein or ATP (adenosine triphosphate) are common first line tests performed on an unknown in order to determine if it is innocuous or a potential threat. Inkjet printing can be used to produce these types of color-change assays at the point of need by replacing standard ink cartridges with indicator reagent cartridges. On-demand printing can also be used to produce purpose-built assays tailored to the task at hand by selecting relevant indicators to combine together on assays customized in size and format. Inkjet printing also permits the deposition of indicators on a range of substrates including fabrics and adhesive-backed materials to create custom contamination and exposure indicators for personnel, vehicles, and fixed or temporary structures, expanding an intuitive sensing modality (observable color change) to multiple concepts of operation and employment.

To enable these capabilities, additional development is required to formulate more color-changing indicators for inkjet printing. The availability of a wide range of chemical indicators which respond to relevant threats with high-contrast color changes works towards the goal of a comprehensive chemical and biological sensing capability. Inexpensive, low-burden, and low-false-alarm threat awareness is essential for maintaining lethality and achieving mission success when operating in a chemical or biological environment. Formulated indicators should be compatible with COTS (commercial-off-the-shelf) inkjet printers using aqueous ink systems, and should be stable, stored in cartridges, for at least two years. Initial printed colors of the indicators should be highly consistent and compatible with a wide range of COTS inkjet printing substrates.

PHASE I: Conduct a feasibility study of indicator chemicals useful against chemical and/or biological targets, demonstrating methods to formulate at least four of these indicators for inkjet printing. Propose and describe concepts of operation for the deployment sensing capability using on-demand printing of indicators and estimate system costs. These formulated indicators, a report on their development, and concept-of-employment descriptions will be the deliverables from this phase.

PHASE II: Mature concepts into a prototype system: Identify and prepare a panel of indicators to treat major classes of TIC/TIM/CWA (toxic industrial chemicals / toxic industrial materials / chemical warfare agent) materials. Formulate these indicators for printing, optimizing printed optical density, consistency, and storage life. Perform storage studies and characterize responses across a range of printing substrates. Develop cost information for production and sustainment of printing systems using these indicators. Develop a capability demonstration based on these materials and participate in a field trial, operational analysis event, or other Warfighter-attended event to obtain direct user feedback. These formulated indicators, a report on their development, and a report on a field demonstration activity will be the deliverables form this phase.

PHASE III DUAL USE APPLICATIONS: Refine and validate the prototype system. In addition, working with appropriate partners, identify or develop indicators against novel and emerging threats and add these targets to the system. Establish manufacturing processes and transition to commercial and military customers.

Phase III Dual-Use Applications

Military needs alone will not likely be a sole driver for this technology or approach. However, there are a variety of potential non-military users which include various aspects of chemical manufacturing (leak detection, process monitoring and validation, chemical hygiene), civilian first responders, food processing, and biomaterials research and production. Therefore the proposed concept of operation and commercialization plans should consider nonmilitary markets.

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KEYWORDS: Chemical, Biological, Sensing, Maneuver Support, Expeditionary, On-Demand Production, Low-Burden



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A20-126 TITLE: Programmable AC/DC Lithium-ion Battery for High-voltage Applications

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Reconfigurable, software programmable AC/DC Lithium-ion battery modules and packs capable of supporting high-voltage ground vehicle and robotic applications.

DESCRIPTION: Developing next generation electric based ground vehicles will require a battery module in the 24 V to 60 V range that can be assembled into a high voltage pack up to 1000V. Emerging military hybrid vehicle platforms, such as the Robotic Combat Vehicle (RCV) or Optionally Manned Fighting Vehicle (OMFV), will require high-voltage battery packs with the following expected characteristics: nominal voltage from 450 to 600 V, continuous power capability of 250 to 400 kW, and 25 to 100 kWh installed energy. Currently, in an electric- or hybrid-electric vehicle system, power electronics are required to convert between all of the different AC and DC voltages required by the various components, such as the AC motors and DC battery. These electronics include DC-DC converters, AC-DC rectifiers, DC-AC inverters, chargers, and motor drive controllers, and each extra component contributes to power losses and packaging inefficiencies. In the solar panel sector, AC batteries which are composed of energy storage coupled with micro-inverters are available as an alternative to having a large external DC-AC inverter to connect the DC energy storage source to the AC loads and provide enhanced space & power efficiencies. Accordingly, innovative solutions must be developed and demonstrated for vehicle high-voltage mobility batteries which will allow for a fully reconfigurable & software programmable AC/DC Lithium-ion battery, which can source and sink various DC & AC voltages with higher power, thermal, & packaging efficiency. Technology developed shall allow for direct charging of the AC/DC Lithium-ion battery off of a wide variety of both DC (ex: 28V, 50V, etc.) and AC sources (ex: 120VAC, 480VAC, etc.). The AC/DC Lithium-ion battery shall also allow for direct connection to an electric motor, or other AC loads, without need for an inverter or motor controller (single & three-phase AC). Technology developed to allow AC/DC variable operation should be fully integral to the battery and shall consider balancing/equalization, reliability, high-voltage safety, and capacity utilization. Technology developed should be scalable to 24V – 60V modules composed of a few cells to a few hundred cells, and should support pack configurations up to 1000V.

PHASE I: Identify and determine the engineering, technology, and embedded hardware and software needed to develop this concept. Drawings showing realistic designs based on engineering studies are expected deliverables. Additionally, modeling and simulation to show projected performance and Ah capacity of the AC/DC Lithium-ion battery modules & pack designed in this phase is expected. Cost analysis projections should also be performed to determine the cost premium between a standard battery system with external conversion electronics and an AC/DC Lithium-ion battery pack (<20% increase in overall product cost). A bill of materials and volume part costs for the Phase I design should also be developed. This phase also needs to address the challenges identified in the above description, including scaling to higher voltage packs.

PHASE II: Develop and integrate prototype embedded hardware and software to create AC/DC Lithium-ion battery modules and packs for high-voltage mobility applications. The AC/DC Lithium-ion battery modules shall interconnect to support series and parallel configurations in a battery pack and shall meet the following minimum requirements: 1.5 – 4 kWh, 10 – 25 liters, <60 kg, 20 – 25 kW peak power, 24 – 60 V, 5 to 10 C-rate, and -30 to 60°C operation with thermal management. Each module shall have a digital communication interface that supports at a minimum high-speed ISO 11898 CAN communication, as well as any other isolated digital communication protocols (e.g. SPI) necessary for operation of the battery module in a high voltage battery pack. Testing should be performed on AC/DC Lithium-ion battery modules and packs to demonstrate operation, performance, and Ah-capacity. Cost analysis should also be performed on the finalized product to determine the cost premium between a standard battery system with external conversion electronics and an AC/DC Lithium-ion battery pack (<20% increase in overall product cost). A bill of materials and volume part costs for the Phase II design should also be developed. Deliverables include electrical drawings and technical specifications, software, M&S and test results, and one AC/DC Lithium-ion battery pack (nominal voltage from 450 to 600 V) composed of reconfigurable, programmable AC/DC Lithium-ion battery modules. The pack battery management system (BMS) shall have at a minimum two SAE J1939 interfaces to support communication to the vehicle.

PHASE III DUAL USE APPLICATIONS: This phase will begin installation of the AC/DC Lithium-ion battery packs using the solutions developed in Phase II on selected vehicle platforms (military, commercial EV/HEV, etc.) and will also focus on integration of Phase II embedded hardware and software technologies into the production processes of current Li-ion batteries.

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KEYWORDS: Lithium-ion, batteries, power, energy, battery management systems, CAN bus, low-voltage, high-voltage


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A20-127 TITLE: Retractable Gunner Restraints

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The retractable gunner restraint system will restrain and protect gunners in various vehicles from high energy events by rapidly retracting them back into the vehicle during typical injurious scenarios like Vehicle Borne Improvised Explosive Devices (VBIED), underbody blast, top/bottom attacks, crash, and rollover events.

DESCRIPTION: Occupants in the gunner position are often in non-traditional seats that either provide ineffective or no restraints. The restraints are often constrictive, preventing them from efficiently performing their mission leading them to not be used. Additionally, the restraints have no functionality to safely pull the occupant back into the vehicle leaving them vulnerable to injury during high energy events. A new retractable gunner restraint system shall be internally mounted in the vehicle and must restrain and protect Soldiers within the central 90th percentile while fully encumbered. The system may interface with the Improved Outer Tactical Vest (IOTV), but this feature is not required. The system shall react and retract rapidly enough to provide protection during events including, but not limited to: underbody blast, crash, rollover, top/bottom attack, and VBIED without inducing injury to the occupant due to the retraction.

PHASE I: Define and determine the technical feasibility of developing a retractable gunner restraint system that is lightweight, durable, and will protect the occupants during high energy events without inducing injury due to the retraction. The restraints must be capable of containing the central 90th percentile Soldier population while fully encumbered and durable enough to handle the rugged conditions encountered by ground vehicles. System must be FMVSS 207/210 compliant. The system must, at a minimum, meet FMVSS 208 Injury Criteria (additional injury criteria will be provided once on contract) for the following tests: drop tower testing (up to 350g half sine pulse, delta V 10 m/s) and FMVSS 213 Child Seat Corridor Sled Testing (additional testing criteria will be provided once on contract).

PHASE II: Develop and test at least 5 prototype restraint systems that can protect and contain the central 90th percentile Soldier population during high energy events including, but not limited to, blast, crash, rollover, and VBIED. Based on the findings in Phase I, refine the concept, develop a detailed design, and fabricate simple prototype systems for proof of concept. Identify steps necessary for fully developing a commercially viable restraint system. The system shall by FMVSS 207/210 compliant. The system must, at a minimum, meet FMVSS 208 Injury Criteria (additional injury criteria will be provided once on contract) for the following tests: drop tower testing (up to 350g half sine pulse, delta V 10 m/s) and FMVSS 213 Child Seat Corridor Sled Testing (additional testing criteria will be provided once on contract).

PHASE III DUAL USE APPLICATIONS: System can be commercialized to PD LTV applicable variants (M1151A1, M1152A1, and M1165A1) in addition to NGCV and any fielded ground vehicle with an open gunner position. Additional commercialization to private sector vehicles with exposed occupants like first responder vehicles, garbage trucks, etc.

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KEYWORDS: Restraints, gunner, retractors, underbody blast, crash, rollover, vehicle borne improvised explosive device (VBIED), top/bottom attack, accommodate and protect, central 90th percentile Soldier population

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A20-128 TITLE: Advanced Heavy-Duty Diesel Engine Piston

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Design, develop, and manufacture a heavy-duty diesel engine piston capable of withstanding the severe thermal stresses from a localized, periodic surface heat flux exceeding 20 MW/m2 at frequencies up to 40 Hz, with limited back-side cooling.

DESCRIPTION: Recent commercial industry trends in internal combustion (IC) engine development have focused on reducing air pollutants and fuel consumption in order to comply with environmental regulatory requirements concerning greenhouse gas emissions. Accordingly, diesel engine manufacturers have renewed their efforts to increase engine efficiency from the current status of 45% brake thermal efficiency (BTE) towards the theoretical limit of approximately 65% BTE. A pair of recent technical papers by Cummins, Inc. outlines the potential efficiency gains achieved through improvements in heat transfer reduction, friction reduction, lubricant viscosity, parasitic losses (e.g. oil and water pumps), turbomachinery efficiency, engine downspeeding, exhaust aftertreatment optimization, and last but not least, engine combustion system optimization (SAE 2013-01-2421 and SAE 2019-01-0247). This topic focuses on increasing the thermal efficiency of a 120mm-140mm bore size diesel engine through optimization of the combustion system and the resultant piston heat transfer.

Engine combustion system developments include trends towards higher compression ratios, higher in-cylinder pressures (greater than 300 bar), piston bowl geometry optimization, and increased fuel injector flow rates to enable shorter combustion durations. As the combustion duration shortens and compression ratio increases, the cylinder pressure and temperature will necessarily increase, resulting in gas-side piston surface temperatures that exceed the material temperature limit (~500°C) of traditional steel piston alloys, such as 4140 steel. Another consideration when pursuing these technology developments is increased piston heat transfer. Shorter combustion durations necessitate higher localized heat fluxes (greater than 20 MW/m2) on the piston as the hot flame impinges on the piston bowl surfaces.

Whereas the engine designs of commercial vehicles are heavily weighted towards achieving low emissions and good fuel economy, these attributes are less important in the design of military vehicles. Combat vehicle engines in particular should have high power density and low heat rejection, because the propulsion system competes with the vehicle’s functional systems for the total volume under armor.

Thus, future combat engines designed for low heat rejection (< 0.5 kW/kW) and high output (90 bhp/L) share some of the design limits of a commercial engine, one of which is piston surface temperature. Temperatures above critical material property limits can result in reduced engine life and piston failure. Optimization of piston design for such low rejection, high power density engines while maintaining acceptable piston surface temperature is a critical step in the engine development process.

The purpose of this topic is develop an advanced, heavy-duty diesel engine piston optimized for continuous, high-load operation at desert-ambient operating conditions for military ground combat vehicles. Proposals should aim to increase the peak cylinder pressure limit to 275 bar and the surface temperature limit to 600 °C, or propose technologies to reduce surface temperatures at equivalent thermal loading. The application of thermal barrier coatings to the piston crown will not be considered for this topic.

PHASE I: Conduct the engineering analysis to support the design and development of a prototype 120mm-140mm bore size piston capable of sustained operation at high-load conditions in a direct-injection, heavy-duty diesel engine. Determine the required thermal and mechanical properties and perform laboratory testing to support the selection of an appropriate material for the piston. Identify unique manufacturing requirements and conduct prototyping of a conceptual piston to demonstrate feasibility of the proposed piston technology.

PHASE II: Manufacture and test an advanced heavy-duty diesel piston prototype enabling higher combustion temperatures and pressures without compromising piston strength or durability. Develop a CAD model and engineering drawings with tolerances, surface finishes, anti-corrosion and skirt (friction) coatings, and manufacturing instructions. Develop quality inspection and approval process requirements for the prototype piston. Required deliverables include an engine test report, piston temperature analysis, CAD model, drawings, and delivery of a prototype piston to the Government's specification.

PHASE III DUAL USE APPLICATIONS: Further develop an advanced diesel engine piston for use in a commercial engine, and demonstrate the piston development in a multi-cylinder engine. It is envisioned that this technology would benefit high-efficiency, future commercial diesel engines as well, especially in vehicles demonstrating engine brake thermal efficiency of 50%.

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KEYWORDS: Internal combustion engine, Piston, Heavy-duty diesel, High-temperature alloy


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A20-129 TITLE: Rapid Terrain/Map Generation for Robotic and Autonomous Vehicle Simulations

RT&L FOCUS AREA(S): Autonomy
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: The objective is the rapid generation of Real World Landscapes (Geo Specific) with features (e.g. ground material, bushes/trees, roads, buildings) for Unreal Engine 4 using GIS Data (Digital elevation model), LIDAR data, satellite images, Photogrammetry so that the Landscape map in Unreal Engine 4 is high fidelity enough to use for Robotic and Autonomous Vehicle Simulations

DESCRIPTION: The Ground Vehicle System Center (GVSC) performs research using interactive ground vehicle simulations akin to realistic video games. In these simulations we measure the performance of soldiers at tasks such as planning and driving. The GVSC interactive ground vehicle simulations are also used for the development of robotic and autonomous systems and the evaluation of these autonomous driving algorithms. It presently takes months to create a geospecific terrain model for use in the simulation largely due to the quantity of area that needs manual creation and touch-up. This is primarily due to our unique requirement for high visual quality (and rendering performance) but only landmark level accuracy for geotypical features.

We are using Unreal Engine for rendering our camera views which put some requirements on the structure of the data that we use. The digital elevation model of the terrain surface is a rectangular grid of altitudes in UTM-style coordinate system. Accompanying the elevation data is any number of layers which we use, one each, for grass, dirt, road, etc. Each layer has a single graphical "material" which affects how it drawn and a blend weight image (of the same dimensions as the elevation data) which represents the "weight" of coverage of that material on that part of the map. On top of this terrain surface we place 3D polygon models of bushes, trees, fences, rocks, buildings, etc. Outside of particular areas of interest, we repeatedly use the same models as we only care about the location of a tree not if every branch is in the right place.

Specifically we model the terrain type and elevation with a post spacing of .5m-1.0m which we cover with "typical" imagery of grass, dirt, asphalt, etc. at <1cm/pixel resolution. In addition to the re-use of 3D models, large non-navigable areas outside our areas of interest, such as forests and buildings, will modeled as solid volumes with imagery on the sides. While these models don't necessarily visually match the real objects in the area they must be located in the exact spots as we sometimes replay position data recorded from real vehicles.

Existing solutions for generating this data are either too detailed, preventing rendering at interactive speeds, too specific, or accurate only when viewed from a distance. A complicating factor is that we are viewing the scene from the ground at a height of 1m-4m which is close to perpendicular to the viewpoint of commonly available imagery. Aerial imagery looks blurry when shown from a viewpoint that close. This difference in viewing angle leads to a deficiency in 3D model generation algorithms that use aerial imagery (e.g. Google Maps 3D view). The resulting models are misshapen, misaligned, and of insufficient detail when viewed up close and from the ground but otherwise look fine when viewed from above. A secondary failing of areal imagery in our use case is that it is blind to the area under a tree. Drawing a tree canopy on the ground surface is clearly wrong when viewed from low angles. While we can never truly know what is under the tree we need to back fill those areas with plausible terrain.

There is a lot of existing research into terrain classification/segmentation which we can use to generate terrain layers. However, these algorithms are unable to look under the trees where we don't have data yet but need plausible terrain. Classifying the terrain is also important from a driving perspective. While we don’t need to model soil properties, our simplified tire models need to know, broadly, if we’re on asphalt vs. dirt vs. grass. We also don’t need to model geometric features as small as a pot hole.

A possible solution to filling in the gaps is inpainting or image healing, akin to Photoshop, but such tools require manual intervention. There is no present tool to automatically identify obscured areas in the terrain and fill them in with plausible data. In addition, some these areas, such as a single tree, will need to be identified and replaced with a 3D model that is not part of the terrain.

This SBIR is seeking innovative solutions to the development of realistic terrain models with dimensions up to 8km x 8km with rectangular regions of 5-10 km2 being typical. The solution should be standalone software which accepts as input elevation data and satellite imagery and then generates a visually rich terrain suitable for use in the Unreal Engine. The solution must be highly automated employing classification to generate specific terrain types to include roads, fields, forests, water features and buildings as well as detect, remove, and inpaint the terrain covered by individual trees, cars, people, etc. The solution must provide methods for human-guided interpretation and classification of areas that are ambiguous by means of selective labeling and or morphing. The tool shall allow an adept user to convert convincingly real terrain at a rate of 1 km2/hr.

PHASE I: The vendor shall deliver a prototype system demonstrating the classification/inpainting of terrain. From a 2-D elevation data (height-map) (.5m/px resolution) and aerial imagery aligned to the elevation data, classify/segment the image into terrain types; one lossless greyscale image per type (png, tiff, etc). The input imagery may be at a different resolution than the elevation data with the edges of the data aligned. The output images must be pixel aligned with the elevation data, where white represents 100% coverage or confidence.

Considering the low resolution, multiple terrain types for a given spot are possible, for example a patch of thin grass with dirt showing through could be marked as 50% each on their respective layers. Adjusting the weights for improved appearance encouraged. All-or-none rounding to create hard edges is discouraged. (We acknowledge that this is sub-optimal for paved roads.)

For certain types representing covered areas, the unknown area underneath will be inpainted with a different terrain type surmised from the surrounding area and similar features elsewhere. For example, the area under a tree will be filled in with grass, dirt, etc. or a combination.

The algorithm should also indicate areas that may need to be represented with a new terrain type or otherwise require manual intervention. A user shall have access to intermediate products which can then be adjusted and the following stages of the process re-ran.

We expect that solutions will combine and modify existing image processing and classification tools to accomplish the goals. Developing a custom neural net is outside of the scope for Phase I. The essence of Phase I is the interaction between the classifier, the inpainter, and the user. Although we discuss a segmentation/inpainting process, other classifying/fill-in-the-gaps algorithms along with other pre/post processing steps is permitted.

PHASE II: The vendor shall deliver a plugin for Unreal Editor which will import the elevation data and aerial imagery, classify and heal it, and generate terrain elevation model, terrain type layers, unreal rendering blueprints, etc. as necessary to represent the terrain. As part of this process, a user may manually override classification in certain areas and the software must rework the final output based on the changes.

For certain movable objects such as people, vehicles will be erased. For areas that represent large objects (trees, rocks, road signs), it will place a representative model in the scene. These 3D models will be user provided but the software must automate the placement.

For areas that represent impassible terrain (forests, buildings), a 3D model representing the footprint of the area extruded to a best-guess height will be generated. (This model will be used by an artist as a basis for detailed model which is outside the scope of this project.).

Hard edged roads shall be detected, erased, and replaced with a polygonal model.
Physics material properties may be provided by the user and if so, the software will attach them to the corresponding terrain. (Software does not need to understand what these represent.)

PHASE III DUAL USE APPLICATIONS: Military application is for the development and testing of automated vehicles or vehicle functions which are highly dependent on a modeling and simulation environments with geospecific high fidelity terrain/maps that can be generated rapidly. It is for the development and testing of such systems. The U.S. Army GVSC has a critical need for geospecific high fidelity terrain/maps. Commercial application is in the automated driving technology testing and assessment. This applies to both the automotive industry as well as military OEMs and suppliers.

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KEYWORDS: Modeling & Simulation, Autonomous Systems, 3D Terrain, three-dimensional models. geospatial intelligence, Digital Terrain Models, Digital Surface Model


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A20-130 TITLE: Mobile Medic Interior Seating

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Materials

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 section 3.5 of 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 mobile medic interior seating will allow medics to remain safely seated and restrained while enabling them to travel along and around a litter to provide necessary medical care to a wounded Soldier. This can be integrated into any medical vehicle and adapted for usage beyond medics to enable Soldiers to be mobile within the vehicle to perform various missions while maintaining occupant protection. The seating will protect medics from high energy events by rapidly retracting them back into the vehicle during typical injurious scenarios like Vehicle Borne Improvised Explosive Devices (VBIED), underbody blast, top/bottom attacks, crash, and rollover events.

DESCRIPTION: Occupants in the medic position are often not seated or not restrained properly in order to provide the necessary medical care to an injured Soldier. The medic’s seat is typically in a fixed position at the head of the litter and does not allow them to move along the litter to assess the injury and provide care. A new mobile medic seat will travel along and around a litter while allowing them to remain seated and restrained. The system shall be internally mounted in the vehicle and be able to be integrated into an existing vehicle or litter system. The seating system shall accommodate and protect the central 90th percentile Soldier while encumbered. The system shall endure and provide protection during events including, but not limited to: underbody blast, crash, rollover, top/bottom attack, and VBIED.

PHASE I: Define and determine the technical feasibility of developing a mobile medic interior seating system that is lightweight, durable, and will protect the occupants during high energy events while allowing them to be mobile within the vehicle. The system must be capable of containing the central 90th percentile Soldier population while encumbered and durable enough to handle the rugged conditions encountered by ground vehicles. System must be FMVSS 207/210 compliant. The system must, at a minimum, meet FMVSS 208 Injury Criteria (additional Injury Criteria will be provided once on contract) for the following tests: drop tower testing (up to 350g half sine pulse, delta V 10 m/s) and FMVSS Child Seat Corridor Sled Testing (additional testing criteria will be provided once on contract).

PHASE II: Develop and test at least 5 prototype systems that can protect and accommodate the central 90th percentile Soldiers during high energy events including, but not limited to blast, crash, rollover, and VBIED. Based on the findings in Phase I, refine the concept, develop a detailed design, and fabricate simple prototype systems for proof of concept. Identify steps necessary for fully developing a commercially viable system. The system shall be FMVSS 207/210 compliant. The system must, at a minimum, meet FMVSS 208 Injury Criteria (additional Injury Criteria will be provided once on contract) for the following tests: drop tower testing (up to 350g half sine pulse, delta V 10 m/s) and FMVSS 213 Child Seat Corridor Sled Testing.

PHASE III DUAL USE APPLICATIONS: System can be commercialized to AMPV, in addition to any NGCV or fielded vehicle with a medic position or mission need for an occupant to be mobile.

Additional commercialization to private sector vehicles with a need for a mobile occupant like first responder vehicles (ambulance, fire, etc.).

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KEYWORDS: Medic, litter, seats, underbody blast, crash, rollover, vehicle borne improvised explosive device (VBIED), top/bottom attack, accommodate and protect, central 90th percentile Soldier population

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A20-131 TITLE: Radio Network Model Plugin for Unreal Engine Vehicle Simulation

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: The objective is to develop a plugin for Unreal Engine 4 that can be used to simulate a wireless radio network using the Unreal Engine environment (e.g. Landscape Map, weather …) that supports the same conditions as in the real world (e.g. line of distance interference) for evaluation of robotic and autonomous systems (RAS) operating in Manned-Unmanned Teaming (MUMT) scenarios.

DESCRIPTION: In order to appropriately develop and test autonomy software/algorithms for Army ground vehicles the Army needs to use modeling and simulation (M&S) to look at all the different conditions and scenarios the autonomy software will operate in. A key component of robotic and autonomous systems (RAS) operating in Manned-Unmanned Teaming (MUMT) is the Army wireless radio data network.

The goal of this SBIR topic is to provide the Army with a way to develop and test RAS with a correct representation of the Army wireless radio data network using M&S that includes the 3D terrain with features (e.g. ground material, bushes/trees, roads, buildings) and weather conditions. The simulation should support being able to model the entire network, antennas and military wireless radios so GVSC can evaluate how the wireless radio would operate in a military network during virtual military experiment (e.g. autonomous vehicle convoy, manned unmanned vehicle teaming) using Unreal Engine simulation vs how they would operate in real world with line of distance interference.

Army data networks need to work in harsh ever-changing conditions. They can do so through sophisticated radio technologies, though they are not always successful. The Army needs a simulation capability that can predict failures (i.e what is the probability of a packet reaching its destination) in real time during the execution of simulation. Full information of the terrain and weather as well as with respect to all radio sources will be available in real time (or can be pre-calculated as needed). It is expected that a continually updated channel model will be created taking into account relevant aspects, considering multipath, scatter, Doppler, fading models, diffraction, etc. as appropriate. Models of radios used by the Army such as the Persistent Systems MPU5 will use this channel model to determine the likelihood of packet loss, as well as latency estimates.

This SBIR is seeking innovative solutions to the development of Radio Network Model as plugin for Unreal Engine. The solution should be able to use the 3D terrain with features along with the simulation's weather conditions in Unreal Engine to determine how the radio and radio network would be affected. The solution should allow the simulation user to attached the radio to vehicles in Unreal Engine simulation and dynamically be able to handle the movement of these vehicle and the affects to the radio network.

PHASE I: In Phase I the vendor shall develop an architecture and describe how it will meet the goal of creating Radio Network Model Plugin for Unreal Engine Vehicle Simulation. The vendor shall demonstrate using a simplified models of a channel as well as of a radio are expected as the result of the Phase I effort. These models will utilize a Government provided Unreal terrain database to extract relevant information to make this feasible.

PHASE II: In phase II the vendor shall fully develop the architecture started in Phase I. The expected deliverable would be a channel model as an Unreal Engine plugin that models enough to be useful to the radio models downstream. To build an effective model, additional data may be added to the terrain. If so, these additions to the 3D terrain will be identified by the offeror along with how this would be supported. The product shall include the ability through the plugin to attach the simulated radio to the simulated vehicles in Unreal Engine. The product shall demonstrate modularity by including at least one radio model with the capability provided via an editor in Unreal Engine or via a configuration file for Army personnel to be able to create additional radio models. The product shall demonstrate ability to provide the simulate radio network during an Unreal Engine vehicle simulation scenario. If feasible, captured data of the MPU5 radio's performance in the terrain modeled by the Unreal database will be provided for the purposes of validation of the model.

PHASE III DUAL USE APPLICATIONS: Military application is for the development and testing of robotic and autonomous vehicles systems in manned unmanned teaming which are highly dependent on a modeling and simulation environments with a simulated radio network. A product modeling radio networks with dynamic players using them would be useful for more than just Army Ground Vehicle simulations. The Unreal Engine is poised to be used in many commercial simulation, not just games. These commercial simulations include, but are not limited to, self-driving vehicles (and their networks), emergency/natural disaster simulations, vehicle network simulations, as well as mobile phone simulations.

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KEYWORDS: Modeling & Simulation, Radio Channel Modeling, Radio Simulation, Unreal Engine


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A20-132 TITLE: Lightweight Robotic Mule

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: A robotic personal mobility device that can carry a soldier or that they can carry.

DESCRIPTION: Off road terrain poses a continual challenge to military movement. Coupled with the heavy loads that dismounted soldiers are required to carry, resupply robots such as the Squad Machine Equipment Transport (SMET) can provide a needed capability for the US Army and USMC, but struggle with narrow trails and urban environments. The goal of this topic is to overcome current SMET mobility limitations by expanding the terrain that an SMET robot can negotiate while intrinsically improving the transportability of the system. It is anticipated that a lightweight robotic mule will improve the mobility of the SMET through narrow trails and urban environments while being easier and lighter to maneuver. The goal is to be able to maneuver through a standard door opening, while being light enough unloaded for one-man lift.

PHASE I: Develop a mechanical design to support additional weight while negotiating a narrow door opening or narrow trail and balancing dynamically. The mechanism must be easily packed and transported by hand into another vehicle. Demonstrate the mechanism feasibility in a Computer Aided Design (CAD) environment such as SolidWorks or equivalent. The mechanism must be suitable for one-man lift, with weight not to exceed 20kg (Threshold) or 15kg (Objective). The robot should be able to negotiate a standard door opening while fully loaded.

PHASE II: Prototype the mechanical design developed in Phase I and demonstrate it on a soldier following mission, such as an SMET demonstration. The system should support between 100kg (Threshold) and 150kg (Objective) of payload. The system should provide soldier following capability and be able to perform with or without the operator on board. The system should control balance of the vehicle, while avoiding obstacles, and negotiating narrow urban or off-road terrain. The system shall be able to navigate through a standard handicap accessible door width, 80 cm (threshold) to 50 cm (objective) The top speed on flat terrain should be 5m/s (Threshold) to 7m/s (Objective) with a range of 15 miles (Threshold) to 20 miles (Objective). The objective terrain is a standard nature trail in a boreal forest, which may have a few roots and rocks but free from climbing obstacles.

PHASE III DUAL USE APPLICATIONS: This topic is developed in direct connection to several Army programs, e.g. Soldier Machine Equipment Transport (S-MET). The civilian sector would also significantly benefit from the developed technology for use in urban transportation applications. The benefits of this development would be inherently safe autonomy in and around people. This type of vehicle could be optionally manned, it can carry you, or you can carry it. This topic addresses the “last mile” problem which has dual-use applications in industry.

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KEYWORDS: robotics, path planning, personal mobility, soldier load

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A20-133 TITLE: Innovative Technologies for Precision Timing of Onboard Munition Navigation Systems

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a technology for precision time in the onboard navigation systems of precision guided munitions (PGM) for purposes of navigation and to assist with post launch acquisition and tracking of Global Positioning System (GPS) or alternate navigation sources (ALT-NAV).

DESCRIPTION: The U.S. Army has a need for precision time in the onboard navigation systems of precision guided munitions (PGM), such as Excalibur or Precision Guidance Kit, for purposes of navigation and to assist with post launch acquisition and tracking of Global Positioning System (GPS) or alternate navigation sources (ALT-NAV). Current PGM systems can experience relatively large errors in timekeeping (seconds) during the gun launch, due to the shock of the 12,000+g loads experienced in the gun barrel. The resultant time uncertainty increases the risk to acquiring GPS or ALT-NAV sources in challenged environments, makes the PGM entirely reliant on successful acquisition of a trusted time source (eg. GPS) to reset the clock post-gun-launch. Currently available alternatives are either less survivable in the gun environment, do not meet size (less than 1 cubic cm), weight (less than 1 ounce), and power constraints (less than 1 watt) (SWaP), or would require too much time to temperature stabilize pre-launch. Operating temperatures range from -40 degrees to +160 degrees Fahrenheit. Technologies that have the potential to be significantly more precise and less susceptible to time shifts during gun launch, enabling the keeping of accurate time (less than 10 ms) through the gun environment and enabling improved acquisition of GPS and ALT-NAV sources without any adverse SWaP impacts. Potential beneficial applications extend beyond the PGM environment, since these devices could prove to have positive SWaP implications without compromising performance. The end result of this effort would be a technology that is fully performance characterized and proven in the extreme gun environments, and ready for integration in munitions such as Excalibur, Precision Guidance Kit - Anti-Jam (PGK-AJ) and Hypervelocity Projectile (HVP).

PHASE I: Phase I will consist of an engineering study that will result in laboratory bench top prototypes demonstrating the performance requirements in a laboratory setting. The main focus of the testing will be to demonstrate the timing capability, with an engineering assessment of performance in the actual weapon firing environment. A final report will document all results and analyses. THe Phase I Option, if exercised will develop the system performance specification documenting system requirements and test methods.

PHASE II: Phase II will further mature the technology to meet all requirements in the system requirements specification, with a final demonstration in a relevant environment such as gun launch. Actual gun launch tests will be performed at a government facility with contractor support.

PHASE III DUAL USE APPLICATIONS: Phase III will integrate and qualify the technology in a full-up munition in preparation for transition to production.

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NOTE: The reference to any particular company or product is for information only and not an endorsement of that company or their technology.

KEYWORDS: precision timing, precision munitions, guidance and navigation, PNT, GPS, atomic clock, oscillator

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A20-134 TITLE: Innovative and Intelligent Standoff Detection Algorithm

RT&L FOCUS AREA(S): Autonomy
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of 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 innovative and intelligent Standoff Detection Algorithms for remotely operated explosive hazard detection systems.

DESCRIPTION: The U.S. Army is looking to improve the detection capabilities for robotic explosive hazard detection systems. The existing system has demonstrated success leveraging existing algorithms from the handheld detector that it utilizes. However, due to the additional processing power on board the platform and ability to mount sensors to monitor the detector itself, there is potential to develop algorithms to enhance the signal coming from the detector(s). Without the critical size weight and power restrictions of a handheld device, the robotic platform has the ability to process additional data and integrate more inputs. There are opportunities to implement volumetric analysis, enhanced visualization, augmented reality, and machine learning or artificial intelligence to improve the detection capabilities (by learning from past experiences), intelligently integrate signals from multiple sensors (such as ground penetrating radar, pulsed induction, and electromagnetic induction, and relay of that information to the user. Advances in detection algorithms beyond the existing performance can improve the detection capability, increasing the survivability of the system and most importantly the warfighter. The end result of this effort will be mature algorithms that can undergo testing for detection performance and human factors. This effort will help advance the maturation of a solution to be able to rapidly field a capability.

PHASE I: Phase I will result in laboratory and field demonstrations of the prototype algorithm(s) to test the ability to meet requirements. Simulated hazards will be used to test the system. The primary objective of these tests will be to demonstrate the detection and processing speed as it relates to false vs true readings. The Phase I Option, if awarded, will develop the system specification based on results of the Phase I demo, which will be used to drive requirements for Phase II.

PHASE II: Phase II will fully mature the algorithms to a robustness required to demonstrate in a simulated operational environment, and integrated into the demonstration platform. Phase II will culminate with an operational demonstration at a government facility using a combination of simulated and actual hazards.

PHASE III DUAL USE APPLICATIONS: Phase III will consist of full qualification of the technology in the host system in preparation for transition to fielding.

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KEYWORDS: hazard detection, mine detection, explosive detection, robotics, tele-operate, mine detector, hand held detector, UXO, metal detector, trip wire

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A20-135 TITLE: Low-Cost Gamma Dose Rate Technology for Military Operations

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Nuclear

OBJECTIVE: Develop and demonstrate very low-cost gamma dose rate sensors that are applicable for the wide range of military operations: very rugged, able to work in all military environments, nuclear survivable, and low SWAP (size, weight, and power).

DESCRIPTION: The United States Department of Defense (DoD) needs the ability to measure the dose rate throughout its range of operations. Standard radiation detection requirements for the military includes accurate gamma dose rate measures through the entire range of operations (from background to 100 Gy/hr), ability to maintain accuracy over a wide temperature range (-50 C to 55 C), and nuclear survivability [1].

The standard gamma dose rate sensor is the Geiger-Müller tube (or G-M tube). The venerable G-M tube has been the standard dose rate sensor for nearly one hundred years [2]. However, it is expensive for large-scale deployment (an average of $100 per tube), requires high voltage and counting circuitry, and requires several tubes to span the range of dose rates pertinent to military applications. The G-M tube certainly has characteristics beneficial for military applications to include somewhat inherently nuclear survivability, limited temperatures dependence, and very mature technology.

In recent years, a number of radiation manufactures have started to use solid-state devices such a photodiodes for dose rate measurements. These detectors offer advantages in cost, size, and power consumption. However, tests have shown that these types of sensors struggle with nuclear survivable, an absolute most for this type of capability for the military. Temperature sensitivity and non-linearity over a wide dose range also affect many of the current solid-state sensors. DoD is concerned that this evolution of the technology for commercial radiation detectors from G-M tubes to the current solid-state devices continues maybe detrimental to the military's ability to continue to field radiation detectors that are survivable on the nuclear battlefield.

The DoD has decided to fund research to develop low-cost gamma dose rate sensors that are suitable for military operations, including fighting and surviving on the nuclear battlefield. The successful result of this SBIR topic would be a dose rate sensor that is:

- Low-cost (preferably significantly under $100 per sensor),
- Able to accurately deep absorbed dose rate, defined as the absorbed dose rate at a depth of 10 mm in International Commission on Radiation Units and Measurements (ICRU) tissue,
- Accurate across the dose rate range pertinent for military operations (from background to 100 Gy/hr),
- Able to maintain accuracy over a wide temperature range (-50 C to 55 C),
- Nuclear survivable,
- Very rugged, and
- Very attractive to radiation manufactures for use in their radiation detectors for the commercial and medical sector.

PHASE I: Demonstrate through proof-of-concept experiments that the proposed sensor can measure the radiation dose rate, at least in a laboratory environment. Using the results of the proof-of-concept tests, conduct feasibility study to determine if the proposed sensor will meet the overall requirements for DOD and to predict better its expected performance. Plan for the continued development and testing of the proposed sensor. Update the cost estimation for the fielded system based on realistic material costs, testing requirements, and projected DoD needs.

Phase I deliverables will include meetings (at vendor location or telecom) as needed, monthly reports, and a final report with the results from the tasks in the preceding paragraph.

PHASE II: Mature the propose sensor into a prototype system that meets the DoD needs as previously stated. Demonstrate accurate measurement of dose rate throughout the needed range on the prototype systems. Demonstrate and document the prototype sensor's temperature dependence, nuclear survivable, and ruggedness. Further develop the manufacturing process to ensure quality and reproducibility, while keeping the cost of the final sensor low. Update the cost estimation for the fielded system.

Phase II deliverables will include meetings (at vendor location or telecom) as needed, monthly reports, and a final report with the results from the tasks in the preceding paragraph.

Additionally, the offeror will deliver three of the prototype systems to the government for further testing.

PHASE III DUAL USE APPLICATIONS: Refine and validate the sensor technology to ensure the technology meets the U.S. Army's concept of operations (CONOPS) and meeting the end-user requirements to include ruggedness and environmental stability. Finalize manufacturing process to ensure a low-cost sensor. Transition the new sensor technology to both commercial and military radiation detectors.

The end-state of the SBIR is a dose rate sensor that is:
- Low-cost (preferably significantly under $100 per sensor),
- Accurate across the dose rate range pertinent for military operations (from background to 100 Gy/hr),
- Able to maintain accuracy over a wide temperature range (-50 C to 55 C),
- Nuclear survivable,
- Very rugged, and
- Very attractive to radiation manufactures for use in their radiation detectors for the commercial and medical sector.

PHASE III DUAL USE APPLICATIONS:
The production quantities of the DoD by itself is not enough to continue to sustain and further mature radiation sensor technologies. Therefore, the proposed sensor must be an attractive alternative for use in commercial radiation detectors. This technology has applications in multiple federal agencies and the private sector for identification of and protection from radiation hazards.

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KEYWORDS: Radiation, Dose Rate, Nuclear Survivability, Geiger-Müller tube

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A20-136 TITLE: Automated Encounter Documentation and Data Driven Decision Support Systems

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Bio Medical

OBJECTIVE: The objective of this topic is to identify and prototype an algorithm for combat casualty care scene interpretation using sensing modalities such as computer vision with the goal of automating medical treatment documentation and providing inputs on data driven decision support systems aimed at providing diagnosis and treatment recommendations to combat medics during prolonged field care. The algorithm shall be platform agnostic and capable of recognizing interventions performed by the medic to automate patient documentation and allow decision support systems to make inferences regarding the course of treatment. To facilitate immediate access in denied, intermittent, and low-bandwidth (DIL) communications environments, capabilities should be resident on a local device and be able to operate offline. Therefore, the system shall be compatible with current and future program of record systems such as Nett Warrior and Integrated Visual Augmentation System (IVAS). The systems that can 'perceive' medic-patient interactions will truly enable autonomous data collection with minimal interaction with the end user. This capability would further support development of robotic autonomous medical systems. The reduction of task and cognitive burden will allow medical personnel to focus on the operational mission to support of Soldier Lethality.

DESCRIPTION: Future combat will likely involve greater dispersion and near isolation over great distances, necessitating units to be more self-sufficient and less dependent on logistical and other support units. The potential for delayed medical evacuations due to anti-access and area denial challenges, poses a difficult dilemma for combat commanders with wounded, sick or otherwise incapacitated personnel and will likely result in periods of prolonged field care (PFC) near the sites of injury pending evacuation windows of opportunity. Such scenarios may require a few organic or attached combat medics to deal with many casualties, minimizing the time spent with each casualty. The DoD and civilian organizations are looking at intelligent systems to provide decision support systems (DSS), closed loop, and autonomous care capabilities to act as PFC force multipliers to enable medics to handle more patients at the same time. However these systems, are heavily data driven. Current data capture systems require hand entry of data which is both time consuming and distracts the medic from providing direct care; while recording patient encounter data (observations, interventions performed, and patient disposition) could wait, treatment cannot. Therefore significant research efforts are underway to provide hands free data entry during PFC. Much of that work is aimed at speech input which itself can distract from direct patient care, is limited to what the medic dictates, and is not conducive to noisy environments. The Army Medical Combat Developer has suggested that medical encounter data be captured by perception systems and interpreted with emerging AI techniques to enable real-time generation of input to on-site medical decision support systems as well as to capture patient encounter data for posting to the soldier's medical record and forwarding to the next role of care. For such a capability to work, the Automated Encounter Documentation capture would have to be automatic, completely hands free, and capable of working in the dark. Additionally, redundant data storage and analysis on both a local device and in a medical data cloud would be needed to facilitate reliable operation and near-real-time response from DSSs and autonomous care systems during DIL communications, as well as to ensure data would not be lost if the medic's EUD is lost or destroyed. The use of novel, and multi-modal sensing methodologies is encouraged to automate the capture of a wider range of data elements and to increase data capture accuracy and reliability.

PHASE I: Based on proposed solutions, develop designs to prototype, integrate and demonstrate a proof of concept light-weight perception system that can generate input into mobile medical information systems and decision support systems aimed at providing diagnosis and treatment recommendations to combat medics during prolonged field care or to be stored and potentially forwarded to a government operated medical data cloud for interpretation and upload to the patient's medical record. The system shall be demonstrated using representative COTS sensors and hardware with the eventual goal of integrating with a system that can be carried by a single dismounted combatant along with other combat equipment. Identify potential datasets to be used for machine learning strategies. Produce a system design including analyses of alternatives for components to be used for prototyping and demonstration during Phase II. Initiate interoperability and integration plans for future hardware implementations using DoD programs such as the Army's Integrated Visual Augmentation System (IVAS).

PHASE II: From Phase I work, develop and demonstrate a perception system that can generate input into mobile medical information systems and decision support systems aimed at providing diagnosis and treatment recommendations to combat medics during prolonged field care or to be stored and potentially forwarded to a government operated medical data cloud for interpretation and upload to the patient's medical record. In order to accommodate initial prototype software evaluations with soldiers in the field and/or for fielding consideration, final system must be capable of being implemented on highly ruggedized, light-weight military End User Device (EUD) hardware. Develop integration plans for DoD programs such as the government owned mobile medical information system. Demonstrate an operational prototype in a field exercise with medics/corpsmen as coordinated by US Army TATRC.

The offeror shall define and document the regulatory strategy and provide a clear plan on how FDA clearance will be obtained. The offeror should plan for Phase III integration of the prototype capabilities with fielded Army or Joint systems. Further develop commercialization plans that were developed in the Phase I proposal for execution during Phase III, which may include exploring commercialization potential with civilian emergency medical service systems development and manufacturing companies. Seek partnerships within government and private industry for transition and commercialization of the production version of the product.

Other important considerations for the system concept include: 1) If a separate battery is used, it should be easy and quick to replace the battery in the field. 2) No new or proprietary display devices should be proposed; if a display is needed for the initial human-in-the loop attended or tele-operated prototyping phases, any required display should be designed to use a standard military issued Android End User Device (EUD) such as the Army Nett Warrior or SOCOM Android Tactical Assault Kit. 3) The system shall be designed with respect to existing and emerging medical device interoperability standards. 4) If intra-device communications are involved in proposed prototype capability, Ultra-Wideband (UWB) communications technology (Ref 15-17) is the desired communications protocol in Phase II for connecting component technologies together and/or to tactical radios for remote teleoperations since UWB is being actively pursued as a secure wireless technology with minimal electronic signature for Open Body Area Networks (OBAN) in combat environments. Use of other innovative solutions for providing secure short-range wireless communications in a tactical environment will also be considered for system designs that require wireless intra-device communications. 5) System should adhere to existing military standards based upon the research approach, such as compliance with existing IVAS standards, if exploring a vision-based perception system. 6) This research is not designed to address the development of wireless capabilities. It is focused on development of a perception system. 7) Speech-to-text capabilities will not be considered. 8) Perception systems include but are not limited to vision-based systems. 9) During Phase II field exercise coordinated by TATRC, the perception system be employed by multiple medics using it in medical scenarios (sample size n=32) to validate accuracy of the perception system. The medical scenarios will consist of medical procedures within a 68W Health Care Specialist's Scope of Practice, as identified in Solder Training Publication STP 8-68W13-SM-TG dated 03 May 2013. The initial demonstration tasks are: 081-833-0065 Apply a Combat Application Tourniquet (C-A-T); 081-833-0068 Bandage an Open Wound; 081-833-0212 Apply a Pressure Dressing to an Open Wound; 081-833-0075 Perform a Needle Chest Decompression; 081-833-0033 Initiate an Intravenous Infusion; 081-833-0168 Insert a Chest Tube; and 081-833-0301 Administer an Intramuscular Injection with notation of medication given. 10) This SBIR topic is not to develop new mobile medical applications that are required, but rather a capability that can be integrated into existing mobile military medical applications, such as JOMIS, BATDOK or MEDHUB. The vendor is not responsible for integration into existing mobile military medical applications. Proposals providing an approach, that supports integration that will be performed by or in conjunction with the appropriate government organization in follow-on Phase III spiral development activities, are preferred.

PHASE III DUAL USE APPLICATIONS: Refine and execute the commercialization plan included in the Phase II Proposal. The Phase III plan shall incorporate military service specifications from the U.S. Army, U.S. Air Force, U.S. Navy, and U.S. Marine Corps as they evolve in order to meet their requirements for fielding. Specifications will be provided in Phase II as they become available. The prototype system component may be integrated into a system of systems design and evaluated in an operational field environment such as Marine Corps Limited Objective Experiment (LOE), Army Network Integration Exercise (NIE), etc. depending on operational commitments. Present the product ready capability as a candidate for spiral development fielding (even without completion of the entire system of systems objective), to applicable Department of Defense. Army, Navy/Marine Corps, Air Force, Program Managers for Combat Casualty Care systems along with government and civilian program managers for emergency, remote, and wilderness Medicine within state and civilian health care organizations. Execute further commercialization and manufacturing through collaborative relationships with partners identified in Phase II.

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KEYWORDS: Perception Systems, Artificial Intelligence, Image Processing, Automated Documentation, Prolonged Care, Electronic Medical Documentation, Electronic Health Record, Medical Robotics, Medical Autonomous Systems, Combat Casualty Care, Autonomous Enroute Care


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A20-137 TITLE: To Develop and Demonstrate an Advanced Combat Wound Care Technology that Prevents Sepsis from Infected Traumatized Tissue

RT&L FOCUS AREA(S): Biotech
TECHNOLOGY AREA(S): Bio Medical

OBJECTIVE: To develop and demonstrate a technology that prevents infected and traumatized combat wounds on service members from becoming septic during extended tactical operations in austere environments. The technology shall be in an easy-to-use format, require minimal instrumentation, light weight, and compatible with care under fire (CUF). The method should enable deep tissue penetration of anti-microbial agents, analgesics, hemostatic agents, and pH stabilizers or oxygenating agents in the wound bed at minimum. The technology could be based on but not limited to a gel matrix, a fiber or polymer, a dissolvable gauze, spray and stay chemistry, nano-material, any wave or magnet based technology, or any combination thereof. All novel transformative technologies and ideas not identified here are welcomed. The end goal is to formulate a matrix technology that prevents infection and subsequent sepsis, preserves tissue viability, and promotes healing/regeneration of traumatic wounds in austere environments.

DESCRIPTION: Urban dense terrain and multi-domain operations of the future are expected to generate complex wounds that will require advanced prolonged field care and stabilization when tactical evacuations to robust rear element medical care infrastructures are delayed. Penetrating combat wounds can be accompanied by foreign body inoculum (metal fragments, rocks, dirt), large zones of bone and soft tissue disruption, nerve damage and localized ischemia (tourniquet/edema), as well as severe hemorrhage with resuscitation (often severe, >10U of 1:1:1 – pRBCs, plasma, and platelets that will systemically disturb overall physiology [immune system dysfunction, some degree of traumatic brain injury (TBI)]). Wound infections will be common in the multi-domain battle space and during prolonged field care; these infections could progress to sepsis. According to the Tactical Combat Casualty Care (TCCC) guidelines, the initial response to battlefield trauma is to stop major hemorrhage with pressure, tourniquet and wound packing with hemostatic agents along with broad spectrum battlefield antibiotics. The hemorrhage resuscitation, blast and use of tourniquets significantly reduce the efficacy of antibiotics in combat wound infections and topical treatments are urgently needed. Packing combat wounds with hemostatic agents with evaporative or tissue sealant properties in granular form or impregnated gauze appear to be effective topical treatments to control hemorrhage from these wounds (2,3). However, these approaches are not without their limitations in field applications to include incompatibility with brisk bleeding or coagulopathic patients (4,5) and their unsuitability for long term care (>4 - 5 h). While this paradigm was successful in recent operations where medical evacuation to a higher echelon of care was possible within hours of traumatic injury, the conceivable shift in the future battle space requires serious considerations to this evacuation strategy. As a result, the need for aggressive battlefield trauma care technologies that combine good medicine (i.e. better risk-to-benefit ratio) with host-physiology-augmenting innovations are paramount to controlling life threatening external hemorrhage and sepsis for complex battle wounded service members in austere environments that are removed from access to advanced medical care.

The ultimate goal of the technology in this request is to augment current technologies available in the market in the form of gauze, gels, polymers, or powder that combine hemostatic agents with antimicrobial agents or analgesics alone. Commercialization of a technology that addresses the multidimensional problems of traumatized tissue biology will accelerate the next generation of innovations that combine tissue regeneration, pain management, and immune modulations to prevent sepsis and hemorrhage while expediting wound recovery. The aim of this SBIR/STTR is to develop a universal combat matrix of choice that may deliver multiple components such as but not limited to anti-microbial agents, analgesics, regenerative agents, immune modulators, hemostatic agents, oxygenating agents, and pH stabilizers deep into infected traumatize tissues to prevent sepsis. When proposing a technology, it is paramount, but not limited to, to consider the factors below:

- The starting technology plans to have or already has FDA or equivalent clearance for one or more indications
- The anti-microbial of choice shall cover a wide array of infectious organisms
- The analgesic of choice can be, but not limited to, non-opioid agents
- The regenerative and immune modulators of choice can be, but not limited to, proteins, peptides, hormones, small molecules
- The matrix should stabilize pH and endotherm conditions within the wound bed
- The composition may include, but not limited to, hemostatic agents, metal ions, lantibiotics, natural products, bacteriophages, antibodies, polymers, nano-fibers
- Controlled release of agents as a feature (optional)
- If a wave or magnet based instrument is to accompany a given technology, simplicity of operation and weight will be considered
- Effortless applications, ability to withstand high-winds, water, hot and cold temperatures and minimal storage conditions will be factored in the nomination process

PHASE I: Given the short duration of Phase I and the high order of technology integration required, phase I should focus on system design, compatible composition selection, and development of proof-of-concept prototypes that address the majority of the requirements of interest. Prototypes may combine "classes" of agents into different "sets" of matrices or formulations with sequential application to reflect the different stages and priorities of wound healing. At the end of this phase, working prototypes should demonstrate feasibility and proof-of-concept using in vitro systems for components of proposed technology and establish "release profile". This phase should identify a pre-clinical animal model of infection, such as, but not limited to, punctured or open soft tissue wounds against a gold standard treatment for Phase II. Proposals may include different formulations for different phases of infection development and healing. Evaluation must include data for the first 24, 48 and 72 hours at a minimum, if not longer.

PHASE II: During this phase, the integrated system should be refined to enhance proof-of-concept into a product. Further optimization of technology for deep penetration of technology components into traumatized wound bed should be demonstrated during this phase. Qualitative and quantitative outcomes of product with regards to wound healing rate, regenerative properties, prevention of infection, pain control, hemorrhage control, and decolonization by invading organisms must be demonstrated as specific performance characteristics of the product compared to commercially available product. This testing should be controlled, rigorous, and under GLP conditions. Testing and evaluation of the prototype to demonstrate operational effectiveness in simulated environments (i.e. extreme heat, cold, wet environment) should be demonstrated. Here, the selected contractor may coordinate with WRAIR to set up testing sites and models. Stability of product in an austere environment should be evaluated to include extreme conditions. This phase should also demonstrate evidence of commercial viability of the product. Accompanying application instructions, simplified procedures and training materials should be drafted in a multimedia format for use and integration of the product into market. The offeror shall define and document the regulatory strategy and provide a clear plan on how FDA clearance will be obtained at the end of this phase. Offeror should also consider a pre-pre-submission communication with the FDA.

PHASE III DUAL USE APPLICATIONS: This phase should encompass both large animal models and randomized clinical trials that would require formal IRB approval as well as shelf-life optimization of at least 2 years in austere environments. The ultimate goal of this phase is to develop and demonstrate a technology enabling the prevention of sepsis in wounded service members from infected traumatic combat wounds and control of hemorrhage under prolonged field care with proper regulatory (FDA) clearance for human use. This effort should seamlessly be integrated into the TCCC paradigm of initial response to trauma. Once developed and demonstrated, the technology can be used both commercially in civilian or military settings to save lives. The selected contractor shall make this product available to potential military and civilian users. The contractor should coordinate with WRAIR/NMRC to establish a National Stock Number (NSN) as the first step towards the potential inclusion into appropriate "Sets, Kits and Outfits" that are used by deployed medical forces in the Defense Acquisition System.

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KEYWORDS: wound infections, sepsis, prolonged field care, combat wound care, multi-domain operation, urban dense area warfare


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A20-138 TITLE: Distributed Coded Computing for Content Management at the Tactical Edge

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: To develop a software solution for edge devices (such as smart phone, robot, UAS, IoT sensors, etc. to perform distributed computing and content based storage for efficiently processing, storing, and disseminating computational intensive tasks and information across available edge devices in a Disconnected, Intermittent, Low-Bandwidth (DIL) environment. The warfighters will benefits from increased situational awareness under contested environment in support of future Man-Unmanned Teaming operations and IoT sensor applications.

DESCRIPTION: Handheld mobile technology is reaching first responders, disaster-relief workers, and soldiers in the field to aid in various tasks, such as speech, image, video recognition, natural-language processing, command and control, decision making, and mission planning. However, these edge devices offer less computation power than conventional desktop or server computers and the tactical edge networks are bandwidth limited and suffer from intermittent connectivity to higher echelons in contested environment. In addition, exponential growth in mobile sensing technology is generating large amount of content exceeding the ability of individual edge devices to process/store and the network to disseminate them. This requires tactical edge networks to be able to process, store, and distribute content locally using available edge devices.

Distributed computing in the commercial networks is based on centralized schedulers where the scheduler allocates tasks to computing devices and they all report back to the scheduler. Cloud or fog computing in commercial network requires fixed computing infrastructure and 24/7 access to the cloud. Today client server paradigm requires connectivity between edge devices and server hosting platforms. Once the dismounted soldiers get disconnected from the server hosting platforms, there is minimal-to-no capability to process, store, and share locally collected information between connected dismounted soldiers. Separately, in the commercial network, the content based networking approach uses client/server paradigm which is not suitable at the tactical edge. In the academic, there is research being conducted in distributed computing, but mostly following commercial network paradigm.

To address the challenges at tactical edge, an innovative distributed computing approach is required to that perform computationally intensive tasks to reduce the collected information into meaningful content using machine learning techniques. The unique aspect of this research involves combining distributed computation with a content based networking paradigm to disseminate and store information efficiently across available edge devices for easy retrieval. Techniques within distributed computing that does not rely on centralized scheduler, works on resource constrained edge devices, addresses changes in number of computing nodes and associated resources and bandwidth limitations is required. New and innovative coded computing paradigms needs to be explored to address challenges of changing computing resources as well as metadata generation, distributed hashing, social networking, and role based encryption techniques to store and disseminate content efficiently across available edge devices should be explored.

PHASE I: Explore and design an architecture for distributed computing suitable for tactical edge network. The architecture shall include machine learning techniques to perform information processing such as object detection, and classification for extracting meaning information. The architecture design shall include content coding and dissemination techniques that considers various network constraints (i.e. computation resources, network bandwidth, and power). The implementation shall include distributed content storage mechanisms, content tagging and encryption technique for secure content dissemination and retrieval. The chosen approach and the algorithms should be substantiated by means of analysis, modeling and simulation or early breadboard prototyping. This task aims to explore the strengths and weaknesses of the architecture for Phase II.

PHASE II: Implement the above architecture and algorithm on COTS edge computing devices. Develop specification of the protocols which make use of the algorithms from phase I. Software implementation of the proposed protocols and algorithms to be implemented on a COTS platform. Demonstrate the system ability to process information using distributed coded computation and perform object detection, and classification to extract and store meaningful information relevant to the users within the network. Demonstrate and deliver capability in a network consisting of 10 node for laboratory assessment. Deliver a prototype system to CERDEC for further testing.

Demonstration of capabilities using a network of wireless mobile nodes under a relevant scenario. Demonstration of the scalability properties of the proposed solution using a combination of COTS radio nodes and network emulation tools. Final demonstration shall be conduct in field environment in a network consisting 30 edge computing devices.

PHASE III DUAL USE APPLICATIONS: Development of distributed coded computation along with content based networking techniques can be integrated with Army's Nett Warrior and Digital Warrior technologies to bring computationally intensive capability that extracts useful information to increase situational awareness capabilities to the foot soldiers on the ground. The proposed software system shall be integrated with hardware and software of Nett Warrior/Digital Warrior. In addition to military applications, this research is applicable for the First Respondent and the Homeland Security environments where distributed computation tasks to be performed are required especially in the events of natural disasters.

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KEYWORDS: distributed computing, content based networking, DIL environment, classification, machine learning, cloudlets, fog computing, architecture, edge devices, UAVs, and UGVs

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A20-139 TITLE: Software Defined Everything (SDx) and 5G/6G Cellular Design Prototype for Tactical Radios

RT&L FOCUS AREA(S): Network, 5G
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop a materiel solution that prototypes a converged network capability designed to converge modern telecommunications and internetworking concepts (e.g. Software Defined Everything (SDx), 5th /6th Generation (5G/6G) cellular) with that of military, tactical radio wireless communications technologies (e.g. Barrage Relay Networks (BRNs), Wideband High Frequency (WBHF) networks, Single Channel Ground Airborne Radio System (SINCGARS), and NATO Narrowband Waveform (NBWF). The target implementation would converge military-specific wireless communications technologies with these modern enabling network technologies. Software Defined Perimeter (SDP) can and should specifically be explored as means to simplify current network designs for military multi-level security services, black/red cryptographic separation and black core networking services. Modern military wireless communications provide advancements, and ready convergence with other advanced wireless communications solutions is critically needed; specifically 5th/6th Generation cellular.

DESCRIPTION: Warfighters need the right information, in the right place, at the right time, wherever they are located. Radio-aware networks are emerging to address these needs. A recent Internet Engineering Task Force (IETF) develop, RFC 8175, defines a Dynamic Link Exchange Protocol (DLEP) mechanism for integrating IP routers and mobile radios, enabling faster convergence, more efficient route selection, and better performance for delay-sensitive traffic – generally known as “Radio Aware Routing” (RAR). The data networking services of SINCGARS, WBHF and the NATO NBWF were developed prior to these innovations. The desired solution at completion with provide the commander the capability to integrate SINCGARS, WBHF and NATO NBWF into converged Internet Protocol (IP) based data networks leveraging modern convergence approaches.

PHASE I: The Phase One deliverable will be a comprehensive white paper describing:

- Study focusing on means to achieve a converged SDx based network leveraging current military tactical radios and 5G/6G cellular technology.
- Analysis of approaches and opportunities for an SDx based tactical network

PHASE II:

- Develop and demonstrate a prototype solution of an SDx- based network leveraging current and emerging PM Tactical Radio platforms and currently available technology (e.g. 5G)
- Phase Two deliverables will include:
  - Prototype solution suitable for supporting a battalion operation which has reached TRL 5
  - Demonstration of the prototype with Army tactical radio systems
  - Test report detailing solution performance
  - Product documentation detailing functions and operations of the prototype Monthly Progress reports. The reports will include all technical challenges, technical risk, and progress against the schedule.
  - A baseline schedule for phase III.

PHASE III DUAL USE APPLICATIONS:

- Develop and demonstrate a solution that provides a viable technology insertion to migration to an SDx based design.
- Phase Three deliverables will include:
  - Prototype solution suitable for supporting a battalion operation which has reached TRL 6
  - Demonstration of the prototype with Army owned or emerging radio systems

- Test report detailing solution performance
- Product documentation detailing functions and operations of the prototype
- Productization readiness report which presents any remaining design or implementation issues with respect to suitability to deploy within the command post
- Monthly Progress reports. The reports will include all technical challenges, technical risk, and progress against the schedule.

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KEYWORDS: VHF Radio, HF Radio, Digital RF, Signal Processing, HMS, SINCGARS


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A20-140 TITLE: High Performance Optical Fibers for 100-Watts Infrared Lasers

RT&L FOCUS AREA(S): Directed Energy
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop a high performance, low loss (less than 0.5dB/m), infrared (IR) fiber technology for transmitting high power (greater than 100 Watts CW) from a multi-band mid-infrared laser (2-6 micron).

DESCRIPTION: Infrared (IR) lasers are of high importance to the US military for multiple applications including infrared countermeasures (IRCM), free space optical communications, and imaging laser radars. To provide increased capability in these areas, the Department of Defense has made significant investment in high power IR laser sources. The objective of this SBIR is to leverage the advancing laser technology for IRCM systems by developing a corresponding high-performance infrared fiber technology.

Current IRCM laser systems integrate a multi-band mid-infrared laser with a pointer-tracker as a mated pair, comprising a single replaceable unit. The pointer-tracker assembly then directs the laser power to confuse and jam the attacking threat missile. Performance and reliability of current IRCM laser systems in high-power, high-stress environments is limited by thermal and vibration issues due to the use of free-space optics in the laser systems. The potential use of optical fiber to transmit the high-power laser beam to the pointer would create IRCM systems that meet the requirements of Modular Open Systems Approach (MOSA), whereby the infrared lasers and pointer-trackers become line replaceable units (LRU) connected through fibers. This would enable IRCM laser systems with simpler vibration isolation, better thermal control, higher performance and reliability, and significant cost reduction (unit, repair, and maintenance costs). Fibers with appropriate composition should be robust and reliable so that they can be made insensitive to temperature changes, vibration, and moisture. Fiber strength and resistance to mechanical damage are also important.

Current fiber capabilities at these wavelengths are limited by either water absorption or other losses. In addition, fiber strength and ability to withstand adverse environments is an issue. New technology is required to advance the state of the art in mid-infrared fibers to fulfill emerging requirements. Of particular interest would be methods for providing advanced infrared transmissive materials with high performance characteristics. The ability of the material to withstand representative stresses and survive in the extreme environments found in Army applications is also of interest.

The development, characterization and demonstration of fiber production, infrared transmission and advantageous material properties of fibers are key elements of any proposed research. The ability to integrate these fibers with traditional fiber components, such as connectors, multiplexers, other fibers and switches, would be advantageous. Efforts are needed to develop novel approaches to achieving development of these high performance fibers and maturation of the technology and manufacturing base. The end result of this research would be high performance optical fibers to advance the state of the art in mid-infrared laser applications.

PHASE I: Design an approach to produce optical fibers capable of low-loss (less than 0.5dB/m) transmission between 2-6 micron that exceeds the current state of the art. The optical fiber must have the capacity of transmission greater than 100 Watts laser power over 5-meter long fiber with the mechanical properties to operate in military environments (vibration, temperature, and humidity). Demonstration and measurement of physical properties such as fiber strength and resistance to the environment is critical. Since there is more than one wavelength to be covered, the fiber should be able to transmit a broad range of wavelengths (2-6 micron). A clear development path toward manufacturing the new fiber technology must be presented. The Phase I deliverable will be a final report including the initial fiber technology and performance assessment.

PHASE II: Demonstrate production of usable lengths of mid-infrared fiber to transmit high power (> 100 Watts CW) laser output in the 2-6 micron region with less than 0.5dB/m loss and high material strength. The minimum requirement for the constructed and demonstrated fiber prototype is 25W of optical power transmission with low-loss (<0.5dB/m). The transmitted beam shape should be as close as possible to a smooth Gaussian beam, which would typically be launched into it. Survivability of fibers under representative stress (such as applicable Mil-Specs) should be demonstrated. Key factors for this fiber technology are reliability, reproducibility, cost, and transmission characteristics. Required Phase II deliverables will include a fiber prototype, tests in a laboratory environment, and a final report.

PHASE III DUAL USE APPLICATIONS: Military. Upon successful completion, set up a manufacturing process to produce high performance IR fiber that will transition to the Army and DoD for integration into IRCM defensive systems being developed for rotary and fixed wing aircraft.

Commercial. High performance optical fibers for high power IR lasers should find uses in laser marking, laser machining, and laser micromachining. The new fiber technology in the IR wavelengths has potential applications in medical laser procedures, remote bio/chemical detection, and scientific instruments. Mid-wave infrared (MWIR) radiation is a valuable tool for spectroscopic investigations, and the use of fiber-optic technology in this wavelength band allows spectroscopic measurements to be made in normally inaccessible locations.

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KEYWORDS: IRCM, fiber optics, single mode, Chalcogenide, low-loss, laser beam delivery, cable


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A20-141 TITLE: C4ISR/EW Modular Open Suite of Standards (CMOSS)-based Common Data Link (CDL) Radio Transceiver

RT&L FOCUS AREA(S): Network
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and build a C4ISR/EW Modular Open Suite of Standards (CMOSS)-based Common Data Link (CDL) Radio Transceiver.

DESCRIPTION: Increases in Operational Tempo (OPTEMPO) and the need for greater mobility to support operations On The Move (OTM) are driving requirements for reduction in Size, Weight, and Power (SWaP) for U.S. Army intelligence ground stations. CMOSS-compliant OpenVPX chassis and modules are the target form factor for USARMY tactical communications electronics. This includes sensor radio transceivers. CDL is a secure U.S. military communications protocol that is the primary protocol for communicating with imagery and signals intelligence sensors. This includes aerial sensor platforms such as Joint Strs, EMARSS, and ARL-E. The current effort would port a successful proven technology (CDL) to an innovative platform. Developing a CMOSS-based CDL radio transceiver would increase modularity and maintainability/usability in the ground stations, as well as reducing SWaP.

PHASE I: Develop overall system design that includes specification of module component design, interfaces, CMOSS module profiles, and required CMOSS chassis profiles.

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct field testing to prove feasibility in connecting to CDL sensor platforms.

PHASE III DUAL USE APPLICATIONS: This system could be used in a broad range of USARMY and USAIRFORCE ground stations, including the USARMY Tactical Intelligence Targeting Access Node (TITAN), connecting to space (Commercial and Military), aerial (Joint Stars, EMARSS, and ARL-E), and terrestrial sensor systems (TLS, Prophet).

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KEYWORDS: CMOSS, sensors, CDL

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A20-142 TITLE: Federated Intelligence, Surveillance, Reconnaissance (ISR) Collection Management Using Machine Learning (ML)

RT&L FOCUS AREA(S): Network, AI/ML
TECHNOLOGY AREA(S): Information 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 section 3.5 of 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 desired end product of Phase II is to have a federated collection management software that provides a coordinated collection plans across National to Tactical ISR collection to include Joint and Mission Partner Environments (MPE) using machine learning to optimize collection plans across the enterprise.

DESCRIPTION: The Army technical problem can be broken down into several areas as it relates to Multi-Domain Operations (MDO). First, current collection plan generation is performed in a silo approach based on mission objectives. Often times it is completed through spreadsheets and PowerPoint. Second, these collection plans are not visible or sharable to entities outside of unit organizations that create them. Third, this leads to redundant collection plans often times relying on ISR collection assets that would be collecting on plans that may have common objectives. This leads to inefficiencies and increased timeliness of critical information. Lastly, collection plans are largely manually generated which requires multiple human generated steps to develop an optimized collection plan that has no relationship to other collection plans that may have similar objectives or National/Tactical ISR collection assets could collect in route if multiple desperate collection plans are geo-spatially and temporally close.

PHASE I: Provide a concept that addresses the challenges related to objectives of this SBIR. As part of the concept define what the minimum viability of the capability will provide with the goal of increased functionality while providing a fluid user experience in Phase II. Phase I shall also address concepts for built in training and reminders for users to quickly operate and maintain proficiency of the system.

PHASE II: Provide a physical proof of concept system that showcases how a federated collection plan is implemented with some level of automation applied in the creation of collection plans. Additionally, the proof of concept system shall implement machine learning to optimize the federated collection plans while also enabling unit organizations to significantly improve their abilities to leverage existing or previously generated collection plans that potentially have similar objectives.

PHASE III DUAL USE APPLICATIONS: This SBIR would enable current Synchronized High Op-tempo Targeting (SHOT) S&T efforts that are part of the Long Range Precision Fires (LRPF) portfolio. SHOT does not currently have a federated ISR collection task. The SBIR would also enable the Tactical Intelligence Targeting Access Node (TITAN) program under PM DCGS-A which would provide a path for transition into an operational capability. Lastly, the commercial applicability of this effort shall support commercial geospatial capability providers as well as consumers that utilize commercial satellites, manned/unmanned aircraft for land/surface surveilling to include law enforcement.

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KEYWORDS: ISR, MDO, MPE, National, Tactical, Collection Plans, Collection Management, SHOT, LRPF, Machine Learning, TITAN

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A20-143 TITLE: A Novel Non-Uniformity Correction (NUC) Approach for Night Vision Cameras

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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 objective of this project is to develop a novel technique to perform Non-Uniformity Corrections (NUC) of infrared focal plane arrays by minimizing and potentially eliminating the need to use active thermal reference sources. The desired approach is to use an in Dewar variable aperture or other similar mechanism to generate the gain and offset parameters in place of active thermal reference sources and thereby eliminate the resultant loss of live infrared imagery to correct staring arrays. The results of this project will be used by the Government to assess the feasibility to eliminate the cost of the active thermal reference sources and reduce the time required to perform the NUC.

DESCRIPTION: Sensors using cooled staring focal plane detector arrays will typically need some form of NUC to suppress random noise such that the scene can be viewed accurately. The pixel-to pixel variations are typically characterized as differences in gain and offset. The gain parameter refers to the slope of the pixel output (rate of change) response versus the input signal and the offset parameter is a fixed additive value unique to that specific pixel. The non-uniformity issue arises when each neighboring pixel in the focal plane array has a different gain and offset which leads to a fixed pattern noise which can dominate the output video unless it is electronically compensated. A standard method of compensation involves blocking the focal plane array with a known uniform source at different temperatures to measure each pixel's gain and offset values and then apply these offsets to each pixel on live output video to remove the fixed pattern noise. The downside of this approach is that while the thermal reference source is being used for a NUC the focal plane array is blocked from viewing the outside scene and thereby blinding the operator.

The 3GEN FLIR is a new technology for combat vehicles that incorporates a variable aperture mechanism (VAM) inside the cold space of the Dewar to vary the F# to enable the sensor to switch long focal length optics without increasing the aperture size. The aperture mechanism is structured like a conventional iris such as used in photographic camera optics. This means that the change in aperture shape will vary the amount of light flux from a given object source in a controlled and known fashion. By including the VAM in the NUC process to change the incoming photon flux instead of the thermal reference source, the NUC could be performed faster and not block the live image from the sensor operator. This new technique could be applied to a full two point correction calibration at system turn on and one point offset correction during live scene viewing thus eliminating blackout time of the sensor. This Novel NUC approach would eliminate blind time, which is extremely important to the warfighter that is common with the conventional NUC approach that uses thermal reference sources.

PHASE I: Develop the non-uniformity process sequences, algorithm, and performance metrics for one and two point simulated corrections using an in Dewar variable aperture mechanism or similar mechanism in the optical chain without the presence of an active thermal reference source compared to the conventional approach with a thermal reference source. Use Mat Lab or equivalent software to show with at least static imagery that the variable F# technique (either in Dewar or in the warm space) can correct the spatial noise of a longwave focal plane array to less than 25% of the temporal noise. Also, demonstrate the compatibility of the process algorithm with other scene-base non-uniformity correction methods that may be running in parallel. Deliver documentation of the work effort and the results in a technical report per DI-MISC-80048.

PHASE II: Using a 3GEN Dewar (this will be a GFE), produce a breadboard apparatus and perform laboratory and field tests in both static and on the move scenarios with live video-rate processing to obtain non-uniformity corrections that result in the spatial noise to be less than 25% of temporal noise. Measure performance over an eight hour window and check the stability of the corrections. Document and deliver the optimum processing algorithm, actual test apparatus hardware details, and the test raw data, analysis, and conclusions per DI-NDTI-80809B.

PHASE III DUAL USE APPLICATIONS: The end state is the 3GEN FLIR which will eliminate the Thermal Reference Source and use the variable aperture for the non-uniformity correction. The transition will be Low Rate Initial Production (LRIP) and full rate Production of the 3GEN FLIR through an engineering change proposal. Having Non-uniformity correction capability that doesn't block the visual scene can be applied across DOD and industry for Night Vision Devices.

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KEYWORDS: Variable Aperture Mechanism, 3GEN FLIR, Non uniformity correction, infrared, offset, gain, focal plane array

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A20-144 TITLE: Aerostat Payload Protection (APP) System

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The objective of the Aerostat Payload Protection (APP) system is to minimize Aerostat payload damage when Aerostat flight operations are terminated and the Aerostat descends back to the ground.

DESCRIPTION: Modern Aerostats carry very sophisticated and expensive Electro-Optic/Infrared cameras, RADAR, and Communications payloads. These Aerostats also possess a Flight Termination System (FTS) that quickly bring the Aerostat to the ground in the event of major events such as a fully severed tether, or deliberate user initiation.

Currently, when the FTS is activated, these payloads frequently impact the ground at high velocities. The payloads are often damaged to the point that they become partially or fully Non-Mission Capable (NMC). Mission losses are approximately $ 10 million per year (approximately $ 1,000,000 of payload lost in 10 incidents per year).

The typical damage modes of these payloads include:

- Impacting the ground with relatively high impact velocities in a direction normal to the ground (i.e. high kinetic energy)
- Impacting the ground with a relatively high deceleration rate (i.e. high "g-loading")
- Impacting the ground with a relatively high velocity parallel to the ground (i.e. "scraping")

The APP will be a feature or system on, in, or of the Aerostat, to significantly reduce the level of payload damage and incurred costs.

PHASE I: Generate an APP design concept with a technical feasibility that would lead to an eventual (at Phases 2 and 3) physical manifestation. Multiple (three) concepts are recommended to perform trade-off studies for performance, reliability, and SWAP-C comparisons of the different design concepts. Describe the CONOPS (Concept of Operations) of the design(s). Perform basic, essential Engineering studies that would demonstrate the efficacy of the design ("hand calculations", MS-Excel worksheets, etc.). Perform simulations or computer modelling (kinematics, kinetics, FEA, CFD, etc.). The main goal of these calculations is to predict the performance of an Aerostat with an APP before it is ever built. For any computations involving actual numbers, sample data can be provided for Aerostats in the 22 to 36 meter range. Some the parameters for these computations will include:

- Weight of the Aerostat (W_aerostat)
- Lifting capability of Aerostat (L_aerostat)
- Weight of the Payload (W_payload)
- Weight addition as the result of incorporating an APP system (W_app)
- Altitude of Aerostat when activating the APP (z_act)
- Prevailing wind velocity at time of APP deployment (v_wind)
- Distance from mooring platform (r_MP)

To better illustrate the APP objective, several examples of design concepts are presented below. These are for guidance only, and not direction. Furthermore, these in no way shall limit, constrain, or otherwise drive the solution:

- Controlled release of Helium to ensure that the Aerostat both touches down at a slow enough velocity but also does not migrate beyond a required distance from the Mooring Platform (i.e. “throttling” of the release valves, using on board GPS and altitude sensors, etc.)
- Parachutes, including steerable versions
- Inflatable cushions (aka “airbags”)

And here is a sample CONOPS:

“The Aerostat’s APP system, as the result of an adverse incident or by user input, is triggered. The APP automatically executes an action or sequence of actions which will bring the Aerostat from its initial operating altitude down to ground level, within a defined distance from the Mooring Platform. At the moment that the payloads hit the ground, they have either impacted the ground at a sufficiently low velocity, or have a sufficient deceleration zone so that the g-loading is low and payload damage is minimized. The payloads can be subsequently recovered with a minimum of inspection or repair, re-installed on a new Aerostat, and re-launched to altitude.”

As Aerostats are exceedingly weight sensitive airborne vehicles, the total added weight from incorporating an APP shall be less than 10% of the Aerostat’s payload lifting capability. As an example, a typical 36 meter long Aerostat has a payload lifting capability of approximately 1,000 lb.

PHASE II: The Phase II effort would equip and demonstrate a functional APP system on an Aerostat with a minimum 12 m overall length.

The following will be some basic functional requirements:

- The APP shall be capable of activation both automatically (due to separation of the tether-to-ground connection), or manually from the ground based on user input.
- The APP shall ensure that the designated payloads retain Full Mission Capability (FMC) after the APP is activated at an altitude of $z_{act}$ and the payloads return to an altitude of $z = 0$ while prevailing winds are at a velocity from 0 to $v_{wind}$. For reference, the typical payloads would retain FMC after being subjected to MIL-STD-810 Method 516.8, Procedures IV Transit Drop, VI Bench Handling, and VIII Arrested Landing.
- The payloads shall return to the ground within $r_{MP}$ of the Mooring Platform, in the prevailing winds with a velocity $v_{wind}$.
- Weight of any new APP components shall be less than $W_{APP}$.
- The APP shall be capable of protecting payloads up to $W_{payload}$.

Where mathematical symbols are presented above, the actual values that will be assigned to those symbols will be provided based on the outputs from Phase I.

PHASE III DUAL USE APPLICATIONS: The goal of Phase III is a fully operational Aerostat equipped with a functional APP system. A full size, 1:1 prototype of the APP shall be constructed and tested. This will be for an Aerostat of approximately 28 m to 36 m overall Aerostat length. PD Aerostats will provide the basic Aerostats, dummy payloads, and the test site for demonstrating APP trials. Values for requirements will be provided at this phase.

The commercialization potential for this APP would include military and civilian Aerostats (i.e. tethered balloons and even unmanned airships).

An approximate cost for estimate for the APP implementation will be an output from Phase III.

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KEYWORDS: Aerostats, airships, survivability, parachutes, inflatable restraints, airbags, controlled descent, impact, shock mitigation

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A20-145 TITLE: Active Noise Reduction HGU-56P Aviator Helmet

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Reduce noise and improve speech intelligibility with least weight increase to HGU-56P Aviator Helmet

DESCRIPTION: Improved speech intelligibility is a fundamental component of soldier lethality, one of the six army modernization priorities of the Army which includes the core requirement of communication. Army aviation has relied on noise cancelling microphone technology based on performance specification MIL-PRF-26542F for over 20 years. Naval aviators have relied on active noise reduction (ANR) earcups with the same microphone based on performance specification MIL-E-29581 for over 20 years. The Army never adopted the ANR system because the Navy specification calls out Rigid Earcups (paragraph 3.3.2.1.1) which violates the requirement for impact protection in the ear dome to prevent basilar skull fractures. The ANR earcup was considered too heavy and rigid for integration into the HGU-56P.

Active noise reduction technology has improved and the electronics for achieving better speech intelligibility has shrunk dramatically since the original Navy specification was released. Commercial headsets commonly used on jets and rotary wing aircraft which incorporate ANR include the Lightspeed Zulu 3 Aviation Headset - GA Plugs: https://www.lightspeedaviation.com/product/zulu-3-anr-headset/; Bose A20 Aviation Headset: https://www.bose.com/en_us/products/headphones/aviation_headsets/a20-aviation-headset.html; David Clark DC PRO-X2: https://store.davidclark.com/dc-pro-x2-series

Improvements among these and other headsets designed to address better passive and active noise reduction include better ear cups which allow sealing the ears even when wearing eyeglasses, lighter weight, reduced size, improved active noise cancellation, automatic gain control, and active equalization. In addition, modern aviation headsets include either a standard interface audio jack or Bluetooth allowing commercial phones to be used while in flight without taking off the headset, something else not core but desired.

This solicitation intends to identify an existing commercial solution to provide the best overall reduction in ambient noise reaching the user's ears while improving speech intelligibility. Threshold improvement requirement is 10% over current sound attenuation of the HGU-56P Aviator helmet. Objective is 30 decibels of noise reduction average across frequencies without removing speech from user as side effect.

According to the Department of Veterans Affairs, hearing problems such as tinnitus are described by the VA as among "the most prevalent service-connected disability among American Veterans." Improved hearing protection can not only improve communication, it can reduce hearing loss and the cost of long term veterans benefits paid to our service members.

PHASE I: This effort shall identify and test the most promising combination of passive and active noise reduction technology that can be retrofit into the HGU-56P aviator helmet at the least weight and cost. The initial proposal shall identify a solution which provides noise reduction data showing acoustic attenuation of the technology proposed by comparison to paragraph 3.4 of MIL-E-29581 earcup and MIL-PRF-26542F microphone (if proposal includes replacement of microphone). The contractor shall perform a laboratory demonstration in Phase I demonstrating and quantifying noise reduction and speech intelligibility improvement in benchtop tests using two Government furnished HGU-56P helmets. The contractor shall modify one of the helmets with the proposed improvements and perform identical tests using one modified and one unmodified HGU-56P helmet so that comparison data clearly shows performance improvements achieved. Noise reduction shall be measured using a probe microphone method (REAT Method is not allowed). A report shall be provided which details the tests performed and the improvement demonstrated. Speech intelligibility shall be evaluated using the Modified Rhyme Test method (ANSI S3.2-1989). A Noise Reduction Rating shall be produced IAW ANSI S3.19-1974. The contractor shall document changes to the existing earcup and/or microphone specifications which definitize performance improvement. The report shall estimate costs and weight impact of the technology solution proposed. Measurement of real-ear attenuation of hearing protectors shall be performed IAW ANSI S12.6. The current sound attenuation of the HGU-56P aviator helmet when tested IAW ANSI S12.6 is as follows:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| • Frequency (Hz) | 125 | 250 | 500 | 1000 | 2000 | 3150 | 4000 | 6300 | 8000 |
| • Attenuation (Decibels) | 17 | 14 | 20 | 21 | 26 | 38 | 37 | 44 | 42 |

PHASE II: The solution identified in phase I will be applied and tested to meet all requirements of the specifications proposed for update or replacement. As example, if a replacement earcup is proposed, the existing ear cup specification (MIL-E-29581) would serve as a starting point for a new ear cup specification. Likewise, if the microphone is proposed to be replaced, the microphone specification (MIL-PRF-26542F) would serve as a starting point for a new microphone specification. The contractor shall propose written changes for any existing hardware specifications associated with hardware being changed or replaced. All testing shall be performed IAW the updated hardware specifications submitted by the contractor. A summary report at the end of the test shall document all performance improvement of the new solution to include capabilities added to the performance specifications identified in Phase I. If testing shows initial projections of performance differ from actual results, the contractor shall update any product specifications being replaced or updated as necessary. The contractor shall perform bench testing for all ear cup specification requirements on production representative prototypes if the ear cup is being modified/replaced with an earcup equipped with ANR IAW a contractor proposed update or replacement of MIL-E-29581. The contractor shall perform bench testing for all microphone specification requirements on production representative prototypes if the microphone is being modified/replaced with an improved noise cancelling microphone IAW a contractor proposed update or replacement of MIL-PRF-26542. The contractor shall build sufficient quantities of noise reduction solutions and retrofit Government furnished HGU-56P helmets to account for testing all performance requirements in the updated specifications. The new noise reduction system shall be capable of being retrofit into the HGU-56P helmet without special tools. Objective of the replacement solution is to be capable of installation as direct part swap for original component(s). The ANR solution shall be capable of accepting power between 3 and 5V DC for operation.

Deliverables will include test plan, test report, updated performance specification(s) reflecting measured improvement in audio performance, minutes for all meetings conducted with the vendor, presentation slides for test readiness review, a white paper detailing the installation cost of the retrofit solution, and a cost report detailing manufacturing cost as a function of helmet quantity from a minimum of 50 and up to 1000 at a time.

TRL: (Technology Readiness Level) TRL Explanation Biomedical TRL Explanation TRL 6 - System/subsystem model or prototype demonstration in a relevant environment

PHASE III DUAL USE APPLICATIONS: Develop production processes and implement any design changes required to optimize components for retrofit into HGU-56P helmet. Update any specifications needed to reflect final production configuration weight and performance. Repeat bench qualification testing if production configuration deviates too far from prototype configuration tested in Phase II. Support operational testing on multiple Army rotary wing aircraft. Aviation helmets used throughout DOD may find retrofit application for this same solution. Most aviation headsets are designed for fixed wing applications (quiet cockpits) due to their greater density in commercial applications (moving people and cargo). This solution will be optimized for rotary wing applications which are far louder, and will therefore have commercial applications in both commercial helicopters, service and maintenance activities around operational aircraft on runways, motorcycles, and the racing industry where engine noise is very loud.

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2. https://jramc.bmj.com/content/141/2/98



KEYWORDS: Active Noise Reduction, Acoustic Noise Reduction, Passive Noise Reduction, Speech Intelligibility



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A20-146 TITLE: Low Voltage Cable Reflectometer Built in Test Module

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Develop a modular circuit board which implements a low voltage reflectometer capable of determining cable faults and reporting results back to a processor or Field Programmable Gate Array (FPGA) as part of Built in Test (BIT) circuitry. Goal is to demonstrate a cable test technology for integration at the circuit board level for new electronics equipped with data, power, and antenna cables that are human, aircraft or vehicle mounted (not long distance transmission).

DESCRIPTION: Improved and simplified troubleshooting of electrical systems constitutes a fundamental component of sustainment, which falls under soldier lethality, one of the six army modernization priorities of the Army. PM Air Warrior is developing the next generation of body mounted electronics for the aviator. Previous development efforts ran into substantial reliability issues with body mounted cables due to their tendency to flex and crimp far more than what is seen on an air or ground vehicle. Cable and connector issues were a big contributor towards an unsuccessful conclusion of that program. The Rapid Innovation Fund topic "Wireless Air Soldier Power" is developing a power and data hub through which all body mounted cables will be connected. While digital BIT is implemented, analog wire testing is not part of the current design approach.

The Office of the Secretary of Defense (OSD) recently polled the development program managers Army wide for feedback on the deployment and use of test equipment designed to identify intermittent faults in electronics. Due to the weight and cost of external support equipment capable of this, plus the training associated with adjusting the results for the equipment under test, an external test set is not desired. Instead, an internal test which allows the user to know if the system has problems prior to mission start is needed providing immediate go/no-go status of cabling which includes assessment of whether wire performance is likely to experience intermittent failures if signals show weak spots.

While cable test reflectometers have been around for many years, methods that work with much lower voltage have recently been developed that can test external cables from a central box using an approach integrated inside the box. Research on this includes the following citations:

- https://pdfs.semanticscholar.org/7903/3efd09b2a44016c5896442a6c13b57586dc5.pdf
- www.emo.org.tr/ekler/b849cf30f2a2030_ek.pdf
- https://www.researchgate.net/publication/228888052_INTELLIGENT_FAULT_LOCATION_FOR_LOW_VOLTAGE_DISTRIBUTION_NETWORKS

This solicitation intends to identify existing low voltage cable assessment test equipment and incorporate this technology into a modular chip capable of introduction to a circuit board with the following features identified:

- Recommend interface for standardized chip to communicate with processor or FPGA.
- Cable types that can be evaluated (single strand, twisted pair, coax, Twinax, etc.)
- Upon verification of working system operation after initial installation, perform a baseline assessment of existing cable performance.
- Upon startup BIT for all subsequent power on to system, perform assessment of existing cables and compare to assessment of initial verified operational cables. If significant deviations found, provide code to processor or FPGA corresponding to which connector and pin is found to be a potential problem.

PHASE I: This effort shall develop and demonstrate a breadboard prototype circuit board capable of identifying fault types of different cables connected to the circuit board to include short circuits, open circuits, and intermittent faults due to loose or damaged pins in connectors. A laboratory demonstration is required to demonstrate breadboard operation of the circuit board and show proper fault analysis when faults are introduced. A test plan is required showing how faults will be introduced to the cables and what faults can be detected by the tester. A test report is required documenting the results of the laboratory demonstration and the accuracy of the fault detection actually achieved by the circuit board. The contractor shall write and deliver a plan for a Phase II integration of the circuit board into the power and data hub. The integration plan shall project cost, size, weight, and power consumption of the circuit board to be integrated into the power and data hub based on the breadboard build prototype.

PHASE II: The contractor shall partner with the vendor building the power and data hub to design a modification introducing a circuit board prototype to deliver a new power and data hub that can automatically detect cable faults as part of the power up sequence for BIT, and allows a "calibration" function that the user can implement when a working set of cables and subcomponents are mated to the hub. A total of not less than eight hubs with the fault detection chips introduced shall be built and delivered. An interface control document shall be provided to the Government and the hub vendor detailing mechanical and electrical interface for the fault detection module. The HUB vendor shall have project management control of weight/space/power assignment of the fault detection module integration.

The contractor shall host a Preliminary Design Review and perform a Critical Design Review (CDR) at the Government's facility in month eleven. Critical Design Review (CDR) shall serve as the first milestone at the end of year one. Both design reviews shall make projections for weight/space/power requirements of the fault detection module. CDR shall present a cost projection for the fault detection module. Design reviews shall address how the fault detection module will have access to all hub connector wires without interference in normal operation, automatic activation when BIT is initiated, automatic disable of module operation when BIT is not active, how faults will be reported to hub processor, and an assessment of fault determination and accuracy. Delivery of fault detection modules to the HUB vendor for integration shall serve as the 2nd year milestone.

The contractor shall provide technical support to the HUB vendor by phone and travel to the hub vendor site for first integration build activity. The contractor shall design the fault detection module as a circuit board module within the hub. The contractor shall provide final measured fault detection module capability and weight/space/power information to the hub vendor so that the product specification for the hub can be updated. The contractor shall perform a bench demonstration of the first fault detection module built to verify space/weight/power, functions, and capability.

Deliverables will include briefing slides for the design review, meeting minutes for bi-weekly status telecons and design reviews, a test plan for fault detection module performance demonstration showing compliance to hub integration requirements, test report documenting test accomplishments, data for updated hub performance specification reflecting measured fault detection module performance, and a report detailing projected cost of the final fault detection module design as a function of quantity from a minimum of 50 and up to 1000 at a time. A preliminary technical data package for the fault detection module shall be delivered.

PHASE III DUAL USE APPLICATIONS: Develop production processes for fault detection module prototypes built and delivered in Phase II. Update the hub item specification to reflect final production process weight and performance impact based on production configuration fault detection module. Build thirty six (36) production representative fault detection modules to supply to hub vendor for final operational testing on multiple US Army helicopter configurations. Provide technical data package for fault detection module. Fault detection module may migrate into other Army avionic boxes under development. Primary commercial application of fault detection module may focus on vehicle wire harness interface to central computers, dedicated controllers for industrial machines with complex wire harnesses, and network hubs delivering Power Over Ethernet (POE).

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KEYWORDS: Intermittent Cable Fault Detection, time domain reflectometer



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A20-147 TITLE: Light-weight Internal-combustion High-power, Transformative, Novel, Individual New Generator (LIGHTNING)

RT&L FOCUS AREA(S): general warfighting, network
TECHNOLOGY AREA(S): Human Systems

OBJECTIVE: Design, develop and demonstrate a light-weight, Soldier wearable, safe, small Soldier Power Generator (SPG) system using JP-8 fuel as a minimum.

DESCRIPTION: The Soldier's power generation capability must provide an on–the-move power to enable battery recharging. System weight including 350 Watt-Hours of fuel (inclusive refillable Bladder / canister type fuel container) shall be less than 3 Lbs. A minimum of 30 Watts continuous power shall be provided with ability to have a "LOW" setting at 20W, a "MEDIUM" setting at half way between 20 W and Maximum, and a "HIGH" setting at maximum power to allow the operator to adjust power available, noise, and fuel conservation as needed. The LIGHTNING system shall have an attachable hose (not included in system weight) to allow for indoors operation or to vent heat exhaust away from the Soldier. Fuel at a minimum will be JP-8, with objective of being multi-fuel system. The LIGHTNING System shall have a volume of less than 60 cubic inches including fuel and with a length and width not exceeding 7 inches and a depth not to exceed 3 inches in any dimension, with an objective of less than 45 cubic inches. System design and implementation shall allow for Soldier operation between -20°C to +55°C, be rugged, droppable, operate in rain and immerse able (2 hours 1 meter – shake out and able to be restarted without system damage) in Soldier use environments (iaw MIL-STD-810). The system shall have an embedded self-start function that may use power from the Soldier's 10 to 20 VDC battery. A selector switch shall be provided to select between 10 to 20 VDC output (15-19 VDC Nominal) and 10 to 32 VDC output (28-32 VDC Nominal) power output. Full power shall be available within 5 seconds. Output power shall be interoperable with items that can scavenge power looking for Maximum Power Point Tracking (MPPT) when connected to external systems (Examples – Thales Universal Battery Charger – Lite; Revision Squad Power Manager (solar panel input); Advanced Power Electronics Corporation – Solar In-line Recharge Enabler). The system shall be relatively quiet generator < 80 dB (Threshold) / < 60 dB (Objective) at 30W output. The system shall be safe to touch (iaw MIL-STD-1472) (T); <3°C higher than ambient Temperature (O). The system shall provide Safe on-Soldier and on ground operations (T) and operate indoors (may include snorkel to outdoors) (O). The system shall be designed to operate for 2000 hours operation with minimal maintenance. At a minimum, the LIGHTNING System shall have a two pin shrouded trailer hitch and / or a 7 socket GlenAir Mighty Mouse (i.e. Glenair Part Number 8071-1472-12 / 8070-1299ZNU7-7DY - 807-663-12/807-348-01ZNU6-7SY, 8070-1675-01ZNU6-7SY or equivalent connector). The system shall be safe with minimal carbon monoxide output. Future objectives would be to output power such that it is compliant with System Management Bus (SMBus) version 1.1 or higher output to directly charge batteries as one of its output power modes, and to provide power that has an auto shut off function when the power drain is minimal. Other objectives would be to have items such as a digital readout with power out, time remaining on current cartridge/canister/bladder of fuel, and system state of health (SOH) / overall hours operated, if SMBus controlled output, - connected battery State of Charge / SOH, and time to charge complete, etc.

PHASE I: Develop an innovative approach and a detailed design of the proposed LIGHTNING System that would employ JP-8 fuel source. The design shall take into consideration the Soldier's equipment and space claim along with appropriate placement on the Soldier, its human factors to include comfort, acoustics, emissions, etc., in order to provide a positive implementation for use on the Soldier on the move and shall not interfere with Soldier operations. Perform a tradeoff study of candidate configuration/options and identify best solution. The final report shall be a complete design of the proposed LIGHTNING System. The report shall delineate how the system will allow for proper use on the Soldier and interoperability with power scavengers and appropriate ruggedness. The report shall also provide an estimate of the cost, size, weight, system acoustics, system temperatures, system power generation, and any tradeoffs.

Provide prototype of or details of proposed solution that meets the light-weight (less than 3 Lbs. at greater than 30 W output) and small on-Soldier form factor size and power requirements. A prototype system will be bench-demonstrated in form-factors relevant to the Army's needs, with key metrics including weight of the Soldier-worn power generation device, power transfer range, peak-power, frequency, and overall system efficiency. In order to be considered for this effort, the bidding firm must also show that they are capable of performing proof-of-principle experiments.

PHASE II: Based on the selected Phase I design, build a minimum of two (2) fully functional, rugged prototype of the proposed SPG system, then integrate and test it with Army provided power scavengers and recharging devices (UBC-Lite; SIREN, SPM 622) as defined by the Project Manager Close Combat Squad (PM CCS) Ground Soldier Systems (GSS) – Soldier Power (SP) team and employ on and off the Soldier and verify operational performance to provide power. Demonstrate the capability of the LIGHTNING System to operate on and with existing Soldier gear and equipment (E.g. Radios and GPS systems – Government supplied) with minimal impact to Soldier or Systems performance. Submit a report detailing test and demonstration results. The report shall include the study of how the System will complement or impact Soldier operations and equipment. All software / firmware / Graphical User applications generated for the System shall be provided as open source information to the Government along with any input/output data/ICDs to / from the LIGHTNING System. Supporting data shall include analysis for LIGHTNING system's performance throughout its lifecycle. Identify any other issues that should be addressed in Phase III like hardening the technology to survive Soldier environments (e.g. MIL-STD-810, MIL-STD-461, etc.), handling, and ease of use along with considerations for low-cost production processes for mass production.

PHASE III DUAL USE APPLICATIONS: In conjunction with PM CCS GSS SP, optimize the prototype fabricated in Phase II to commercialize the system and be rugged for operations in Tier 1 (most austere environments) mission operations and durable enough for Soldier fielding. Provide a transition path to DoD Program managers for use of this novel power system. The development of this LIGHTNING System also could have considerable commercialization potential for outdoor activities such as hiking and camping that do not have traditional power available.

REFERENCES:

1. Department of the Army Memorandum THRU General Robert W. Cone, Commanding General, U.S. Army Training and Doctrine Command, Fort Monroe, VA; Subject: FY12 Warfighter Outcomes (WFO) to Guide Science and Technology (S&T); Dated: 08 Jun 2011.
2. Department of the Army Headquarters, United States Army Training and Doctrine Command Fort Monroe, VA 23651-1047 Military Operations Force Operating Capabilities dated 7 March 2008 TRADOC Pamphlet 525-66.
3. Capability Development Document For (U) Small Unit Power (SUP) Increment: 1 dated 12 July 2013, CARDS # 16160 approved 26 SEP 13.
4. Military Standard - Environmental Engineering Considerations and Laboratory Tests (MIL-STD-810G): http://en.wikipedia.org/wiki/MIL-STD-810.
5. Military Standard - Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (MIL-STD-461).
6. Military Standard – Human Engineering (MIL-STD-1472).
7. Military Standard - Characteristics of 28 Volt DC Electrical Systems in Military Vehicles (MIL-STD-1275).
8. Integrated Soldier Power & Data System – Core Performance Specification (PM-SWAR-SPS-ISPDS-C Dated 27 June 2014) – Project Manager Soldier Warrior Soldier Systems & Integration, 10125

Kingman Road, Bldg 317, C18 Fort Belvoir, VA 22060-5820. Note: PM SWAR is now PM CCS located at 5966 12th Street, Bldg 1024, Fort Belvoir, VA 22060.

9. Published Conformal Battery Specification (MIL-PRF-32383/4): Base Spec and Slash 4: http://quicksearch.dla.mil/basic_profile.cfm?ident_number=277787&method=basic http://quicksearch.dla.mil/basic_profile.cfm?ident_number=279268&method=basic
10. Military Operational Environments - http://www.dtic.mil/doctrine/jel/service_pubs/fm3_0a.pdf.

KEYWORDS: Expeditionary Soldier Power, Internal Combustion Engine, Power Generation, DC Power, Lightening the Soldier Load, Operational Flexibility.

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A20-148 TITLE: Flight Test Execution Team Pre-Mission Training Tool

RT&L FOCUS AREA(S): general warfighting
TECHNOLOGY AREA(S): Information 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 section 3.5 of 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: To develop innovative distributed tools for performing pre-execution on-console training to optimize flight test execution team readiness, and establish quantifiable metrics suitable for objective evidence.

DESCRIPTION: Increases in flight test complexity, geographically distributed test execution teams and accompanying growth in complexity of formal Launch Constraints and other test execution procedures drive the need for new and innovative test-execution team training tools and methods. An integrated training environment controller is required which can be deployed across the distributed execution team to support real-time anomaly insertion, track operator actions and assess team readiness for the increasingly complex flight testing programs.

The challenge is to develop a tool that is sufficiently flexible to model the ever increasing mission-specific flight test constraints which evolve through the Government's requirement to produce realistic flight test events and push the developed systems to their maximum performance limits. This requirement, in turn, also impacts the required training cycle and forces a drastic improvement with the training realism and the resulting value of mission rehearsals. The specific challenge to be addressed is that the tools must codify mission-specific training metrics which can be logged automatically for post-rehearsal readiness assessments.

If successful, the software tools will benefit many military applications such as test directors and operators by ensureing the personnel are fully capable and prepared to execute test events which cost hundreds of millions of dollars to execute. The specific weapon and target platforms of interest for this topic is a test targets for ground-based High Energy Laser (HEL) weapon systems, long range hypersonic weapons, and ballistic missile defense systems.

The objective software application for this topic is not specified as the government currently utilizes a small set of Monte Carlo trajectories to execute the simplistic training due to the lack of operator training tools. It is expected that the design be modular in nature and can be applied to a variety of range commercial and military testing applications. The offeror must include a demonstration system (software and some integration hardware) for performance demonstration during Phase II.

PHASE I: The phase I effort will result in the concept feasibility, architecture, design of the proposed solution, and demonstrate prototype components. The phase I effort shall include a final report including software requirements, system software architecture, software detailed design, and cyber-security approach.

PHASE II: The Phase I designs will be utilized to develop, integrate, interface, test and evaluate a breadboard system. The breadboard system design will then be modified as necessary to produce a final prototype. The final prototype will be demonstrated to highlight the suitability to representing the range flight systems and controls. A complete demonstration system inclusive of representative elements must also be provided by the offeror. TRL (Technology Readiness Level): TRL 5 - Component and/or breadboard validation in relevant environment.

PHASE III DUAL USE APPLICATIONS: Civil, commercial and military applications include training systems for commercial and military test ranges. High energy lasers and advanced propulsion systems can leverage this technology to ensure safe operations of flight vehicles by the use of this/these software tool(s) to train qualified personnel for range safety. The Phase III effort would be to 1) design and build a training system for long range precision fires applications in connection with multiple MRTFB test ranges and/or 2) design and build a target detection/tracking processor that could be integrated into the Army's High Energy Laser Mobile Tactical Truck (HEL-MTT) vehicle for test targets as necessary. Military funding for this Phase III effort would be executed by the US Army Space and Missile Defense Technical Center.

REFERENCES:

1. Software Testing Tutorial: Free Course. (Guru99 2019). Retrieved from https://www.guru99.com/software-testing.html
2. White Sands Missile Range WSMR Public > RCC > Available Publications. (Year, Month Date of publication). Retrieved from https://www.wsmr.army.mil/RCCsite/Pages/Publications.aspx
3. Secretariat, Range Commanders Council "TELEMETRY NETWORKS," Telemetry Group Range Commanders Council, (May 2011)


KEYWORDS: Test, Range, Telemetry, Training, Tool, Software, Packet, Transmission, Display, Student, Laser, Missile, Safety, Operator, Computer, Cyber, Cybersecurity, Security


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A20-149 TITLE: High-Power Tapered Amplifier Laser Diode Array With Active Phase Control Feedback Loop for Future High Energy Laser Weapons

RT&L FOCUS AREA(S): Directed Energy
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a kilowatt class near infrared direct diode laser array based on tapered amplifier technology with emitter-level phase control for extracavity coherent beam combination.

DESCRIPTION: High-power, high brightness direct diode lasers exhibiting single mode performance and displaying high beam quality are needed to scale the output power of SWAP-constraint mobile high energy laser weapons by surpassing the fundamental efficiency limits of high energy fiber laser systems. Commonly the output power of diode lasers can be increased by increasing the semiconductor active area. However, a direct consequence is a degradation in the emitted beam quality, which severely limits laser beam propagation. Therefore, broad area diode lasers are not practical solutions for high energy laser weapons. Instead, solutions that can emit at a high power while maintaining excellent beam quality are needed.

At the single emitter level, tapered amplifiers have achieved some of the highest output powers (Watts) in the field of diode lasers at brightness levels of 1000 MW/cm(2)/sr, while maintaining near single mode beam characteristics and diffraction limited beam quality in the fast axis [1,2]. Efforts to improve the beam quality of the slow axis have achieved near diffraction limited slow axis performance, and external micro-optics can match the divergence angles and address astigmatism between the two axes. A tapered amplifier is driven by a high quality seed laser, which may be integrated into each amplifier element, or a single seed may supply multiple tapered amplifiers in an active master oscillator power amplifier (MOPA) architecture [3].

Realizing an array of tapered amplifiers to produce a high power laser (kW-class power, GW/cm(2)/sr-class brightness) poses two overarching challenges. First, the solution to construct a dense array, e.g. monolithically, needs to address thermal management, wall plug efficiency, seed geometry, and irregularities such as “smile” in the fabrication stages. Tradeoffs between array fill factor, external array symmetrisation and optics, as well as thermal management need to be considered in the context of SWAP and efficiency.

Secondly, a method to actively control the phase relationship between N elements, which is necessary to achieve predictable coherent beam combining (CBC) results at high combining efficiencies, needs to be developed. Indeed, the added complexity of phase control at each element may in turn decrease the complexity of the optical path from laser to telescope: beam control methods such as the use of adaptive optics to address atmospheric effects, fast steering mirrors, and associated mechanical and electronic control loops may be addressed by the laser itself through its ability to control the phase at each element at kilohertz speed.

PHASE I: Design the architecture and fabrication technique to construct a kW-class (>=1kW) laser array based on tapered amplifiers. The design must include predictable wall-plug efficiency, beam quality characteristics, fabrication cost, tolerances and areas of risk. Furthermore, the design must be complete with a detailed description of the proposed CBC architecture including all hardware components from seed laser to phase detectors, packaging, as well as phase modulation and feedback algorithms to produce predictable and highly stable phase relationships between all elements of the diode array. The design must include a hardware solution for physically combining N elements into a single, coherent, high beam quality, high power laser beam.

PHASE II: Construct a kW-class (>=1kW) laser array based on the design delivered during Phase I. To address uncertainty in cost for realizing such an array, at a minimum, a 500W array has to be delivered if the design clearly shows that scalability to over 1kW per array is straightforward, and does not pose additional technical challenges. The array shall be delivered with external beam combining hardware to demonstrate the ability to coherently combine all elements. For demonstrational purposes, the maximum level of constructive, and destructive interference in unites of output power and coherence length shall be reported on to provide quantitative results for combining efficiency. Furthermore, the beam quality of the combined beam shall be characterized. Quantitative efficiency values related to the individual amplifiers, diode array, and CBC method shall be clearly identified.

PHASE III DUAL USE APPLICATIONS: Optical metrology, which is an emerging field as a non-contact measurement method for military and industry will benefit from a high power tapered array with phase control, which can open the door for electronic beam steering of lasers. Tapered amplifiers are needed for nonlinear research through second harmonic generation as well as for pumping of Raman or other solid state amplifiers, requiring high power and high brightness. Furthermore, a CBC tapered amplifier array will allow for amplitude modulation of the high power laser beam, which is very difficult with current state of the art high energy lasers.

REFERENCES:

1. B. Sumpf and K. Paschke, "Spectrally stabilized high-power high-brightness DBR-tapered lasers in the VIS and NIR range," Proc. SPIE 10518, 44 (2018).
2. C. Fiebig, G. Blume, C. Kaspari, D. Feise, J. Fricke, M. Matalla, W. John, H. Wenzel, K. Paschke, and G. Erbert, 12W high-brightness single-frequency DBR tapered diode laser, Electronics Letters, 44, 1253-1255, 2008
3. S. M. Redmond, K. J. Creedon, J. E. Kansky, S. J. Augst, L. J. Missaggia, M. K. Connors, R. K. Huang, B. Chann, T. Y. Fan, G. W. Turner, and A. Sanchez-Rubio, "Active coherent beam combining of diode lasers," Opt. Lett. 36(6), 999–1001 (2011).
4. G. Schimmel, I. Doyen-Moldovan, S. Janicot, M. Hanna, J. Decker, P. Crump, G. Blume, G. Erbert, P. Georges, and G. Lucas-Leclin, "Rear-side resonator architecture for the passive coherent combining of high-brightness laser diodes," Opt. Lett. 41(5), 950–953 (2016)



KEYWORDS: Direct Diode HEL, tapered amplifiers, high-brightness diode lasers, phased locked lasers



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A20-150 TITLE: Photonic Crystal Surface Emitting Semiconductor Laser

RT&L FOCUS AREA(S): Directed Energy
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of 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 the design space for high-power, high-beam quality photonic-crystal surface emitting lasers (PCSELs) and demonstrate a set of PCSEL prototypes.

DESCRIPTION: High power diode lasers have been almost exclusively reserved to edge emitting diodes. However, edge emitting diodes bring about challenges with respect to mode quality, beam symmetry, and the combination of many diodes into high power diode arrays and modules. Surface emitting diodes such as the vertical-cavity surface-emitting lasers (VCSEL) have many beneficial properties to include advantageous mode quality, beam shape, absence of catastrophic optical damage COD. However, the output power of element emitters is on the order or milliwatts, hence, thousands or diodes need to be efficiently combined to generate high power laser beams. This leads to a complicated and challenging beam combination process.

Recently, photonic-crystal surface-emitting lasers (PCSEL) have emerged as potential solution that rivals edge emitting diode lasers in output power while maintaining radially high symmetric beam quality of approximately M2 = 1.1 [1-3]. A properly designed and implemented square-lattice photonic crystal will produce a singularity point, which allows for single-mode two-dimensional wave coupling and hence, two-dimensional broad-area cavity modes for high power lasing. By coupling this two dimensional architecture to radiation modes outside the photonic crystal via diffraction, vertical emission, i.e. a surface-emitted output beam can be realized [4].

The design considerations for a PCSEL need to be explored and understood clearly to inform the trade and implementation space in the context of high energy laser weapons. These design considerations include selections in the photonic crystal structure and fabrication techniques, semiconductor layer design, materials and fabrication, beam mode quality and coherence properties as well as beam shape and divergence angle. Previous academic work promises PCSEL output power on the order of 1 Watt per emitter, and beam quality of M2 < 1.1, which as a combination may outperform current state of the art edge emitting as well as surface emitting diode solutions considered for HEL weapons. Furthermore, forecasting technology advancements suggest that output powers of greater than 10W may be achievable without loss in M2 performance. Additionally, the design freedoms associated with the crystal structure and electrode placement may allow for active beam steering [5].

PHASE I: Formulate the trade-space towards the design and development of high-power, high-beam quality PCSELs through a modelling and simulation (M&S) approach. The M&S approach will address photonic crystal structures, layer placement and respective thicknesses, geometries to couple from the two-dimensional cavity into free space for high-quality surface emission, choice of materials, and fabrication techniques and challenges. The deliverable will be a modelling and simulation tool to investigate PCSEL performance and characteristics as a function of the aforementioned trade space, and two PCSEL solutions will be proposed for development and fabrication in Phase II.

PHASE II: Design and fabricate two separate PCSEL emitters that vary in their respective approach in terms of photonic crystal structure, layer structure and material choices, and fabrication technique. The PCSEL prototypes will be fabricated and delivered in a package similar to a development board to report on and allow for independent test and evaluation of various laser parameters to include mode quality, coherence, conversion efficiencies, thermal stability, etc.

PHASE III DUAL USE APPLICATIONS: Develop beam steering solutions to transition high power PSCEL technology into sensor applications such as automated driving, and free space high bandwidth telecommunication. Develop a high power PCSEL array towards the next generation high energy laser weapons.

REFERENCES:

1. K. Hirose et al., "Watt-class high-power, high-beam-quality photonic crystal lasers," Nature Photon., vol. 8, pp. 406–411, 2014
2. E. Miyai et al., "Lasers producing tailored beams," Nature, vol. 441, p. 946, 2003
3. S. Noda, T. Okino, K. Kitamura, Y. Tanaka, and Y. Liang, "Two dimensional Photonic Crystal Surface-Emitting Lasers," Japanese Patent 6080941, Jan. 27, 2017
4. S. Noda, et al., "Photonic-Crystal Surface-Emitting Lasers: Review and Introduction of Modulated-Photonic Crystals," IEEE Journal of Sel. Top. In Quant. Elec., vol. 23, 4900107, 2017
5. D. Yasuda, A. Nishigo, K. Kitamura, and S. Noda, "Investigation of photonic-crystal lasers with two-dimensional beam scanning capability (III)," presented at 63rd Japanese Society of Applied Physics, Spring Meeting, Tokyo, Japan, Mar. 19–22, 2016, Paper 21a-S621-10


KEYWORDS: Direct Diode HEL, high-brightness diode laser, surface emitting lasers


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**ARMY**
**20.2 Small Business Innovation Research (SBIR)**
**Direct to Phase II**
**Proposal Submission Instructions**

## INTRODUCTION

The US Army Combat Capabilities Development Command (CCDC) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Website: https://www.armysbir.army.mil/.

Broad Agency Announcement (BAA), topic, and general questions regarding the SBIR Program should be addressed according to the DOD Program BAA. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the BAA. To obtain answers to technical questions during the formal BAA period, visit https://www.dodsbirsttr.mil/submissions/. Specific questions pertaining to the Army SBIR Program should be submitted to:


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The Army participates in three DoD SBIR BAAs each year. Proposals not conforming to the terms of this BAA will not be considered. Only Government personnel will evaluate proposals.

## DIRECT TO PHASE II

15 U.S.C. §638 (cc), as amended by NDAA FY2012, Sec. 5106, and further amended by NDAA FY2019, Sec. 854, PILOT TO ALLOW PHASE FLEXIBILITY, allows the Department of Defense to make an award to a small business concern under Phase II of the SBIR program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project. Army is conducting a "Direct to Phase II" implementation of this authority for this 20.2 SBIR Announcement and does not guarantee Direct to Phase II opportunities will be offered in future Announcements. Each eligible topic requires documentation to determine that Phase I feasibility described in the Phase I section of the topic has been met.

### INTRODUCTION

Direct to Phase II proposals must follow the steps outlined below:

1. Offerors must create a Cover Sheet using the DOD Proposal submission system (follow the DOD Instructions for the Cover Sheet located in section 5.4.a.). Offerors must provide documentation that satisfies the Phase I feasibility requirement* that will be included at the beginning of the Direct to Phase II proposal. Offerors must demonstrate that they have completed research and development through means other than the SBIR/STTR program to establish the feasibility of the proposed Phase II effort based on the criteria outlined in the topic description.

2. Offerors must submit a Phase II proposal using the Army Phase II proposal instructions below.

* NOTE: Offerors are required to provide information demonstrating that the scientific and technical merit and feasibility has been established. The Army will not evaluate the offeror's related Direct to Phase II proposal if it determines that the offeror has failed to demonstrate that technical merit and feasibility has been established or the offeror has failed to demonstrate that work submitted in the feasibility documentation was substantially performed by the offeror and/or the principal investigator (PI). Refer to the Phase I description (within the topic) to review the minimum requirements that need to be demonstrated in the feasibility documentation. **Feasibility documentation MUST NOT be solely based on work performed under prior or ongoing federally funded SBIR or STTR work.**

**DIRECT to PHASE II PROPOSAL SUBMISSION**

SBIR Direct to Phase II (DPII) proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. **Please note that the Army will not be accepting a Volume Five (Supporting Documents), nor a Volume Six (Fraud, Waste and Abuse) as noted at the DOD SBIR website.** The Technical Volume .pdf document has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments. Small businesses submitting a DPII Proposal must use the DOD SBIR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Cost Volume, how to upload the Technical Volume, and Company Commercialization Report. For general inquiries or problems with proposal electronic submission, contact the DOD SBIR Help Desk at 703-214-1333.

The small business will also need to register at the Army SBIR Small Business website: https://sbir.army.mil/SmallBusiness/ in order to receive information regarding proposal status/debriefings, summary reports, impact/transition stories, and Phase III plans. **PLEASE NOTE**: If this is your first time submitting an Army SBIR proposal, you will not be able to register your firm at the Army SBIR Small Business website until after all of the proposals have been downloaded and we have transferred your company information to the Army Small Business website. This can take up to one week after the end of the proposal submission period.

Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent in other sections of the proposal as these will count toward the 38-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report are excluded from the 38-page limit. **Army Phase II proposals submitted containing a Technical Volume .pdf document containing over 38 pages will be deemed NON-COMPLIANT and will not be evaluated. It is the responsibility of the Small Business to ensure that once the proposal is submitted and uploaded into the system that the technical volume .pdf document complies with the 38 page limit.**

Phase II proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase II proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DOD Program BAA.

20.2 DP II Key Dates

| | |
|---|---|
| BAA closes, proposals due | 2 Jul 2020, 12:00 pm ET |
| Direct to Phase II Evaluations | 7 Jul 2020 – 29 Sep 2020 |
| Phase II Selections Announced | 30 Sep 2020 |
| Phase II Award Goal | 30 Nov 2020* |

**Subject to the Congressional Budget process*

## DP II IS A TWO YEAR PROJECT

The DP II is a two year project and the proposal must include activities and budget for both years. The second year must be included within the 38-page limit for the Phase II proposal. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent, in other sections of the proposal as these will count toward the 38 page limit.

## PHASE II COST VOLUME

A firm fixed price or cost plus fixed fee Direct to Phase II Cost Volume of **$1,100,000 maximum-** must be submitted in detail online. Proposers that participate in this BAA must complete a Direct to Phase II Cost Volume not to exceed a maximum dollar amount of **$1,100,000** and 24 months The Direct to Phase II year one and Phase II Year two costs must be shown separately but may be presented side-by-side in a single Cost Volume. The system generated Cost Volume DOES NOT count toward the 38-page Phase II proposal limitation when submitted via the submission site's on-line form. When submitting the Cost Volume, complete the Cost Volume form on the DOD Submission site, versus submitting it within the body of the uploaded proposal.

Army SBIR Direct to Phase II Proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume .pdf document has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes), data assertions and any attachments. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 38-page limit. As with Phase I proposals, it is the proposing firm's responsibility to verify that the Technical Volume .pdf document does not exceed the page limit.

Only the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report are excluded from the 38-page Technical Volume.

**Army Direct to Phase II Proposals submitted containing a Technical Volume .pdf document over 38 pages will be deemed NON-COMPLIANT and will not be evaluated.**

DOD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DOD Program BAA very carefully. Direct to Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the BAA.

## BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

**FOREIGN NATIONALS**

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.5 of this BAA for definitions of "lawful permanent resident" and "protected individual"] as key personnel, they must be clearly identified. **For foreign nationals, you must provide 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. Please ensure no Privacy Act information is included in this submittal.**

**OZONE CHEMICALS**

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

**CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)**

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase II (**$1,100,000 maximum**), under "CMRA Compliance" in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://www.ecmra.mil/.

The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

(1) Contract number, including task and delivery order number;
(2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
(3) Estimated direct labor hours (including sub-contractors);

(4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
(5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
(6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
(7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

## DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA) (FORMERLY KNOWN AS DISCRETIONARY TECHNICAL ASSISTANCE)

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed nine Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

**For more information go to**: https://www.armysbir.army.mil, then click the "SBIR" tab, and then click on Transition Assistance/Technical Assistance.

As noted in Section 4.21 of this BAA, firms may request technical assistance from sources other than those provided by the Army. All such requests must be made in accordance with the instructions in Section 4.21. It should also be noted that if approved for discretionary technical, and business assistance from an outside source, the firm will not be eligible for the Army's Technical Assistance Advocate support. All details of the TABA agency and what services they will provide must be listed in the technical proposal under "consultants". The request for TABA must include details on what qualifies the TABA firm to provide the services that you are requesting, the firm name, a point of contact for the firm, and a web site for the firm. List all services that the firm will provide and why they are uniquely qualified to provide these services. The award of TABA funds is not automatic and must be approved by the Army SBIR Program Manager. The maximum TABA dollar amount that can be requested in a Phase I Army SBIR proposal is $5,000. The maximum TABA dollar amount that can be requested in a Phase II Army SBIR proposal is $5,000 per year (for a total of $10,000 for two years).

**COMMERCIALIZATION READINESS PROGRAM (CRP)**

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

**NON-PROPRIETARY SUMMARY REPORTS**

All award winners must submit a non-proprietary summary report at the end of their Direct to Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:
A summation of Direct to Phase II results
A description of the technology developed
The anticipated DOD and/or non-DOD customer
The plan to transition the SBIR developed technology to the customer
The anticipated applications/benefits for government and/or private sector use
An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at:
https://sbir.army.mil/SmallBusiness/ and is due within 30 days of the contract end date.

**ARMY SBIR PROGRAM COORDINATOR (PC) for Army SBIR 19.3 for Direct to Phase II**

| Participating Organizations | PC | Phone |
|---|---|---|
| AFC (Army Futures Command) | Casey Perley | 715-574-6311 |

**ARMY SUBMISSION OF FINAL TECHNICAL REPORTS**

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) Submit two copies of the approved scientific or technical report delivered under the contract to the Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA

22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://discover.dtic.mil/.

**PROTEST PROCEDURES**

Refer to the DOD Program Announcement for procedures to protest the Broad Agency Announcement.

As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests After Award should be submitted to:

Monroe Harden
Acting Program Manager
Army Small Business Innovation Research (SBIR)
Phone: 866-570-7247
Email: usarmy.apg.ccdc.mbx.sbir-program-managers-helpdesk@mail.mil

These protests will then be forwarded to the appropriate contracting officer based on the sponsoring organization for the topic.

**DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST**

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DOD requirements specified in the BAA. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase II effort (up to **$1,100,000** with up to a 24-month duration).

2. The proposal is limited to only **ONE** Army BAA topic.

3. The technical content of the proposal includes the items identified in Section 5.4 of the BAA.

4. SBIR Direct to Phase II Proposals have four (4) sections: Proposal Cover Sheet, Technical Volume, Cost Volume, and Company Commercialization Report. The Technical Volume .pdf document has a 38-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal submission as THESE WILL COUNT AGAINST THE 38-PAGE LIMIT. Any information that details work involved that should be in the technical volume but is inserted into other sections of the proposal will count against the page count. ONLY the electronically generated Cover Sheet, and Cost Volume are excluded from the Technical Volume .pdf 38-page limit.

5. The Cost Volume has been completed and submitted for the Direct to Phase II for the first and second year or the contract and the costs are shown separately. The Army requires that small

businesses complete the Cost Volume form on the DOD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. If applicable, Foreign Nationals are to be identified in the proposal.

# ARMY

## ARMY SBIR Direct to Phase II Topic Index

A20-D01 TITLE: Portable Atomic Clock

RT&L FOCUS AREA(S): General Warfighting
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of 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, demonstrate, and deliver a portable (rackmount) optical atomic clock with volume < 20 L, weight < 30 kg, power < 100 W, and stability (< 3 x 10-13 at 1 second) that can be utilized in Army systems requiring precise timing in global positioning system (GPS)-denied environments.

DESCRIPTION: Precise timing is critical for numerous Army applications such as navigation, communications, surveillance, and synchronization of sensors and systems. Assured positioning, navigation, and timing (PNT) solutions currently rely on acquiring GPS signals, which may not be readily available in increasingly contested environments and therefore may need to hold precise time for minutes to hours. To ease reliance on GPS, long-holdover clocks with cost, size, weight, and power (CSWaP) appropriate for various DoD platforms are necessary to enable mission-critical functions even in contested environments.

Focused research over the past 10-15 years has led to portable timing technology advances including miniaturized vapor cell microwave atomic clocks [1] that are now commercially available. The chip-scale atomic clock (CSAC) has impressive stability performance at its size, weight, and power (SWaP), but it suffers limitations in long-term performance due to various drift mechanisms that are currently being addressed through exploration of new physics approaches. Optical atomic clocks have shown superior stability performance [2] but face challenges to being deployed outside of the laboratory, such as technical complexity and reliability in dynamic environments. Certain proposed optical clock architectures [3] have shown relative simplicity over others but have not yet been realized in a form factor that is appropriate for SWaP-constrained platforms nor have they been characterized for long-term reliability in dynamic environments. The goal of this SBIR is to develop and demonstrate an optical clock that provides a combination of performance and CSWaP that currently deployed atomic clocks cannot offer.

PHASE I: * We would like this topic to be Direct to Phase II if possible, as commercial development has already demonstrated feasibility **

Determine technical feasibility of realizing a portable optical clock that can be evaluated for deployment in Army applications. Develop a preliminary clock design, model key elements of the proposed clock, and identify subcomponents that demonstrate a clear path to achieving a fractional frequency instability of < 3 x 10-13 at 1 second and reaching a flicker floor of 10-14 at 10,000 seconds with size, weight, and power less than commercial rackmount cesium beam tube clocks [4]. Phase I deliverables include a design review including expected device performance as well as quarterly reports and a final report presenting Phase II plans.

DIRECT TO PHASE II: Offerors interested in submitting a Direct-to-Phase-II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.

PHASE II: * We would like this topic to be Direct to Phase II if possible, as commercial development already demonstrated feasii **

Develop an integrated optical clock system design (physics package, electronics, firmware/software). Build the clock to specifications determined in the Phase I design study and refined through proof-of-concept breadboard demonstration of subcomponents.

Construct and demonstrate a prototype clock, and validate its performance by measuring short-term frequency stability, long-term drift, and flicker floor outlined in Phase I. Perform temperature cycling and inversion tests to determine environmental and acceleration sensitivities. Phase II deliverables include a clock prototype for further Army evaluation, as well as quarterly and final reports.

Awardees of this topic will have the ability to voluntarily participate in quarterly soldier touch-points, a 1-2 day trip within the continetal US. Touch point will be provided free of charge however participating companies must travel and participate out of company internal operating budgets. Soldier touch point details will be provided to awardees under this topic at Phase II award.

PHASE III DUAL USE APPLICATIONS: Developments in this program should enable widespread deployment of clocks with stability exceeding current rackmount primary frequency standards. These clocks could lead to more reliable and robust global positioning, synchronization, and time-keeping in GPS-denied environments, as well as secure communications. Potential commercial applications include precise synchronization of telecommunication networks for high-bandwidth communications, next-generation satellite atomic clocks for global positioning, and improved reliability of business activities in the event of GPS outages (e.g. time-stamping of global business transactions).

REFERENCES:

1. Lutwak, R., Rashed, A., Varghese, M., Tepolt, G., LeBlanc, J., Mescher, M., Serkland, D. K., Geib, K. M., Peake, G. M., Römisch, S., "The Chip-Scale Atomic Clock - Prototype Evaluation," Proceedings of the 39th Annual Precise Time and Time Interval Meeting, Long Beach, California, November 2007, pp. 269-290.
2. W. F. McGrew, X. Zhang, H. Leopardi, R. J. Fasano, D. Nicolodi, K. Beloy, J. Yao, J. A. Sherman, S. A. Schäffer, J. Savory, R. C. Brown, S. Römisch, C. W. Oates, T. E. Parker, T. M. Fortier, A. D. Ludlow. Towards the optical second: verifying optical clocks at the SI limit. Optica, 2019; 6 (4): 448 DOI: 10.1364/OPTICA.6.000448
3. Ye, Jun & Ma, Long & Hall, John. (2001). Molecular Iodine Clock. Phys. Rev. Lett.. 87. 270801. 10.1103/PhysRevLett.87.270801.
4. https://www.microsemi.com/product-directory/cesium-frequency-references/4115-5071a-cesium-primary-frequency-standard


KEYWORDS: optical atomic clock; GPS-denied environments; positioning, navigation, and timing (PNT); precise timing


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**DEPARTMENT OF THE NAVY (DON)**
**20.2 Small Business Innovation Research (SBIR)**
**Proposal Submission Instructions**

**IMPORTANT**

- **The following instructions apply to SBIR topics only:**
  - **N202-088 through N202-147**
- **The information provided in the DON Proposal Submission Instruction document takes precedence over the DoD Instructions posted for this Broad Agency Announcement (BAA).**
- **DON updates the Phase I Technical Volume (Volume 2) page limit to not exceed 10 pages.**
- A Phase I proposal template specific to DON topics will be available to assist small businesses to generate a Phase I Technical Volume (Volume 2). The template will be located on 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.
- The optional Supporting Documents Volume (Volume 5) is available for the SBIR 20.2 BAA cycle. The optional Supporting Documents Volume is provided for small businesses to submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. DON will not be using any of the information in Volume 5 during the evaluation.

**INTRODUCTION**

The Director of the DON SBIR/STTR Programs is Mr. Robert Smith. For program and administrative questions, contact the SYSCOM Program Manager listed in Table 1; **do not** contact them for technical questions. For technical questions about a topic, contact the Topic Authors listed within each topic during the period **6 May 2020 through 2 June 2020.** Beginning **3 June 2020,** the SBIR/STTR Interactive Technical Information System (SITIS) (https://www.dodsbirsttr.mil/submissions) listed in Section 4.15.d of the Department of Defense (DoD) SBIR/STTR Program Broad Agency Announcement (BAA) must be used for any technical inquiry. For general inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-703-214-1333 (Monday through Friday, 9:00 a.m. to 5:00 p.m. ET) or via email at dodsbirsupport@reisystems.com.

**TABLE 1: DON SYSTEMS COMMAND (SYSCOM) SBIR PROGRAM MANAGERS**

| Topic Numbers | Point of Contact | SYSCOM | Email |
|---|---|---|---|
| N202-088 to N202-090 | Mr. Jeffrey Kent | Marine Corps Systems Command (MCSC) | jeffrey.a.kent@usmc.mil |
| N202-091 to N202-122 | Ms. Donna Attick | Naval Air Systems Command (NAVAIR) | navairsbir@navy.mil |

| Topic Numbers | Point of Contact | SYSCOM | Email |
|---|---|---|---|
| N202-123 | Mr. Timothy Petro | Naval Facilities Engineering Center (NAVFAC) | timothy.petro@navy.mil |
| N202-124 to N202-133 | Ms. Lore-Anne Ponirakis | Office of Naval Research (ONR) | loreanne.ponirakis@navy.mil |
| N202-134 to N202-135 | Mr. Shadi Azoum | Naval Information Warfare Systems Command (NAVWAR) | shadi.azoum@navy.mil |
| N202-136 to N202-147 | Mr. Michael Pyryt | Strategic Systems Programs (SSP) | michael.pyryt@ssp.navy.mil |

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 pertaining to the DON's mission can be obtained from the DON website at www.navy.mil.

**PHASE I GUIDELINES**

Follow the instructions in the DoD SBIR/STTR Program BAA at https://www.dodsbirsttr.mil/submissions for requirements and proposal submission guidelines. Please keep in mind that Phase I must address the feasibility of a solution to the topic. It is highly recommended that proposers follow the Phase I Proposal Template that is specific to DON topics as a guide for structuring proposals. The template will be located on https://navysbir.com/links_forms.htm. Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

**PHASE I PROPOSAL SUBMISSION REQUIREMENTS**

The following MUST BE MET or the proposal will be deemed noncompliant and may be REJECTED.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR BAA section 5.4(a).

- **Technical Proposal (Volume 2).** Technical Proposal (Volume 2) must meet the following requirements:
  - Content is responsive to evaluation criteria as specified in DoD SBIR/STTR Program BAA section 6.0
  - 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.

*For headers, footers, listed references, and imbedded tables, figures, images, or graphics that include text, a font size smaller than 10-point is allowable; however, proposers are cautioned that the text may be unreadable by evaluators.

Volume 2 is the technical proposal. Additional documents may be submitted to support Volume 2 in accordance with the instructions for Supporting Documents Volume (Volume 5) as detailed below.

**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 or any subsequent award, the proposer shall identify and describe all fundamental research to be performed under its proposal, including subcontracted work, with sufficient specificity to demonstrate that the work qualifies as fundamental research. Fundamental research means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons. Simply identifying fundamental research in the proposal does NOT constitute acceptance of the exclusion. All exclusions will be reviewed and noted in the award. NOTE: Fundamental research included in the technical proposal that the proposer is requesting be eliminated from the requirements for prior approval of public disclosure of information, must be uploaded in a separate document (under "Other") in the Supporting Documents Volume (Volume 5).

Phase I Options are typically exercised upon selection for Phase II. Option tasks should be those tasks that would enable rapid transition from the Phase I feasibility effort into the Phase II prototype effort.

- **Cost Volume (Volume 3).** The Phase I Base amount must not exceed $140,000 and the 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.

- **Period of Performance.** The Phase I Base Period of Performance must be exactly six (6) months and the Phase I Option Period of Performance must be exactly six (6) months.

- **Company Commercialization Report (Volume 4)**. As specified in DoD SBIR/STTR Program BAA section 5.4(e).

- **Supporting Documents (Volume 5)**. The optional Volume 5 is provided for small businesses to submit additional documentation to support the Technical Proposal (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. A template for Volume 5 is available on https://navysbir.com/links_forms.htm. DON will not be using any of the information in Volume 5 during the evaluation.

  Note: Even if you are not providing documentation within Volume 5, DSIP will require you to respond to a "yes" or "no" question regarding the volume. Failure to respond may stop you from submitting and certifying your proposal.

  - Letters of Support relevant to this project
  - Additional Cost Information

- SBIR/STTR Funding Agreement Certification
- Technical Data Rights (Assertions)
- 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

NOTE: The inclusion of documents or information other than that listed above (e.g., resumes, test data, technical reports, publications) may result in the proposal being deemed "Non-compliant" and REJECTED.

A font size smaller than 10-point is allowable for documents in Volume 5; however, proposers are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD has implemented the optional Fraud, Waste and Abuse Training Certification (Volume 6). DON does not require evidence of Fraud, Waste and Abuse Training at the time of proposal submission. Therefore, DON will not require proposers to use Volume 6.

**DON SBIR PHASE I PROPOSAL SUBMISSION CHECKLIST**

- **Subcontractor, Material, and Travel Cost Detail.** In the Cost Volume (Volume 3), proposers must provide sufficient detail for subcontractor, material and travel costs. Enter this information in the "Explanatory Material" field in the online DoD Volume 3. 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. 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).

- **Performance Benchmarks.** Proposers must meet the two benchmark requirements for progress toward Commercialization as determined by the Small Business Administration (SBA) on June 1 each year. Please note that the DON applies performance benchmarks at time of proposal submission, not at time of contract award.

- **Discretionary Technical and Business Assistance (TABA).** If TABA is proposed, the information required to support TABA (as specified in the TABA section below) must be added in the "Explanatory Material" field of the online DoD Volume 3. If the supporting information exceeds the character limits of the Explanatory Material field of Volume 3, this information must be included in Volume 5 as "Additional Cost Information" as noted above. Failure to add the required information in the online DoD Volume 3 and, if necessary, Volume 5 will result in the denial of TABA. TABA may be proposed in the Base and/or Option periods, but the total value may not exceed $6,500 in Phase I.

**DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)**

The SBIR and STTR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Firms may request, in their Phase I Cost Volume

(Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award. The TABA amount, of up to $25,000, is to be included as part of the award amount and is limited by the established award values for Phase II by the SYSCOM (i.e. within the $1,700,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee application by the SBIR/STTR awardee and must be inclusive of all applicable indirect costs. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project.

Approval of direct funding for TABA will be evaluated by the DON SBIR/STTR Program Office. A detailed request for TABA must include:

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

TABA must NOT:

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

TABA must be included in the Cost Volume (Volume 3) as follows:

- Phase I: The value of the TABA request must be included on the TABA line in the online DoD Volume 3 and, if necessary, Volume 5 as described above. The detailed request for TABA (as specified above) must be included in the "Explanatory Material" field of the online DoD Volume 3 and be specifically identified as "Discretionary Technical and Business Assistance".
- Phase II: The value of the TABA request must be included on the TABA line in the DON Phase II Cost Volume (provided by the DON SYSCOM). The detailed request for TABA (as specified above) must be included as a note in the Phase II Cost Volume and be specifically identified as "Discretionary Technical and Business Assistance".

TABA may be proposed in the Base and/or Option periods. 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

NOTE: Section 9(b)(5) of the SBIR and STTR Policy Directive requires that a firm receiving technical or business assistance from a vendor during a fiscal year submit a report with a description of the technical or business assistance received and the benefits and results of the technical or business assistance provided. More information on the reporting requirements of awardees that receive TABA funding through the DON can be found on https://www.navysbir.com/links_forms.htm. Awardees that receive TABA funding through the DON will upload the report to https://www.navysbirprogram.com/navydeliverables/.

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

All Phase II awardees not receiving funds for TABA in their awards must attend a one-day DON STP meeting during the first or second year of the Phase II contract. This meeting is typically held in the spring/summer in the Washington, D.C. area. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

## EVALUATION AND SELECTION

The DON will evaluate and select Phase I and Phase II proposals using the evaluation criteria in Sections 6.0 and 8.0 of the DoD SBIR/STTR Program BAA respectively, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. As noted in the sections of the aforementioned Announcement on proposal submission requirements, proposals exceeding the total costs established for the Base and/or any Options as specified by the sponsoring DON SYSCOM will be rejected without evaluation or consideration for award. Due to limited funding, the DON reserves the right to limit the number of awards under any topic.

Approximately one week after the Phase I BAA closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, the e-mail address on the proposal Cover Sheet must be correct.

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

Protests of Phase I and II selections and awards must be directed to the cognizant Contracting Officer for the DON Topic Number, or filed with the Government Accountability Office (GAO). Contact information for Contracting Officers may be obtained from the DON SYSCOM Program Managers listed in Table 1. If the protest is to be filed with the GAO, please refer to instructions provided in section 4.11 of the DoD SBIR/STTR Program BAA.

Protests to this BAA and proposal submission must be directed to the DoD SBIR/STTR BAA Contracting Officer, or filed with the GAO. Contact information for the DoD SBIR/STTR BAA Contracting Officer can be found in section 4.11 of the DoD SBIR/STTR Program BAA.

## CONTRACT DELIVERABLES

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

## AWARD AND FUNDING LIMITATIONS

Awards. 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 Section 4.14.b of the DoD SBIR/STTR Program BAA for Phase II awards, the DON may (under appropriate circumstances) propose the use of an Other Transaction Agreement (OTA) as specified in 10 U.S.C. 2371/10 U.S.C. 2371b and related implementing policies and regulations. The DON may choose to use a Basic Ordering Agreement (BOA) for Phase I and Phase II awards.

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $1,700,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $1,700,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

**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. Please refer to instructions provided in section 7.2 of the DoD SBIR/STTR Program BAA.

**ADDITIONAL NOTES**

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

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

**PHASE II GUIDELINES**

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

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

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

**PHASE III GUIDELINES**

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

## NAVY SBIR 20.2 Topic Index

| | |
|---|---|
| N202-111 | Desktop Tactics Trainer for Maritime Patrol Aircraft |
| N202-112 | Multi-Domain Data Fusion Instructional Strategies and Methods for Pilot Training |
| N202-113 | Mid-Body Range Safety Subsystem |
| N202-114 | High Fidelity Electromagnetic Design, Prediction and Optimization of Airborne Radomes |
| N202-115 | Monolithic Dual-Band Quantum Cascade Laser |
| N202-117 | Optimized Subtractive Manufacturing - Right Parts, Right Time, Every Time |
| N202-118 | Passive System for Detection and Identification of UAVs Using Multispectral/Hyperspectral Imaging Technologies |
| N202-119 | Cross Deck Pendant Health Monitoring |
| N202-120 | Improved and More Robust Automatic Target Classifiers |
| N202-121 | Identifying and Characterizing Cognitive Sensor Systems in Tactical Environments |
| N202-122 | Innovative Multi-Physics-based Tool to Minimize Residual Stress / Distortion in Large Aerospace Aluminum Forging Parts |
| N202-123 | Generation of Hydrogen from Seawater, Powered by Solar PV, Leading to Cogeneration of Electricity and Potable Water |
| N202-124 | Thermal and Magnetic Packaging for Large Superconducting Systems |
| N202-125 | Broadband Photoconductive Terahertz Focal Plane Arrays |
| N202-126 | Scenario Development and Enhancement for Military Exercises |
| N202-127 | Electrical Energy Sensing Device for EOD Detection, Location and Diagnosis of Electronic Safe & Armed Fuzes |
| N202-128 | Innovative Approaches in Design and Fabrication of 3D Braided Ceramic Matrix Composites (CMC) Fasteners |
| N202-129 | Nosetip Ablation Sensor and Telemetry Interface Unit for Hypersonic Vehicle Thermal Protection Systems |
| N202-130 | Cold-water Diving Wetsuit |
| N202-131 | Intelligent Laser System for CBM+ of Naval Platforms |
| N202-132 | Novel Methods to Mitigate Heat Exchanger Fouling |
| N202-133 | Multimodal Interaction Technologies to Support Small Unit Leaders |
| N202-134 | Radio Frequency Buoyant Cable Antenna Transfer Mechanism |
| N202-135 | Model Based Systems Engineering for Tactical Data Link Systems |
| ~~N202-136~~ | [Navy has removed topic N202-136 from the 20.2 SBIR BAA] |
| N202-137 | Sensor Embedding Procedures in Candidate Hypersonic Material Specimens |
| ~~N202-138~~ | [Navy has removed topic N202-138 from the 20.2 SBIR BAA] |

| | |
|---|---|
| N202-139 | Probability of Kill Modeling for Hypersonic Vehicle Missions |
| ~~N202-140~~ | [Navy has removed topic N202-140 from the 20.2 SBIR BAA] |
| N202-141 | Investigate the use of Discrete Patterned Roughness for Turbulent Transition Control in a Hypersonic Boundary Layer |
| ~~N202-142~~ | [Navy has removed topic N202-142 from the 20.2 SBIR BAA] |
| N202-143 | Plasma Switches and Antennas for Contested Electromagnetic Environments |
| N202-144 | Predictive Physics-Based Model for Projectile Trajectory Instability |
| N202-145 | Hypersonic Wake Detection with High Enthalpy Capabilities |
| ~~N202-146~~ | [Navy has removed topic N202-146 from the 20.2 SBIR BAA] |
| ~~N202-147~~ | [Navy has removed topic N202-147 from the 20.2 SBIR BAA] |

N202-088 TITLE: Advanced Low-Level Parachute System

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Develop a low-level parachute system to insert forces while allowing the aircraft to fly faster and lower than current systems.

DESCRIPTION: Current military low-level parachute systems take one of two paths. Non-maneuverable systems allow for many parachutists in the air or maneuverable systems with limited glide capabilities. Current systems were designed to operate in a mountainous environment and do not emphasize a lower operational altitude. The current systems utilize a front mounted reserve that interferes with the wearing of combat equipment. Current building, antenna, span, and earth (BASE) parachute systems are regularly used at altitudes of less than 500 ft. above ground level (AGL) with initial velocities, both horizontal and vertical, of zero. Advances in the use of lightweight fabric and innovative sewing methods allow BASE parachute systems to minimize system weight.

An Advanced Low-Level (ALL) parachute system could combine the innovations of the commercial BASE parachute systems, paraglider reserves, and possibly static line military systems. The design needs to provide a consistent on-heading opening while dissipating the energy from the exit speed and allowing for glide to a small drop zone. The challenges of speed, weight, and altitude pose the greatest risk to a successful design.

Developing an ALL parachute system could replace the current low-level parachute system. The ALL parachute system could require a different sized system to meet the weight and range requirement. The ALL parachute system must include reliability and safety systems for personnel operations. Proposed systems should meet the following performance specifications:

Minimum exit altitude: Threshold (T) 750 ft. AGL Objective (O) 500 ft. AGL
Dropzone height: (T) 2,000 feet Mean Sea Level (MSL) Objective (O) 4,500 ft. MSL
Weight capacity not including ALL system: (T) 105-300 lbs. (O) 105-330 lbs.
Aircraft exit speed: (T) 145 knot indicated air speed (KIAS) (O) 150 KIAS
Dropzone size: (T) 360m X 270m (O) 240m X 180m

PHASE I: Develop concepts for an ALL parachute system meeting the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs and establish the concepts for development into a useful product for the Marine Corps. Use material testing and analytical modeling to establish feasibility, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones and that addresses technical risk reduction.

PHASE II: Develop a prototype for evaluation to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the ALL parachute system. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Determine its effectiveness in an operationally relevant environment. Support the Marine Corps in test and validation to certify and qualify the system for Marine Corps use.

Low level parachutes are currently used primarily as recreational in the United States. New parachute systems could be used by airborne firefighting services to increase reliability and improve access to remote fires. New designs could be utilized by companies interested in delivering items in Class G airspace.

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2. Eslambolchi, Ali & Johari, Hamid. "Simulation of Flowfield Around a Ram-Air Personnel Parachute Canopy." Journal of Aircraft, 50, 2013. doi: 10.2514/6.2013-1281. https://arc.aiaa.org/doi/abs/10.2514/1.C032169

3. Soreide, Kjetil, Ellingsen, Christian Lycke and Vibeke Knutson. "How Dangerous Is BASE Jumping? An Analysis of Adverse Events in 20,850 Jumps From the Kjerag Massif, Norway." The Journal of Trauma: Injury, Infection, and Critical Care 62, no. 5, May 2007, pp. 1113–1117. doi:10.1097/01.ta.0000239815.73858.88. https://www.ncbi.nlm.nih.gov/pubmed/17495709

KEYWORDS: Parachute, Static Line, BASE, Canopy, Lightweight Fabric, Sewing

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N202-089 TITLE: Focused Enhanced Acoustic-Driver Technologies (FEAT) for Long Range Non-Lethal Hail and Warn Capabilities

RT&L FOCUS AREA(S): Directed Energy, Microelectronics
TECHNOLOGY AREA(S): Weapons

OBJECTIVE: Develop a Focused Enhanced Acoustic-Driver Technology (FEAT) for Long Range Non-Lethal hail and warn capabilities. Provide long range non-lethal hail and warn capabilities to deny access into/out of an area to individuals, move individuals through an area, suppress individuals in open and confined spaces, and stop vehicles and vessels by providing intelligible voice commands to vehicle/vessel operators.

DESCRIPTION: Typical Commercial Off-the-Shelf (COTS) acoustic hailing devices (AHDs) employ an array of acoustic drivers in their systems that produce peak acoustic outputs (Sensitivity – anechoic) of ~ 109 dB. These acoustic arrays also employ acoustic beamforming techniques using 8 or more single acoustic drivers to produce maximum peak sound pressure levels (SPLs) at 1 meter in excess of 156 dB (A-weighted). To meet current DoD Hail and Warn range performance requirements, these COTS AHD (arrayed) systems get very large (e.g., > 64 inches in diameter) and very heavy (e.g., > 350 pounds), and are expensive (e.g., > $100K) [Refs 1-2]. Improving the range and voice intelligibility performance of these hail and warn devices is dependent on 4 primary AHD system performance specifications: (1) increasing the acoustic output levels of each of the acoustic drivers (measured in SPLs); (2) increasing the gain in delivered SPLs achieved by employing adaptive beamforming techniques [Ref 3]; (3) improving the clarity/intelligibility and sound penetration capabilities of the voice/warning signal commands delivered at range through complicated battlefield atmospheres by using lower frequencies (e.g., projecting audible frequencies (in-air) from ~ 100 – 2500 Hz) [Ref 4]; and (4) implementing an atmospheric compensation algorithm that will allow for better targeting of individuals at distance in typical battlefield atmospheres.

Increasing the acoustic output levels of the acoustic drivers from 109 dB to 123 dB or greater is a technical challenge. This 14 dB increase in sound pressure level (SPL) equates to a 14X increase in AHD loudness as this is a logarithmic scale. This increase will require research to develop stronger magnets but with lower mass and stronger diaphragm materials to increase overall system reliability. The resulting full-system acoustic driver, which includes the magnet, compression driver and direction horn, shall weigh less than 3 pounds. The AHD shall also incorporate an adaptive beam forming algorithm that will increase the maximum peak sound pressure level output of the entire system. Maximum SPLs in excess of 156 dB (A-weighted) shall be achieved. Improved voice intelligibility shall be achieved at ranges in excess of 2000 meters by employing focused low frequency sound (projecting sound in the 100 – 2500 Hz frequencies ranges). These low frequencies propagate better near the ground and just above the air/water surface, and also penetrate better into structures and confined spaces such as vehicles and/or buildings. Finally, this next-generation AHD system shall incorporate an atmospheric propagation correction tool to allow for better target aiming at range, i.e., the tool will correct for normal acoustic beam refractions in the atmosphere and for windage.

The newly developed next generation compact/lightweight AHD will achieve long range hail and warn at ranges in excess of 2000 meters. The next-gen AHD will incorporate enhanced acoustic drivers (with single acoustic driver outputs of > 123 dB), an acoustic beam forming algorithm, projection of lower frequencies (100 -2500 Hz) for improved voice command intelligibility, and an atmospheric compensator tool to allow for better more precise aiming.

PHASE I: Develop concepts for an improved (more compact/lightweight and longer range) acoustic hailing device (AHD) that meets the requirements described above. This includes developing (1) an improved (123 dB) acoustic output driver design, (2) an optimum adaptive beamforming algorithm for this AHD, (3) low frequency sound projection for improved voice command intelligibility at long ranges, and (4) an atmospheric compensator tool incorporated into the AHD for better targeting. Demonstrate the feasibility of each of these four key AHD subsystems in meeting JNLWD/Marine Corps needs through material testing and analytical modeling, as appropriate of each of the four key sub-systems, as well as for the resulting improved AHD system. Establish that the concepts can be developed into a useful product for the Joint Services. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Develop a next-generation AHD prototype for evaluation to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the next generation AHD. Prototype and test all four key subsystems of the new AHD. Evaluate the system performance of each of the 4 key subsystems and the next-gen AHD system prototype. Confirm and modify the modeling and the analytical methods developed in Phase I to include measuring the required full range of parameters including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that will meet the JNLWD/Marine Corps hail and warn requirements. Prepare a Phase III development plan to transition the technology to Joint Service use.

PHASE III DUAL USE APPLICATIONS: Support the JNLWD/Marine Corps in transitioning the technology for Joint Service use. Develop the next-generation Acoustic Hailing Device for evaluation to determine its effectiveness in an operationally relevant environment. Support the JNLWD/Marine Corps for test and validation to certify and qualify the system for Joint Service use.

A compact, lightweight, long-range acoustic hail and warn capability has significant commercial applications beyond the DoD. Other government agencies, such as the Department of Justice (DoJ) and the Department of Homeland Security (DHS) to include Customs and Border Patrol have actively been researching these types of AHDs to again deliver voice command warnings at ranges in excess of 2000 meters. Local civilian law enforcement specifically conducts missions to support both building entry, clear-a-space, and orderly evacuation. Currently overall system size, weight, and cost have hindered the use of these systems by these agencies. This SBIR topic specifically addresses overall system size, weight, power consumption, thermal cooling, and cost all while drastically improving AHD performance.

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3. Wikipedia, Adaptive beamformer, https://en.wikipedia.org/wiki/Adaptive_beamformer, 10 May 20194. Brixen, Eddy B., "Facts About Speech Intelligibility." DPA Microphones Inc. https://www.dpamicrophones.com/mic-university/facts-about-speech-intelligibility.

KEYWORDS: Acoustic Hailing Device, AHD, Acoustic Drivers, Compression Drivers, Acoustic Adaptive Beamforming, Voice Intelligibility, Acoustic Atmospheric Compensator Tool

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N202-090 TITLE: Single Amphibious Integrated Precision Augmented Reality Navigation (SAIPAN) System

RT&L FOCUS AREA(S): Autonomy, Artificial Intelligence/ Machine Learning
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Develop a single amphibious integrated precision augmented-reality navigation system (SAIPAN) that would integrate the GPS signals from the vehicle/craft's receiver with inertial guidance data and manually entered coordinates to display virtually marked lanes that an operator would use to assist in maneuvering. Ensure that the integrated system is able to communicate with other systems in the littoral environment to create a shared common operating picture, e.g., vehicles could receive updated information on explosive and non-explosive obstacles in the battle space and virtually display these obstacles onto an operator's display that would enable the vehicle/craft operator to maneuver with much higher precision within smaller lanes. Design a system that would have a mounted hardware suite for vehicles/crafts (e.g., Amphibious Combat Vehicle (ACV), Assault Breacher Vehicle (ABV), Amphibious Assault Vehicle (AAV), Landing Craft Air Cushion (LCAC), Landing Craft Utility (LCU)) and a portable/handheld hardware suite for small boats/personal watercraft (Combat Rubber Raiding Craft (CRRC)/RECON Team/SEAL Team).

DESCRIPTION: An integrated driver/operator display that uses a precision navigation and timing system to generate virtually marked lanes is needed for the littoral combat force of the 21st century. The Naval force lacks the ability to mark assault lanes in the littorals from the deep water through the beach zone using a single integrated system. Different platforms use different methods from the physical marking of lanes by humans through the virtual marking of lanes using GPS coordinates. Both the Navy and Marine Corps use different precision navigation systems on land and in the water. The Navy's Amphibious Breaching System (ABS) contains four systems: (1) Coastal Battlefield Reconnaissance Asset (COBRA), (2) MINENet Tactical, (3) JDAM Assault Breaching System (JABS), and (4) Augmented Reality Visualization for the Common Operating Picture (ARVCOP). The ARVCOP program was a USMC program within the ABS but failed and was not fielded. Without this capability the Naval Force cannot mark cleared lanes within mined waters and land. This increases risks to craft operating within a mined littoral environment. The Naval force must currently either accept the risk or spend large amounts of time, resources, and personnel to clear larger areas of land and sea mines. The Naval force could reduce risk and costs by investing in a single integrated add-on augmented/virtual driver display that provides a precision navigation capability.

This single integrated add-on augmented/virtual driver display would pull GPS information from existing and future precision navigation suites (e.g., DoD Assisted GPS Receiver (DAGR), MAPS) and combine it with manually entered information to generate an augmented reality display. The operator would manually enter the grid points of cleared lanes into the system prior to departing the ship. The SAIPAN would combine this information with precision navigation and timing information of existing programs to build the augmented reality picture on the driver display. Once the craft departs the amphibious ship, the operator would drive the craft via the display. The virtual lanes on the display would enable the craft to operate in much narrower lanes with greater confidence than with current naval Tactics Techniques and Procedures (TTPs). The SAIPAN would have a mounted capability for larger crafts/vehicles (e.g., LCAC/LCU/Rigid Hulled Inflatable Boat (RHIB)/ACV/Light Armored Reconnaissance Vehicle (LAV)) and dismounted capability for smaller crafts/vehicles (e.g., Combat Rubber Raiding Craft, Bridge Erection Boat, Divers, Special Forces) and people. Future increments of SAIPAN would take real-time information provided by both sensors and humans and integrate it with existing libraries of information to provide a real-time common operational picture. Inertial navigation data may also be integrated. The precision navigation display would show individual explosive and non-explosive obstacles and allow the craft to maneuver around these obstacles vice having to remove them, increasing the littoral mobility of craft and decreasing the amount of time and resources to clear this area of obstacles.

There are some government off-the-shelf augmented reality driver displays that meet some of the specification listed below.

The key performance parameters of the SAIPAN System include the following:

- Error rate of <1m
- Capable of integrating precision navigation and timing from COTS/GOTS GPS receiver
- Capable of integrating manually typed/downloaded navigation points from vehicle/craft operator
- Driver display video must be of a quality that meets or exceeds current craft/vehicle systems
- Driver display must enable the operation of the vehicle at night and day
- Augmented reality must be able to be seen at night within the driver/operator compartment
- Augmented reality must show left and right lateral limits of lanes
- Display must include 360 degree "birds eye-view" so operator can see direction of vehicle within the lane
- System must be compatible with electric power input from military craft/vehicle. Or it should be capable of operating from rechargeable batteries rated for the austere environments, per MIL-STD 810
- Vehicle-mounted system: Physical characteristics that permit installation in amphibious craft, minimizing cube and weight
- Portable/hand-held system: Physical characteristics equivalent to Commercial Off-the-Shelf tablets or smart phones (e.g., Panasonic Toughpad, Blackview BV5500)

PHASE I: Develop concepts for a SAIPAN system that meets the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs. Establish that the concepts can be developed into a useful product for the Marine Corps. Establish feasibility by material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Develop a scaled prototype for evaluation to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the SAIPAN system. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop a SAIPAN system for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

The system has the potential to be employed by large ships and small crafts to navigate during inclement weather and thus improve safety.

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KEYWORDS: Augmented Reality, Precision Navigation, Driver Display, Navigation, Precision, Virtual

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N202-091 TITLE: Artificial Intelligence for Anti-Submarine Warfare Training

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information Systems, Human 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 section 3.5 of 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: Augment the Navy Anti-Submarine Warfare (ASW) capability via the addition of an artificial intelligence (AI) training aid that can also assist as an operational decision-support tool.

DESCRIPTION: Artificial Intelligence (AI) has increased dramatically over the last five years. This SBIR topic seeks a phased approach to implementing a tactical and evolving Anti-Submarine Warfare (ASW) application with AI technology, specifically the application of AI technology to passive ASW analysis. AI augmentation should be aggressively pursued to increase the manning and training aspects of the AO (operational availability) equation across the Navy.

This topic is not a case for replacing an acoustic operator with a machine, but rather should be seen as an attempt to point out why AI assistant technology during training and operations would be beneficial not just to the operator, but to the overall ability of the U.S. Navy to conduct ASW operations. The importance of the human operator’s ability to adapt to new information, answer questions about information, and truly analyze an ASW target’s characteristics and behavior cannot be overstated. The human acoustic operator is responsible for providing target-quality data, under any conditions and in any circumstance, to complete the kill chain. That job is not one that machines can currently perform unaided by a human, but is one that machines can augment effectively. Although the AI assistance can provide analytical tools on top of the data, the human operator will still be the one to review the outputs of the algorithms and question whether it makes sense or not.

Acoustic operators go through approximately two years of initial training, and 18-24 months of advanced, hands-on training at the squadron, to become a basic qualified “operator.” In order to become proficient, or even experienced, the operator needs years of additional submarine contact time. In order to build proficiency, the operator spends long hours on deployment or detachments, conducting ASW on adversary submarines and observing the differences between his or her training and the data that he or she gains while on-station. With additional capabilities of the Maritime Patrol community coming online, the demands on a given acoustic operator have only increased.

With these increased demands, we must recognize the limitations of human acoustic operators when analyzing acoustic data, especially before initially locating a subsurface target, when unsure of when and where contact will appear. As human beings, they can only apply their cognitive process to information from a single sonobuoy at a time. Experience and training may allow the operator to process the information faster and more accurately, but no matter how quickly they work through the information they can only process a limited number of sonobuoys at one time. Additionally, human operators must choose to allocate their cognitive effort into three categories: speed, accuracy, and quantity. At any given time, an operator may choose to allocate their effort to two of the three categories. If an operator desires to analyze a large quantity of data with a high degree of accuracy, they will sacrifice speed. If they wish to analyze the same set of data quickly, they will sacrifice accuracy. If instead they desire to analyze data with a high degree of accuracy and a high measure of speed, they must reduce the quantity of data they analyze. Although there are exceptions with expert acoustic operators, the majority of acoustic warfare operators (AWOs) are limited by these constraints.

Fortunately, AI that is trained on representative data sets can assist AWOs in the training and operational context. Initially, an AI assistant could provide novice AWOs with explanations and reasoning why it notices a contact within a set of acoustic data. Additionally, confidence values with those explanations would further involve the human trainee in the situation. Flag officers have recently requested that information that AI systems output should come with a confidence factor as standard practice. Although the trainee would have the final say in all matters, the AI can help scaffold the training so that the trainee has useful information about multiple different variables, and the reasoning why confidence values are what they are. For example, given a training scenario in a body of water, the AI could inform the trainee that there is a 60% match based on acoustic signature and that it is an "X" class submarine. It must also inform that overall confidence value is only 40% because it is rare that the "X" class submarine is ever in this particular body of water. This "pulling back of the curtain" via traceable and explainable AI can ensure the student is privy to more of the information and situation than a human could experience un-assisted. This will also assist in deterring adversarial AI practices that can confuse and trick AI systems into believing something that is not true. If successful during training, this AI capability could also be used in operational settings and updated, via modifying its own code as it learns, in real-time to ensure AWOs conducting operations have all the relevant information. This would allow the assistant to improve the ability of crews to do ASW on station as it mitigates a limitation of human operators. Where a human must choose between speed, accuracy, and quantity, an AI need not make such a choice. When "plugged-in" to the aircraft's ASW data stream, an AI with sufficient processing power is able to analyze all ASW data in real-time with accuracy (within the parameters of its training). Although the topic is primarily focused on the training aspect, successful implementation of the technology certainly has use beyond training to help all Maritime Patrol aircrew become more effective at their primary role of ASW.

The final solution must meet AI ethics principles outlined by the Department of Defense (Responsible, Equitable, Traceable, Reliable, Governable) [Ref 7] and will meet Risk Management Framework, Cyber and Navy Marine Corp Internet (NMCI) guidance [Ref 6].

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design, develop, and demonstrate feasibility of AI techniques, methods, and models, and determine the optimum approach for this topic. Demonstrate the feasibility of the proposed training capability within an undersea (or relevant) domain with publicly available training data. The early system should demonstrate a form of explainability and confidence values in outputs provided. Outline future concepts for the inclusion of self-tuning algorithm parameters. AI ethics principles outlined by the Department of Defense will be adhered to (Responsible, Equitable, Traceable, Reliable, Governable). The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and prototype the proposed solution to integrate into a Navy ASW sample training environment. The prototype capability should ingest real-world training data. Demonstration of the prototype AI assistant, that has been trained with real-world data, providing explainable AI recommendations with confidence values to novice AWOs conducting training using low to medium fidelity training devices or simulators. Considerations of how the standalone training device may use continuous data from an operating environment to refine the algorithm's parameters should be included in a Phase II demonstration. Continued adherence to AI ethics principles outlined by the Department of Defense will be required (Responsible, Equitable, Traceable, Reliable, Governable).
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Refine the capability from the Phase II final demonstration and show consistent reliability in a known performance envelop. A Phase III capability must include and demonstrate a function to self-tune its own algorithm based on new data inputs. Integrate within current acoustic warfare operator training and go through verification and validation testing, as well as effectiveness and usability testing. Continue to adhere to AI ethics principles outlined by the Department of Defense (Responsible, Equitable, Traceable, Reliable, Governable). Contractors will harden the software architecture and implement Risk Management Framework guidelines to support IA compliance, including requirements to allow installation on SIPRNet or Navy Internet Protocol Networks (NIPRNet) if appropriate for transition path. The final capability will be required to exist in a representative training environment with all information assurance and cyber security requirement approvals. Final steps will investigate the level of effort required to convert the AI assistant to an operational assistant in the field. Developing AI decision-support tools is beneficial for a wide variety of domains and commercial industries. Techniques and procedures used to develop acoustic training may be immediately of use to other domains, such as oceanography and survey research organizations that study the world's oceans and other bodies of water. Additionally, the technical approaches may be applicable to industries outside of pure acoustics, as the AI techniques that will be implemented will cater to somewhat fuzzy training data sets that may or may not be flush with data samples. As the topic may involve image recognition, as well as acoustic recognition algorithms, the results could also be applicable to areas involving surveillance and automatic image classification.

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KEYWORDS: AI, Artificial Intelligence, Anti-Submarine Warfare, ASW, Machine Learning, Decision-Support, Explainability

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N202-092 TITLE: Small Space, Weight, and Power (SWaP) Multilevel Security Cross-Domain Solution

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information Systems, Battlespace

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a small form factor, integrated, multi-level security, cross-domain solution.

DESCRIPTION: The Navy's integrated warfighting strategy, driven by advancing adversaries, calls for high levels of interoperability while at the same time maintaining the highest level of cybersecurity protection. Multiple security enclaves within a platform are becoming commonplace across the Navy, but no common solution exists. Along with coordination of systems and sensors within a platform, datalinks between similar and dissimilar aircraft are critical to success for the future of the Navy. Due to the current security posture across the Department of Defense (DoD), data of different security levels are often unable to be integrated, limiting warfighters' ability to make tactical decisions. The development and fielding of a small form factor, integrated, multi-level security, cross-domain solution able to be tailored to a platform's need while maintaining a set of common standards would save each program from redundant development [Refs 1, 2]. Each Naval program will have their independent needs for number of domains, required classification levels, and SWaP constraints, but at a minimum, the developed technology must meet the following requirements:

- Demonstrate concurrent operation across four distinct security domains.
- Operator interface with access to all security levels.
- Develop rulesets to control data flows within, in, and out of the system.
- Send and receive data across each domain while ensuring no spillage to unapproved domains with Government designated simulation environment.
- In-flight demonstration of technology with similar and dissimilar aircraft in Government-designated scenario.
- Process DoD classified data at all levels of classification.
- Plan for National Security Agency (NSA) approval as a cryptologic device [Refs 3, 4].
- Maximum physical size of 1" x 4" x 6" per security domain.
- Maximum weight of 8 ounces per security domain.
- Operate via aircraft power at 28VDC or 400Hz AC.
- MIL-STD 810H [Ref 5] for environmental effects.

Without a common solution and coordination of system architecture design, the Navy is at risk of stove piped solutions that would require complete redesign when asked to fight together.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and demonstrate feasibility of a flyable routing solution scalable to various platform configurations with a cross-domain solution addressing multiple security levels. Develop a draft architecture and plan for attaining NSA approval for cryptologic systems. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further design and develop the solution identified in Phase I into a prototype. In conjunction with the Government, develop simulated data and then use that data to demonstrate the prototype. Develop an unclassified set of controls to handle organic and off-board classified data types provided by the Government. Initiate process of attaining NSA approval for designed hardware and software. Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Complete development of the cross-domain control measures and perform final testing in a Government-designated simulation environment. After identifying specific data types and classifications of airborne system data, demonstrate a fully capable multi-level security cross-domain solution in a live fly event. Continue work with the Government sponsor to gain NSA approval for provided approach and transition to applications across Naval airborne platforms.

The control measures and techniques employed may benefit companies seeking to protect proprietary data while working with other organizations. This technology will apply beyond the contractors supporting the DoD. Medical, financial, and civilian electronics industries will benefit from a technology that allows networking with competitors for collaboration while preventing proprietary or personal data from spillage onto an improper domain.

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KEYWORDS: Multi-level Security, Cross-domain Solution, Data Sorting, Adaptive, Small Form-factor, Modular

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N202-093 TITLE: Physical Measurement of Corrosion and Wear Damage on Splined Surfaces

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials

OBJECTIVE: Develop an innovative measurement system capable of quantifying depth of corrosion and wear damage on rotor mast splines (located on the gearbox output driveshaft) to quantify the depth of damage present prior to repair effort to justify repair decision and quantify the depth of material removal during repair/final surface profile to support the justification of the mast's continued use.

DESCRIPTION: There is currently a need for a measurement device to identify the extent of, and depth of, corrosion present in and around mast splines. Surface corrosion and pitting damage on the V-22 Proprotor Gearbox (PRGB) mast splines result in removal of the PRGB from the aircraft. The mast has three splined areas external to the PRGB. Current damage tolerances of 0.0005 inches allow for minimal material removal in the splined areas of the mast. Current measurement tooling is limited to C-micrometer for mast diameter dimension-over-pins measurement and a ball scribe/surface defect probe for determining depth of damage on mast splines. The geometry of the mast splines precludes use of other standard measurement processes (i.e., depth micrometers). Initial damage inspection does not currently measure accurately the depth of damage. After damage is removed dimension of pins is used to confirm that enough material remains on the mast. If measurement is below allowable limits, the PRGB is removed resulting in replacement and repair cost of approximately $8.5K including travel costs.

Two types of measurements are necessary to evaluate and repair mast spline damage. First, existing corrosion/wear damage must be quantified to determine feasibility of repair within damage limits. Second, the material condition of mast (surface profile) after repair must be measured to ensure the repair did not exceed limits. The proposed system must allow for damage depth measurement with a tolerance of 0.0005 inches while mast is installed in the PRGB on the aircraft wing.

The mast material, Cadmium Plated, per SAE AMS-QQ-P-416 [Ref 3], Type II, Class 2, is 4340 stainless steel. The spline geometry can be found in ANSI B92.1-1996 [Ref 1]. The mast has three splined surfaces, two of which have the same geometry. Spline A (upper mast spline) is an external involute, fillet root, side fit spline with 56 teeth, a pitch of 10/20 and pressure angle of 30 degrees. Splines B and C (center mast splines) are also external involute, fillet root, side fit splines with 104 spline teeth, a 16/32 pitch and pressure angle of 30 degrees.

PHASE I: Design, develop, and perform a concept demonstration of a technology that can determine damage depth on spline tooth-face representative of mast geometry for all three splined areas of mast. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further develop and demonstrate a prototype of the technology under operational conditions. Verify and validate measurement of spline damage, both pre- and post-repair, on a mast-installed on-wing.

PHASE III DUAL USE APPLICATIONS: Perform final testing and integrate the developed technology into platform Planned Maintenance Interval (PMI) lines. Document the appropriate level of maintenance (organizational or intermediate) depending on the complexity of the system.

This technology could be useful for all other vertical lift application with mast corrosion issues. Successful development could have application with commercial variants of the H-1 (Bell 204 and 205) as well as the Leonardo AW609. Additionally, the offshore helicopter industry has constant exposure to corrosive saltwater environments that drive the need for increased inspections.

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KEYWORDS: Transmission Mast, Corrosion, Pitting, Splined Surface, Damage Depth, Surface Profile Measurement

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N202-094 TITLE: Novel Multi-Physics Based Simulation Tool for Rapid Heat Damage Assessment of Polymer Composite Aircraft Structures Resulting from Excessive Heat Exposure

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a multi-physics simulation tool able to quickly assess residual structural integrity of thermoset polymer composite aircraft structures subjected to excessive heat.

DESCRIPTION: Naval aircraft in operation face the risk of over-temperature incidents. These include, but are not limited to, fires and high-temperature exhaust gas impingement. Protection of composite aircraft structures from excessive heat is important since thermally damaged composites are vulnerable to compressive failure. While char or discoloration evidence caused by fire or an overheating event may be visible from inspection of structure surfaces, internal thermal damage underneath the fire protection layer or thermal degradation due to long exposures above the designed to continuous operating temperature cannot be detected or structurally assessed by visual inspection alone. Replacement of suspect components is expensive, reduces aircraft availability, and is a known readiness degrader. Continued operation of a thermally damaged composite structure could result in a catastrophic failure. Without knowing the criticality or distribution of the thermally induced degradation, a repair solution cannot be implemented to restore the damaged component to the required load bearing capacity. Existing simulation tools cannot provide a quick solution for the damage assessment of a large-scale structure experiencing an over-temperature incident.

The Navy seeks development of a rapid-heat damage assessment and failure prediction tool to fill the current technology gap and support its mission driven operation. A high-fidelity solution process must be established to generate a rapid prediction tool that can be updated from additional data collected from inspection. Development of a multi-physics model capable of conservative prediction of the structural response for a given temporal and spatial evolution of thermal environment is desired. The thermal analysis of a composite structure exposed to excessive heat is complex because the heat transfer is controlled by many temperature- and rate-dependent processes such as thermal expansion and contraction, pressure rise, chemical decomposition, formation of matrix cracks, voids and delamination. The proposed approach should take into account the following phenomena: heat transfer, phase evolution and property degradation at micro-macro scale, damage progression under thermal-mechanical loading, multiple failure modes interaction, and multi-component structure failure.

A comprehensive multi-physics model shall account for thermo-mechanical and thermo-chemical effects. The model must have the ability to calculate the temperature distribution within the composite when exposed to excessive heat. The model should take into account the effects of heat conduction, thermoset matrix pyrolysis, oxidation of carbon fibers, thermal expansion and diffusion of decomposition gases on the temperature distribution in the system. The model should be able to predict the composite decomposition kinetics as well as the degraded composite structural response. This model should also take into account the composite interaction with the associated high-temperature environment. The model should also include damage and failure prediction modules. The damage prediction module should allow the developed model to predict the type of damage depending on the temperature and exposure time, while the failure prediction module should estimate the failure behavior with respect to the over-temperature event characteristics. The inclusion of these two modules should allow the model the capacity to predict the overall behavior of composite structures when exposed to excessive heat.

PHASE I: Design and develop an accurate tool for the modeling of the transfer of heat through a composite exposed to excessive heat in residual strength analysis that includes the analysis of composition decomposition and damage. The accuracy of the model is dependent on the input data, and thermal experiments should be carried out during this phase. A proof of concept demonstration should be performed indicating the ability of the model in establishing a mapping relation between temperature and response of a loaded structural component. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further develop and validate the model developed during Phase I through component/sub-scale testing. After validation, the model should be extended to multi-component laminated structures and sandwich composite structures. Transition feasibility should also be demonstrated during this phase. Acceptable error between predicted versus experiment can be no more than 2-6%.

PHASE III DUAL USE APPLICATIONS: Finalize and perform necessary testing to verify and validate. Transition to end users and commercial industries. Successful technology development would benefit the commercial aerospace industry.

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KEYWORDS: Composite Fire, Thermal Analysis, Thermo-Mechanical Model And Thermo-Chemical Model, Property Degradation, Post-Fire Damage Assessment, Failure Modes Interaction, Decomposition Kinetics

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N202-095 TITLE: Next Generation Radar and Electronic Warfare Processing Technology

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Information Systems, Battlespace

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 section 3.5 of 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 radar and/or electronic warfare (EW) processing technology to include Synthetic Aperture Radar (SAR) and/or Airborne Electronic Attack (AEA) processing systems for coherent pulsed radio frequency (RF) systems to include new generation non-sinusoidal time-frequency RF waveforms such as wavelets.

DESCRIPTION: A need exists for hardware and software SAR and AEA processing solutions to augment or replace existing airborne processing technology at reduced size, weight, and power (SWaP), and waste heat versus the current state-of-the-art. Current generation commercial digital processor technology recently delivered to the U.S. Navy to perform SAR processing is 0.73 Teraflop, or 1 Trillion Floating Point Operations per Second (TFLOPS) per pound (lb.). This includes 2xCPU's/4xGPU's, power supply, cooling system, 256 GB random access memory (RAM), 3.2 TB Serial Advanced Technology Attachment (SATA) disk, motherboard, and interface elements. Development of processing hardware and software system technology may be digital, optical, hybrid optoelectronic, or of neuromorphic computing capability in order to reduce the SWaP, and waste heat versus existing real-time processing solutions.

OBJECTIVE: 3.0 TFLOPS per LB; THRESHOLD: 1.5 TFLOPS per LB.

The transition goal for this system technology is to reduce the SWaP requirements for air platform integration.

In addition to traditional RF waveforms, such as Linear Frequency Modulated (LFM) chirps, Next Generation SAR and AEA processing system technology should include a capability to process non-sinusoidal time-frequency RF signals, or wavelets; or Low Probability of Detection (LPD), Low Probability of Intercept (LPI) waveforms.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design, develop, and demonstrate feasibility of hardware and software SAR and AEA processing solutions to meet the requirements outlined in the Description. The Phase I effort will include prototype plans to be developed under Phase II. LINUX OS preferred over Windows OS.

PHASE II: Develop a prototype-processing technology. Demonstrate and test that the prototype works toward reduced SWaP form factors for integration to air platforms. Optimize the system design for SAR processing with Phase History Data (PHD) to perform real-time (R/T) image formation for X through UHF-Band SAR and AEA applications. R/T SAR image formation from raw PHD requires is estimated to be .01 TFLOP per Megapixel image at X-Band and 2 TFLOP per Megapixel at UHF-Band.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Test processing systems within aircraft platforms. Perform early development, test and evaluation flights from non-Navy air platforms to simplify integration and reduce flight hour costs. If resourced, later development, test and evaluation test flights are likely to be conducted from Navy test aircraft, to include new generation of Unmanned Aerial Vehicles (UAVs). Lightweight systems technology has the potential to bring full performance SAR collection and processing capability to small Unmanned Aerial Systems (UAS) for support to commercial industry, local governments, and academia such as all-weather terrain mapping, mineral exploration, land use pattern analysis, change detection, and 3-D urban modeling.

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KEYWORDS: Synthetic Aperture Radar, SAR, Size, Weight and Power, SWaP, Airborne Electronic Attack, AEA, In-phase and quadrature components, I/Q Processing, Unmanned Aerial Systems, UAS, Unmanned Aerial Vehicle, UAV

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N202-096 TITLE: Rotorcraft Crash Sensor for Active Safety Systems and Mishap Dynamics Recording

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Bio Medical, Human Systems

OBJECTIVE: Develop a system capable of recording crash dynamics and detecting crash events in real-time, enabling the application of advanced, and life-saving, crash protective technologies.

DESCRIPTION: Current crash protective systems on Naval Aviation platforms rely on primarily "passive" safety systems to protect pilots and aircrew in the event of a crash or other mishap, such as hard landings. Current crash protection technologies, such as aircrew tethers, inertia reels, restraint systems, and energy-absorbing seating systems, minimally respond or adapt to an in-progress or impending mishap. The result is technologies optimized for neither specific crash environments, nor operational use. Crash protective systems are designed to protect aircraft occupants during representative crash pulses, and, in some cases, compromises must be made between crash protection and operational usability. If a crash sensor/recording system were employed, safety systems (such as restraint pretensioners, airbag systems, crashworthy seats, or mobile aircrew restraints) could actively respond to an impending or ongoing crash event.

In Naval Aviation, no recordings are made of crash acceleration data from mishap events, outside of infrequent test events. The dynamic environments that crashworthiness and escape system engineers work with are often reconstructed more from subjective assessment than from available data. A number of assumptions create a best-educated guess as to the actual conditions of an event. In many cases, the dynamic environments to which U.S. Navy and Marine Corp aircrew are being exposed during mishaps are not known. Further incremental increases in mishap survivability have been hindered by the void of actual mishap acceleration data in spite of the fact that computerized controllers can sense and respond to a developing acceleration environment related to an aircraft crash or escape event.

The Navy is seeking a crash detection/recording capability to measure accelerations (notionally +/- 1000g) and angular rates (notionally +/- 2,500 deg/sec) at locations of interest distributed throughout the airframe at sample rates (notionally 20,000 samples/second) and quality necessary to reconstruct the highly kinematic environment present during mishaps. In addition, a system/sensor design, methodology, and algorithm to detect and discriminate mishaps from other events in real-time, such that active safety systems can be triggered early enough in the mishap event to improve occupant survivability and prevent inadvertent activation. The advantage of distributing sensors, including accelerometers and/or angular rate sensors, in multiple locations of interest is that accelerations and rotation rates associated with mishap detection may occur at different times throughout the airframe. Depending on crash conditions a system capable of sensing/recording at multiple locations has the potential to detect mishaps sooner than a single crash sensor, enabling timely activation of crash protection systems.

The proposed system to record and detect crashes should be capable of:

1) recording crash accelerations and angular rates at distributed locations throughout air frame at a quality sufficient for crash reconstruction (including pre- and post-trigger data),
2) discriminating mishaps from operational/landing dynamics in real-time,
3) triggering future active safety systems as early as practical during a dynamic event in order to enable effective safety system performance,
4) non-volatile storage of collected mishap data (one or more events) in a single, hardened unit that is located to be readily-retrievable adjacent to an aircraft egress route after a mishap,
5) integration into the aviation platform without airframe modification other than physical attachment of sensors or other hardware,

6) operation without access to aircraft power (if possible),
7) operation in the Naval aviation flight environment [Refs 3, 4], and
8) being produced at a price target of less than $10k per unit.

The designed capability does not need to include the activation of active crash protective devices; the system should simply provide a local output indicating detection of a probable mishap event. In addition, the algorithms and thresholds associated with mishap detection should be reprogrammable to accommodate a variety of future active safety systems such as restraint pretensioners or air bag systems.

Notionally, the desired capability should not require access to aircraft power or recharging of batteries for 60 flight hours. Additionally, the system may not weigh more than 5 lbs. or have an overall volume of greater than 125 cubic inches.

PHASE I: Design, develop and demonstrate feasibility of a crash recording and detection system as outlined in the Description. Identify and document the trade space associated with the proposed performance requirements, including projected system cost. Develop and determine technical feasibility of approaches that minimize airframe integration challenges (SWaP), and support implementation on legacy platforms. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further develop, test, and demonstrate a prototype system that is capable of achieving the requirements provided for Phase I. Perform validation and verification through a combination of analysis, laboratory testing, and potential full-scale aircraft crash testing and operational flight test. Minimizing the potential for false crash detection events, which could potentially result in the activation of active safety systems, is a focus.

PHASE III DUAL USE APPLICATIONS: Complete design iteration and system testing. Mature the unit for transition to Naval Aviation platforms and commercial users. Crash sensing and recording systems capable of retrofit into aircraft have significant general and commercial aviation applications. Current "black box" or Digital Flight Data Recorder requirements only require aircraft accelerations to be measured at relatively low sample rates, which are insufficient for triggering or recording mishap dynamics. The collection of high-sample rate data would vastly improve aviation mishap investigation, and enable future crash protective technologies. This innovative system will enable rapid and more accurate accident reconstruction and facilitate a more targeted initial focus on the actual crash scenario. Over time, the collection of mishaps will begin to form a statistical basis that will allow critique and potential revision of existing regulations regarding crash injury mitigation based on real world experience. In addition, retrofit capable active safety systems (such as inflatable restraints or pretensioning restraint retractors) typically rely on local measurement of system accelerations. The advantage of an integrated, distributed system that measures accelerations at multiple points on the airframe is the potential for earlier crash detection and improved mishap survivability. The technology that would be developed and matured during this effort has the potential to benefit general and commercial aviation.

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KEYWORDS: Crash Protection, Data Acquisition, Safety Systems, Mishap, Crash, Event Recorder

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N202-097 TITLE: Innovative Aerial Refueling Hose Stowage Methods

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative packaging and/or construction method for stowing aerial refueling hoses that reduces the space required to stow the hose on tanker aircraft, while maintaining fuel flow and structural performance requirements.

DESCRIPTION: Aerial refueling (AR) is the process of transferring fuel from one aircraft to another during flight. The AR process enables important benefits beyond simply extending the range and the time the receiving aircraft can remain airborne, such as reducing fuel weight during takeoff, in turn, providing capabilities for shorter take-off rolls and greater takeoff payloads. The United States Navy (USN) primarily employs probe-and-drogue AR systems on its tanker and receiver aircraft. For organic carrier-based tankers, the USN utilizes the Aerial Refueling Store (ARS) 31-301-48310 or "buddystore" on the F/A-18 tanker, which is also a probe-and-drogue system. In these systems, a drogue is extended from the tanker on a length of refueling hose. The drogue provides stabilization and houses the reception coupling to which the receiver aircraft engages in flight. As new tanker and receiver aircraft come online, the need for longer hoses along with the need for more aerodynamic (lower drag) aerial refueling stores is forcing the USN to evaluate new methods of storing and extending the refueling hoses in tanker aircraft. The goal is to reduce the space required to stow the hose (which will allow more hose in a same space envelope or a smaller store design) while not negatively impacting fuel flow performance. The hose must be compatible with the USN ARS and the receiver end of the hose must be compatible with the coupling interface as defined in MIL-PRF-81975 [Ref 3].

Key areas of performance to assess will be the ability to react/absorb the load during receiver engagements up to 10 feet/second and to handle the repeated stresses of extensions, retractions, stowage, and engagements. Current cycle requirement is 500 cycles without replacement. The system should include the ability to jettison (cut) the hose in flight as a failure mode. Fuel flow performance of up to 350 Gallons per Minute (GPM) (at 60 Pounds per Square Inch (PSI)) should not be impacted and should be assessed. The design should not increase fuel flow velocities to the point where surge pressure will exceed 120 PSI. Keeping velocities below 20 feet/second is generally accepted standard to minimize effects associated with static electricity. The proposer will develop an initial drawing package; and assess manufacturing plans and costs. The proposer may utilize the USN's refueling probe impact test stand to conduct simulated engagements.

The design and analysis produced should account for the full envelope of refueling conditions:

- Altitude: Sea Level to 30,000 Ft
- Airspeed: 180-300 Knots Calibrated Air Speed (KCAS)
- Environment: Day, Night, All Weather
- Receiver Engagement Speeds: 2 to 10 feet/second
- Structural requirements of MIL-H-4495 [Ref 2]

PHASE I: Design, develop and demonstrate feasibility of proposed concept for use on the existing USN "buddystore". Validation should be in the form of modeling and simulation, and/or lab testing. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the concept proposed in Phase I. Define a complete set of detailed design/performance specifications for the new system to use for validation. Build a full-scale prototype and coupon test articles to assess strength, fatigue, fuel flow/pressure, and hose reel operation and engagement performance. Hose jettison analysis should be refined and/or tested.

PHASE III DUAL USE APPLICATIONS: Mature testing in flight on a tanker aircraft. Conduct Receiver Engagements to demonstrate the complete envelope, and complete component qualification to ensure design is ready for the fleet. Perform testing and transition developed technology to appropriate platforms and end users. The commercial aerial refueling industry would benefit from successful technology development.

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KEYWORDS: Aerial Refueling, Refueling Hose, ARS, Refueling Store, Rubber Hoses, Composite Hoses, Flexible Hoses

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N202-098 TITLE: Voice Recognition to Support Assessment of Cross Platform Situational Awareness and Decision Making

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Battlespace, Human Systems

OBJECTIVE: Develop a voice recognition capability that can support analysis and debrief of Carrier Strike Group level decision making and Situational Awareness (SA).

DESCRIPTION: There is a need for complex, highly coordinated, System-of-Systems, Air Defense missions and tactics cross-platform communications. The complexity of coordination associated with integrated tactics necessitates a significant amount of voice communications across the different platforms to provide SA and elicit decision-making. Communication is critical to cross platform coordination and overall tactic execution, yet it remains one of the most challenging training objectives to meet during Air Defense events. Specifically, there are challenges with recognizing when a call or request for communication has been made (i.e., at a specific point in the timeline), ensuring timeliness of communications (i.e., time to respond to a request or provide required information based on environmental cue), and providing the appropriate brevity terms and standard communications protocols. The need for timely, diagnostic feedback specific to cross-platform communications becomes critical. Current practice for assessing communications and overall performance relies solely on qualitative instructor assessments in large part due to the need to understand what is being said, and the context of the situation it is being said in. Challenges are associated with human error, manpower, and time resources required to meet training demands. In addition, debriefs can take thirty to ninety minutes to prepare, which can create potential loss of learning points. Consequently, the need for reliable (i.e., consistently, accurately captures what was said), timely (i.e., data can be synthesized and used for debrief within thirty minutes or less) and diagnostic feedback (i.e., data provided allows instructors to correlate voice communication with tactical execution to provide relevant feedback based on environmental context) for voice communication that can be standardized across platforms is important. A proof-of-concept to demonstrate the ability to create logs and a plan for prototype development and implementation and evolve into a demonstrable capability integrated into the Next Generation Threat System's (NGTS) Analysis and Reporting Tool (ART). In order to integrate with ART, a voice tool would have to provide a parse-able "utterance log" in a compatible format (e.g., json, xml, hdf5) that could log individual utterances with metadata (e.g., start/end time, sender/receiver, text transcript).

The development of an innovative speech recognition tool for cross-platform SA and decision-making will benefit the Fleet by significantly decreasing instructor workload, reducing human error and manpower time requirements, and automatically provide instructors with information on communication protocol adherence and timeliness to improve SA and increase debriefing capabilities. The tool should analyze virtual, and eventually live training events, using speech to text (STT) technologies and natural language processing (NLP) to verify automatically the semantic content of utterances associated with relevant tactical communications. It should provide a parse-able "utterance log" of these utterances to include things like start/end time, sender/receiver, text that accurately captures voice communication, etc., allowing the communications data to be linked to objectively captured contextual cues within the tactical environment (e.g., threat location). Applying this type of technology to Air Defense integrated training will enhance assessment by providing more robust and accurate assessments. The tool will allow for natural, free flowing interactions between platforms, which will result in speech recognition and understanding among groups within context. Additionally, the tool should be designed and developed to include debrief visualizations that support diagnosis and feedback of voice communication tied to context in the tactical environment at the time of the communication. Visualizations should also account for timeliness and accuracy. The tool should be easy to use as determined by usability and technology evaluations that should be documented.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Define and develop a concept for standalone, voice assessment capability for a single Air Defense platform. Demonstrate feasibility of application into the larger, integrated training system. The concept should include a plan for integration into the NGTS ART to allow voice feedback/assessment to be aligned with unclassified performance data from NGTS Ch.10 log files (to be provided as GFI) and include assessment visualizations to support diagnosis and feedback. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a prototype voice assessment capability for a single Air Defense platform through execution of the integration plan developed in Phase I. Integration with NGTS ART will enhance the capability by aligning voice feedback with performance data already collected by the ART. Design and develop the prototype to include visualizations, usability documentation, and technology evaluation.

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

PHASE III DUAL USE APPLICATIONS: Extend functionality to multiple platforms integrated in NGTS ART. Final testing and transition will include regression tests, bug fixes, and patching as required by the NGTS ART transition customer to support the Integrated Training Facility's requirements. Perform an in-depth evaluation of the training effectiveness of the tool and provide return on investment information for program acquisition. Expand to include application of the baseline capabilities to other mission sets and domains as needed.

Development of a voice recognition suite that includes performance and visualizations integrated with various pilot simulations allows for a modular capability. This technology could be used for commercial pilot training as well as other team-based domains, which focus heavily on communication and coordination, particularly within the aviation domain (e.g., Air Traffic Control).

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KEYWORDS: Speech To Text, STT Technologies, Natural Language Processing, NLP, Tactical Speech, Decision Making, Speech Recognition, Voice Recognition

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N202-099 TITLE: Implementing Neural Network Algorithms on Neuromorphic Processors

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Deploy Deep Neural Network algorithms on near-commercially available Neuromorphic or equivalent Spiking Neural Network processing hardware.

DESCRIPTION: Biological inspired Neural Networks provide the basis for modern signal processing and classification algorithms. Implementation of these algorithms on conventional computing hardware requires significant compromises in efficiency and latency due to fundamental design differences. A new class of hardware is emerging that more closely resembles the biological Neuron/Synapse model found in Nature and may solve some of these limitations and bottlenecks. Recent work has demonstrated significant performance gains using these new hardware architectures and have shown equivalence to converge on a solution with the same accuracy [Ref 1].

The most promising of the new class are based on Spiking Neural Networks (SNN) and analog Processing in Memory (PiM), where information is spatially and temporally encoded onto the network. A simple spiking network can reproduce the complex behavior found in the Neural Cortex with significant reduction in complexity and power requirements [Ref 2]. Fundamentally, there should be no difference between algorithms based on Neural Network and current processing hardware. In fact, the algorithms can easily be transferred between hardware architectures [Ref 4]. The performance gains, application of neural networks and the relative ease of transitioning current algorithms over to the new hardware motivates the consideration of this topic.

Hardware based on Spiking Neural Networks (SNN) are currently under development at various stages of maturity. Two prominent examples are the IBM True North and the INTEL Loihi Chips, respectively. The IBM approach uses conventional CMOS technology and the INTEL approach uses a less mature memrisistor architecture. Estimated efficiency performance increase is greater than 3 orders of magnitude better than state of the art Graphic Processing Unit (GPUs) or Field-programmable gate array (FPGAs). More advanced architectures based on an all-optical or photonic based SNN show even more promise. Nano-Photonic based systems are estimated to achieve 6 orders of magnitude increase in efficiency and computational density; approaching the performance of a Human Neural Cortex. The primary goal of this effort is to deploy Deep Neural Network algorithms on near-commercially available Neuromorphic or equivalent Spiking Neural Network processing hardware. Benchmark the performance gains and validate the suitability to warfighter application.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop an approach for deploying Neural Network algorithms and identify suitable hardware, learning algorithm framework and benchmark testing and validation methodology plan. Demonstrate performance enhancements and integration of technology as described in the description above. The Phase I effort will include plans to be developed under Phase II.

PHASE II: Transfer government furnished algorithms and training data running on a desktop computing environment to the new hardware environment. An example algorithm development frame for this work would be TensorFlow. Some modification of the framework and/or algorithms may be required to facilitate transfer. Some optimization will be required and is expected to maximize the performance of the algorithms on the new hardware. This optimization should focus on throughput, latency, and power draw/dissipation. Benchmark testing should be conducted against these metrics. Develop a transition plan for Phase III.

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

PHASE III DUAL USE APPLICATIONS: Optimize algorithm and conduct benchmark testing. Adjust algorithms as needed and transition to final hardware environment. Successful technology development could benefit industries that conduct data mining and high-end processing, computer modeling and machine learning such as manufacturing, automotive, and aerospace industries.

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KEYWORDS: Neural Networks, Neuromorphic, Processor, Algorithm, Spiking Neurons, Machine Learning

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N202-100 TITLE: Preload Indicating Hardware for Bolted Joints

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Develop a method of determining preload on aircraft bolted joints through a visual indication, or alternate means, which does not require physical measurement of torque via a torque wrench and does not require disassembly of any adjacent parts.

DESCRIPTION: Helicopters experience high amounts of vibration and as a result, the onboard equipment experiences different frequency resonances that cause bolted joints to loosen during operation. Torque checks are one of the regularly performed maintenance actions to make sure fasteners are still within designated torque values, and that no bolted joints have loosened over the operational life of the aircraft.

Preload Indicating Hardware is hardware in a bolted joint assembly that gives the user a visual indication that proper tension/torque is applied. Examples in industry for industrial/commercial hardware applications range from one-time use washers with visual indicators to stress indicating bolts that contain a visual coloring or scale indication. Unlike torque checks where the clamping force is approximated via the resistance of the spinning bolt, this type of hardware directly measures clamping force in the bolted joint. Current available products would need to size down to accommodate aircraft application and show that the torque indication accuracy is within the desired parameters.

Another method of determining preload on a bolted joint without the use of a torque wrench or other tool to turn the bolt is the use of ultrasound technology. Ultrasound technology generally involves a probe that emits ultrasonic waves into a material and analyzes the reflection of said waves to determine the characteristics of the material. The clamping force of a bolted joint can be determined through this method by analyzing the amount of strain a bolted joint is exerting on a part. This method of inspection can often require physical contact with the bolted joint, but compared to using a torque wrench, one only needs enough space for the probe to make contact versus space for a full wrench turn. This technology would have to be adopted to detect loss of preload on varying sized hardware to limit the need to manufacture multiple tools and reduce possible maintainer training.

Current torque checking procedures require maintainers to expose the bolts to the degree that space permits free engagement of a torque wrench. After re-installation and the torque check, a vibration check and a functional check flight (FCF) are often required, which take multiple maintenance man-hours to complete. These maintenance man-hours exponentially accumulate in the event a torque check fails or subsequently doesn't pass the vibration check and/or FCF on the first round, affecting overall aircraft readiness. This is where preload indicating hardware could be a significant game changer in reducing maintenance man-hours for torque verification. This technology would give the maintainers a visual indication of whether or not a fastener is still exerting the required amount of preload in a bolted joint, and would eliminate a significant amount of non-mission capable hours (NMCH) and maintenance man-hours required as part of a physical torque verification process.

A product (preload indicator) is needed that can be easily implemented onto existing Navy/Marine aircraft, without major modifications to any part of the structure or any other components on the aircraft. The preload indicator can be built into the bolt, the nut, the washer, or any combination of the three as long as the design does not hinder current torque check procedures, or can be a separate tool so long as it does not damage any surrounding components. The hardware should be able to accommodate bolts as small as 0.375-inches in diameter to as large as 1.6875-inches in diameter. Binary preload indication should be visible enough that maintainers can clearly see an out-of-torque and over-torqued bolt during night conditions typical of ship-based operations. It should be able to withstand flight conditions/loads without loss of preload in the bolted joint over the life of the aircraft for airframe application, or the predefined maintenance interval for dynamic components. The product should be able to endure corrosion prone environments typical of naval operations, vibrations, and accommodate temperatures typical of naval aircraft (details will be provided to Phase I awardees). Debris commonly found inside the aircraft (i.e., hydraulic fluid, gearbox fluid, etc.) should not affect preload indication. Handling and fall damage should not cause the product to lose accuracy. The preload of the current bolted joints should remain the same, as well as keeping to the currently implemented fastener standards. Additional installed hardware on the aircraft should be no more than a combined weight of two pounds. The hardware must have negligible effect (+/-5%) on the natural frequency of the fasteners as to not interfere with the existing health monitoring sensors. Implementation of this hardware should also not introduce new failure modes. Wireless inspection solutions of bolted joint preload must be consistent and accurate. Parts adjacent to the designated bolted joints should not require removal in order for the tool to properly inspect bolt preload.

PHASE I: Develop and design a preload indicator for bolted joints that provides a binary indication of torque value. Ensure that the selected indicator methods have no intrinsic limitations to scaling with the bolt sizes described in the Description. Demonstrate the feasibility of the indicator showing a path forward to meeting Phase II goals. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and build a prototype that can successfully provide indication that a bolted joint, through a visual cue, a tool, or otherwise, has either lost preload, or been over torqued. Demonstrate non-destructive inspection of the bolted joint complies with Naval Aviation standards. Demonstrate that the prototype will withstand handling and fall damage without losing accuracy.

PHASE III DUAL USE APPLICATIONS: Verify and validate the viability of the prototype at a fleet maintenance facility and in the field. Transition the prototype into a final product for Navy/Marine Corp fleet application. Distribute the product, support equipment, and process specifications to maintainers. Commercial applications include structures (e.g., factories, bridges, and buildings), transportation equipment, and commercial aircraft.

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KEYWORDS: Preload, Torque, Bolt, Hardware, Wireless, Inspection

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N202-101 TITLE: Data Link Bottleneck Reduction Using Big Data Analytics

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop innovative approaches utilizing big data analytics techniques to identify and extract critical content from sensor imagery products to reduce data-link bandwidth requirements dramatically, while maintaining or improving the rate at which actionable intelligence is generated.

DESCRIPTION: Navy imaging sensors, like optical, electro-optical, multispectral, hyperspectral, and radar sensors, are producing so much high-quality imagery that it overwhelms on-aircraft data link resources. Techniques to buffer, preprocess and compress data are incrementally improved as are the capabilities of data link hardware but these are not keeping pace with sensor improvements that are leading to a continuous rise in data traffic. This situation exists for both line of sight and beyond line of sight links. Significant research is underway in big data analytics techniques to facilitate rapid, more informed and smarter decision making when faced with vast and overwhelming quantities of information. This SBIR topic seeks to use those tools to analyze and extract critical content from imagery products generated by various sensor systems onboard the aircraft. The operational need for this is critical for unmanned aircraft but certainly not limited to those platforms. The big data analytics toolbox contains a range of techniques for the extraction of features, the automatic parsing, segmenting, indexing and tagging of critical imagery content. Multiple synergistic artificial intelligence (AI) techniques are being utilized to inform those actions in ways to best serve the user's needs. This SBIR topic seeks to leverage these techniques to better serve time critical military operations.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Demonstrate how big data analytics techniques could in principle be used to dramatically reduce data link bandwidth requirements while maintaining or improving the rate at which actionable intelligence is generated. Reductions on the order of 10x threshold and 100x objective are being sought. The scope of the demonstration can be rather limited but must be operationally relevant and sufficient to show feasibility of the proposed approach. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Complete detailed development and demonstrate an end-to-end approach for the intelligent real-time automated extraction of critical sensor imagery products from imaging sensors, like optical, electro-optical, multispectral, hyperspectral, and radar. Show how this will dramatically reduce data-link bandwidth requirements while maintaining or improving the rate at which actionable intelligence is generated.

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

PHASE III DUAL USE APPLICATIONS: Refine the solution, perform final testing, and integrate and transition the final solution to Navy airborne platforms. Typical host computational platforms are Ion Intel® Xeon® Scalable processors and successors with greater than 10 TB SSD storage.

The big-data analytics as applied to data-link information management are applicable to a wide range of applications including law enforcement and border-control surveillance operation.

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KEYWORDS: Big Data Analytics, Data Links, Information Management, Radar, Electro-Optics, Data Mining, Artificial Intelligence, AI

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N202-102 TITLE: Low Cost High Performance A Size Sonobuoy Power Amplifier

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a direct drive power amplifier with a controllable output for an A-size source sonobuoy to mature the latest technologies and achieve significant improvements in the capabilities of source sonobuoys.

DESCRIPTION: A-size sonobuoys currently in use by the Navy require improvement in order to detect the quieter power and propulsion systems of modern vessels. The Navy desires higher sound pressure levels, a broader frequency band (400-600Hz), and a smaller volume (< 35 in. cubed) than today's traditional architectures, as well as a new power amplifier architecture that enhances the performance and capability of an A-size sonobuoy suitable for a future variant of the AN/SSQ-125.

The power amplifier must have the capability to drive the sonobuoy source over a frequency band of 600 to 1100 Hz. The electrical rating [Refs 3, 4] of the amplifier should be adequate for it to withstand the power draw by the system without an electrical breakdown or mechanical failure (thermal failure). The power amplifier should provide a clean output to the system with a very low harmonic distortion. Today's active sonobuoys are key for the Navy in detecting and tracking targets of interest. However, the range of detection and resolution are limited by the source operational performance. A broader operational bandwidth will allow simultaneous search in multiple sub-bands. As the latest source sonobuoys have tight packaging constraints, a new power amplifier architecture that reduces the volume (< 35 in. cubed approximately equal to Diameter: 4in., Height: 3in.), along with an augmentation in capability, is a future source sonobuoy enabler.

The power amplifier must be designed so that it can be easily integrated into an A-size sonobuoy. The purpose of this SBIR topic is to design and develop an amplifier that can eventually be incorporated into an AN/SSQ-125. It is recommended to work with the AN/SSQ-125 sonobuoys vendors to understand all the performance specifications and the interface requirements so that the new power amplifier design can be easily integrated into the sonobuoy for demonstration purposes.

The key performance objectives of this drive system are as follows:

- Validate the packaging fit within a volume of 35 in. cubed (Diameter: 4in., Width: 3 in.) (threshold) or in less volume (objective).
- Validate the control can sweep the power output to operate over the specified frequency band.
- Validate the power amplifier can provide the load required by the transducers.
- Battery Output: (5000 W, 50 A, 117 Voc, 5 Ah)
- Transducers: (800 – 1100 Vrms)
- Validate it can provide a clean output: Self Noise < 25 dB and THD as follows:

| Harmonics | Normal Operating | Power Level at Full Power |
|---|---|---|
| Second | -16 dB | -25 dB |
| Third | -30 dB | -40 dB |
| Fourth and above | -50 dB | -60 dB |

Specifications Requirements:

- The amplifier electrical performance should be tested accordingly to DOD standards (MIL-STD-202G [Ref 3] & MIL-STD-883K [Ref 4])
- The amplifier must meet DOD electromagnetic compatibility standards (MIL-STD-461G [Ref 5] & MIL-STD-464C [Ref 6])
- The amplifier must be waterproof and manufacture tailored to sonobuoy environments. (MIL-STD-810H [Ref 7])
- The amplifier must be able to withstand a depth of 65 – 1000ft (65 -500ft threshold) (MIL-STD-1522 [Ref 8])

Although not required, it is highly recommended that the performer to work in coordination with the original equipment manufacturer (OEM) to ensure proper design and to facilitate transition of the final technology.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Design and develop a power amplifier with a new architecture for an AN/SSQ-125 sonobuoy. The design approach must be compatible with the existing AN/SSQ-125, including the interfaces with the battery and the projector elements. It must fit within the current volume within the AN/SSQ-125.The complete approach that will be pursued must be established in Phase I. Appropriate analyses and top-level drawings should be provided. Demonstrated the design is feasible and cost effective for production. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Finalize the design, manufacture, and validate that the new design of the power amplifier meets the specified requirements using a power source and dummy loads. Integrate it into an AN/SSQ-125. Demonstrate its performance in an underwater test at NAVSEA Seneca Lake Sonar Test Facility at Dresden, N.Y. using five AN/SSQ-125 sonobuoys. If necessary, make adjustments to the design, fabricate revised prototypes, and repeat the testing and model verification regime.

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

PHASE III DUAL USE APPLICATIONS: Continue to refine and test extensively the fabricated prototype, including testing for severe environmental conditions. Revamp the new power amplifier as required and develop the design for manufacturing. Develop low-rate initial production prototypes for follow-on Government testing.

Successful technology development would benefit all U.S. Navy source sonobuoys as well as underwater oil and gas equipment operation monitoring. This technology could also be a cost reduction for the price of the source sonobuoy and would provide significant ROI on the many years of follow-on source sonobuoy production (as per buoy price savings) on the invested SBIR funds. This innovation could be used by the audio industry (headphone amplifiers), the geography industry (terrain mapping equipment), and academia (ocean studies, bathymetry, etc.)

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KEYWORDS: Active Sonobuoy, Anti-Submarine Warfare, ASW, AN/SSQ-125, Direct Drive Amplifier, A-size

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N202-103 TITLE: Software Toolset for Rapid Finite Element (FE) Mesh Generation of As-Built Large Laminated Composite Structural Components

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials

OBJECTIVE: Develop a software toolkit enabling automated generation of Finite Element (FE) meshes to rapidly assess structural capability of as-built and damaged composite structures from Computed Tomography (CT) scan data that accurately captures ply layers, ply-orientations, ply drops, and fiber-resin densities. The mesh should include manufacturing defects such as waviness, air pockets, porosities, and other CT-revealed observable anomalies/defects/damages.

DESCRIPTION: Advanced rotors for vertical lift aircraft and wings on many U.S. Navy fixed wing aircraft are complex assemblies made primarily from composites. CT scans can provide the foundation for analyses of these structures that accurately model manufacturing defects and the quality of a repair. The references cited demonstrate algorithm technologies capable of transitioning CT scans into composite structural FE models. An FE model that accurately captures the in-situ condition of a questionable manufactured part will improve speed, accuracy and consistency in disposition instructions for these non-conforming wings and rotor blades. An FE model that accurately captures the in-situ condition of a new repair will provide stress and strain comparisons to adjacent authorized high stress locations of identical materials. The span of flaw sizes between what is acceptable and what is unacceptable is very large in complex composite structures. Converting the CT scans with authorized manufacturing defects into an FE mesh will provide an analytical stress threshold for assessing these gray areas and for developing repairs to the scanned component. The proposed solution should address the following key requirements:

A. The ability to generate accurate subsurface geometry data for a composite structure that includes all manufacturing defects such as wrinkles and voids at ply interfaces.
B. The ability to automate the conversion from geometry data to structural FE models, where the structural FE models will reveal the influence of these defects on strength and fatigue performance for do-no-harm repairs, life-improvement design changes, and disposition instructions.

The finite element mesh must be applicable to progressive damage analysis of laminated composite structure including manufacturing defects such as wrinkles, marcels, foreign object debris, and ply interface voids. Besides developing possible repairs for field-damaged components, brand new parts will benefit from this software toolkit. Manufacturing processes used to produce thick composite structures can generate defects that could impact their performance and service life. Determining disposition instructions for these new components involves Material Review Board (MRB) efforts that can be long and tiresome. Existing tools used to measure defects with the attempted recreation of these defects in test coupons can result in a perpetually delayed decision about the part's acceptability. The difficulty in assessing defects may result in storing the rotor blades or wings in a warehouse until technological capabilities become available to determine what actions to take: scrap, repair, or sell as-is.

Rapidly built structural diagnostic FE models for evaluating structural integrity using an automated interpretation of the nondestructive measurement data will fill a necessary technological need. FE modeling of the entire data-driven blade or wing assembly will assist in determining the margins of safety for flight qualification. CT conversion of field-damaged large parts to an FE model that captures undamaged adjacent authorized manufacturing defects will provide stress limit thresholds for safely establishing repairs to the component scanned. CT data conversion of flawed new components will greatly assist in MRB decisions. The FE mesh can provide a model for design modifications. This project will merge state-of-the-art nondestructive measurements with composite durability and damage tolerance analyses into an add-on toolkit package for a commercial FE software program.

PHASE I: Demonstrate a semi-automated transition of CT-based measurements of a rotor blade section or wing section to a high-fidelity FE mesh that captures the composite material structure including ply-orientations with a refined mesh surrounding the to-scale, three-dimensional manufacturing defects. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Integrate the automated analysis toolkit into a commercial finite element modeling software for use in high performance computing centers. Demonstrate progressive damage and structural fatigue analysis capability on a rotor blade or wing.

PHASE III DUAL USE APPLICATIONS: Perform full-scale testing on NAVAIR-supplied structures to validate progressive damage predictive capability. Make any corrections identified during full scale testing and finalize toolkit. Transition software toolkit into fleet overhaul facilities, fleet support teams, and OEM commercial markets.

This technology will assist aircraft, automotive, and recreational vehicle industries that use advanced composite materials. This toolkit will assess the strength of prototype composite structural designs and will identify static and fatigue test procedure limits for those prototypes. This toolkit will improve speed, accuracy, and consistency in material review board decisions on non-conforming composite parts.

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KEYWORDS: Composite Wings, Rotors, CT Scan, Finite Element, Damage Progression, Manufacturing Defects, Composite Repairs, Computed Tomography

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N202-104 TITLE: Time and Phase Synchronization of Radio Frequency (RF) Sources across Multiple Unmanned Aerial System/Vehicle (UAS/UAV) Platforms

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Battlespace

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a capability to perform high-precision time and phase synchronization (phase coherency) of multiple distributed radio frequency (RF) sources located on Unmanned Aerial Systems (UASs) platforms such as Group 3 drones separated in a dynamic and Global Positioning System (GPS) denied environment.

DESCRIPTION: Small UASs have found many applications within both the defense and commercial sectors. With the increasing use of small UASs, it is desired to equip them with RF sensors/payloads to permit them to work together to form a coherent beam on a target. In order to do this, precise time synchronization among the UASs is essential. Current techniques rely on either the use of GPS or an embedded signal from the target in order to time synchronize multiple UASs. In order to be more operationally suitable, development of a solution to the time synchronization problem for multiple spatially dispersed UASs, which works in the absence of both GPS and cooperative targets is needed. Additionally, the developed solution must be able to operate in a relevant environment that can have wide ranges in temperature, vibration [Ref 7], and meet the space, weight (<100 lbs), power, and cooling (SWaP-C) requirements of a small UAS such as Group 3 [Ref 6] and typical payloads such as a datalink, an electronic warfare (EW) system, etc.

The goal is to obtain accuracy in timing (10 to 100 picoseconds) and phase coherency to within 1/10 to 1/12 of a relevant RF operating wavelength (UHF or higher band) between nodes (or between slave nodes and the master node).

The details on the methods and mechanism of obtaining coherency across all nodes in the network are requested, additionally, any special waveforms or control signals that are employed and any special oscillators required are also requested. The ability to easily integrate into existing datalinks and radio designs (specify one or more applications for a UHF, C Band, S Band, other data link using single carrier modulation, spread spectrum, or Orthogonal Frequency Division Multiplex (OFDM) or a Common Data Link (CDL) is requested. Provide details of how to integrate this into existing designs or new designs.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop the concept and approach for time synchronization of RF sources across a distributed system. Demonstrate the feasibility of the designed approach through modeling and simulation for a swarm consisting of 10 UAS randomly distributed spatially throughout a one-mile area, and quantify the beam pointing error as a function of frequency. Include the processing blocks that provide the critical functions and include a baseline set of quantitative implementation requirements that will form the basis for further development in Phase II. Phase I will consider UAS's from Group's 1 or 2. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Refine the approach developed in Phase I. Develop prototype hardware and demonstrate the approach on 3 to 6 platforms. Include a static demonstration and then if deemed successful, end with a dynamic demonstration (i.e., quadcopters). Phase II will consider flight demonstrations from UAS Group 3 drones such as the Tigershark XP. Prepare a Phase III development plan to transition the technology for Navy and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: Refine the technology developed for easier integration into tactical data links. Install on several types of Navy UASs and deploy on larger UAS swarms. Successful technology development could benefit the Telecom and Mapping industries.

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KEYWORDS: Swarm, Timing, Phase, Coherent, UAV, Unmanned Aerial Vehicles, Beamforming, Unmanned Aerial System, UAS

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N202-105 TITLE: Digital Twin Technologies to Improve Mission Readiness and Sustainment

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Demonstrate the application of digital twin technologies by developing a virtual model of any naval aircraft product, derive benefits (such as predictive capabilities), and show its impact on total life cycle cost of the product. The models representing any naval aircraft product must allow real-time monitoring of performance and facilitate in-flight service of the product.

DESCRIPTION: A need exists for digital twin technologies, which allows the digital footprint of any product to permeate from design inception, through development, sustainment, and finally to disposal (i.e., the entire product lifecycle). Digital twin technology is viable and allows access to the digital image of the asset in real time, leading to secure actionable information that will improve a process, product, or service of any organization [Ref 1].

The concept has been around for a while, as shown during the disaster of the Apollo 13 mission. NASA demonstrated the technology with a mirrored system on the ground, which rescued the flight, and is further illustrated in Reference 2. Digital twin technology involves creating a virtual representation of a physical product. Digital twins are powered by machine learning algorithms and are continuously learning systems. The products are connected in a cloud-based environment that receives the data from the sensors. The input data is analyzed and compared to the organization's baseline data to identify actionable information. The goal for the digital twin technology is to create, test, and build a product in a virtual environment and demonstrate improved product design, monitor product health to identify potential degradation, and simulate manufacturing processes. This will allow real-time monitoring and preventive maintenance of the product, which will reduce product life cycle costs. In the future, every physical product will have a virtual replica (model) hosted in the cloud and enriched every day with operational data to make the model more robust.

Currently, model-based system engineering (MBSE) approaches, which move the record of authority from documents to digital models managed in a data-rich environment, are used to build products. MBSE approaches enable organizations to understand design change impacts, communicate design intent, and analyze and predict product design before it is built. System architecture models are developed when MBSE integration occurs across multiple domains such as program management, product support, manufacturing (involving analytical), verification, software, and mechanical and electrical models.

Advancements in information technologies (such as computational capabilities, the internet, cloud environment, internet of things enabled by sensors with connectivity and bandwidth factors, and cyber communication) are making the virtual space significant; in this virtual space, analog data from the physical space is converted into digital data that can be easily stored, analyzed, and displayed. Currently, there are huge gaps in the information technologies mentioned; therefore, significant research and development is needed. The combination of information technologies with MBSE enables digital twin technologies [Ref 3].

Digital twin technology is not widespread due to the requirements of prohibitive computing power needs, accessibility, bandwidth, and storage issues. Lack of robust data analytics aided by artificial intelligence, machine learning techniques, and visualization tools is impeding technology development. Digital twin technology has the potential to improve supply chain integrity, flight safety, in-flight service, condition-based maintenance, foreign object detection, and predictive maintenance. For example, developing any predictive maintenance algorithm requires sensor data, which can be utilized to train a classification algorithm for fault detection. This algorithm is used for verification and is installed as a code to the control unit of the product. It is nearly impossible to create the fault conditions necessary for training a predictive maintenance algorithm on the actual product. A solution to this challenge is to create a digital twin of the product (a model), and apply simulation and analysis of sensor data for various fault conditions. A neural network detects abnormal patterns of the sensor data, reflects the trends in predictive models, which are then used to predict failures, and allows tests for all fault conditions with severity. The entire procedure should be automated, thereby allowing tests of “what-if” scenarios on the digital twin model.

Predictive maintenance helps to determine when an aircraft product needs maintenance. It reduces downtime and prevents product failure by enabling maintenance to be scheduled based on the actual need rather than at predetermined intervals. It can be used to calculate maintenance-related parameters (MTBF – Mean Time between Failures), forecast the behavior of the product under different circumstances, and simulate different maintenance scenarios. Thus, predictive maintenance capability helps to extend the product life and reduce total ownership costs. Collectively, it will contribute to improving the Navy’s mission readiness and sustainment significantly.

It is envisioned that we will be able to develop a virtual integrated model-based representation of a physical product, allow the simulation of the product in a real setting in a dynamic fashion, and demonstrate closed loops between the virtual and physical space. Challenges for this include developing an accurate model that precisely reflects the physical twin’s properties. To improve the models further, a digital twin also requires remodeling based on the changes in the product’s configuration. For predicting failures, detailed blueprints of a product’s failure modes are required. Since the digital twin is a replica of the physical product itself, the requirements, qualification, and certification necessary to determine the flight worthiness of the product are the same for the virtual model as well. The expected outcomes of the effort are real-time monitoring and in-flight service of the product, since the digital twin represents an advanced engineered product. This will enable prolonged product life to deliver capabilities continually.

Any product used in naval aircraft can be considered for the proof of concept demonstration (e.g., propulsion engine, electrical power system, fuel system, avionics, air vehicle, auxiliary support equipment, electronic warfare system, human-machine interface).

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop a concept to create a digital twin of a product to show its present state using a model. Develop digital twin processes in the product life cycle – design stage to the field use, maintain and sustain in the real-world case. For validation, demonstrate the closed loop that would exist between physical and virtual space. Apply modeling, simulation, and analysis as necessary. Phase I will include prototype plans for Phase II.

PHASE II: Develop a prototype product (a high-fidelity model) by integrating the physical asset to the digital twin and demonstrate the closed loop between physical - virtual - physical space. Demonstrate the

applicability of readiness and sustainment influencing factors such as condition-based maintenance, foreign object detection, predictive maintenance, and flight safety with quantifiable metrics. Quantify the cost benefits, such as reduction in the operation cost and total lifecycle cost, as applicable.
Demonstrate the applicability of "what-if" scenarios tested against factors such as product performance management, manufacturing processes, and Navy-unique harsh environmental operating conditions.
Demonstrate the scalability of the digital technology to multiple products of an aircraft.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Develop robust architecture, showing the linkage between connectivity and services. Demonstrate the integration of the product into naval aircraft and perform final testing. Successfully transition, implement, and insert the technology for warfighter benefits. Develop mobile application solutions as applicable.

Aerospace industry, Manufacturing, Automobile sectors will benefit from the digital twin technology. The successful demonstration of the digital twin of the product that is operationalized will enable the applicability of the approach to any product/process/service industry to achieve cost benefits.

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KEYWORDS: Digital Double, Artificial Intelligence, Machine Learning, Data Strategy, Architecture, Internet of Things, Cloud, Digital Twin

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N202-106 TITLE: Alternative Software Architecture for Personal Electronic Maintenance Aids

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information Systems

OBJECTIVE: Develop a stable operating system architecture based upon open-source software (OSS) that reduces/eliminates dependence on Microsoft Windows. In comparison to Microsoft Windows 10, OSS operating system architecture should require fewer system resources, reduce software licensing and sustainment costs, reduce the overall Department of Defense (DOD) Information Assurance Vulnerability Alert (IAVA) patch cadence, increase performance, and integrate a robust cybersecurity posture requiring less frequent security updates and reduced typical patch file sizes than Microsoft Windows.

DESCRIPTION: Currently, Portable Electronic Maintenance Aids (PEMAs) employ the Microsoft Operating System (OS) as the host OS. With the transition to Windows 10, Microsoft has migrated to "Windows as a service". Windows 10 currently requires 20 gigabytes (GB) for a clean install. In addition to an ever-expanding footprint, the OS requires continual patching, with patch sizes often exceeding 1 GB. Each patch cycle requires a vigorous level of testing to ensure that the applications installed on the PEMA function in accordance with mission requirements. Windows license activation requirements present an additional level of complexity for systems that must function in austere environments that include both network connected and standalone/closed-loop configurations. Microsoft Windows activation requires a Key Management Service for connected systems and a soft token for disconnected systems.

The PEMA environment includes network bandwidth restrictions inherited from the host site networks: Integrated Shipboard Network System (ISNS), Consolidated Afloat Network Enterprise Services (CANES), Navy Marine Corps Intranet (NMCI), OCONUS Navy Enterprise Network (ONE NET), or Marine Corps Enterprise Network (MCEN). A significant portion of the PEMA footprint consists of standalone/closed-loop configured systems that do not connect to enterprise network. For standalone/closed-loop configured systems, the squadron Central Technical Publication Librarian must download patches from an enterprise network connected system and sneaker-net patches to the PEMA via DVD or USB hard drives. Whether patches come directly from a PEMA connected to the host-site enterprise network or sneaker-net via DVD/USB hard drive, the patches are first downloaded from an enterprise network. Occasionally patches are too large to transfer over slow/intermittent network connections and encrypted media has to be mailed to the squadron, where especially in the shipboard environment, network bandwidth is at a premium. A software architecture that results in a reduction in typical OS patch file size and patch frequency is a win for the warfighter.

The PEMA Support Equipment environment consists of various Type/Model/Series (T/M/S) specific aircraft and each T/M/S specific aircraft typically includes unique, T/M/S-specific applications. The overarching goal for PEMA is to deliver a single device, to Fleet maintainers, that provide access to technical publications and related Support Equipment applications. Considering the disparate applications required by the various T/M/S aircraft represented within the Support Equipment community, an approach that requires native installation of T/M/S specific application is neither sustainable nor supportable. In order to provide a long-term, supportable and sustainable solution that addresses the Support Equipment fleet maintainer mission on one device, the PEMA architecture must support containerized applications. By employing containerized applications, the process of patching and updating the PEMA underlying software OS architecture is streamlined because patches to the underlying OS do not affect the containerized applications. Employing containerized applications significantly reduces the amount of testing required to ensure T/M/S unique applications function according to mission requirements post patch, as the OS patch does not affect containerized applications.

The overarching requirements are to identify and confirm the viability of an OS architecture alternative to Microsoft Windows that:

- Reduces the frequency and volume (relative to Microsoft Windows 10 OS) of ongoing software vulnerabilities and related requirements for software patch updates as identified and represented by the DoD Information Assurance Vulnerability Management (IAVM) process.
- Results in a reduction in typical file size requirements for OS patches (relative to Microsoft Windows 10) in order to lower network bandwidth requirements.
- Natively supports preboot CAC authentication, and full disk data-at-rest encryption including removable media encryption (without the employment of a third party commercial solution). Note: Data-at-rest encryption must meet DoD Risk Management Framework (RMF) [Ref 4] Controls: SC-28.1 Protection Of Information At Rest and applicable DISA Security Technical Implementation Guides (STIGs) [Ref 5] that include Control Correlation Identifier (CCI) 001199; SC-28(1).3 and SC-28(1).4 Cryptographic Protection and applicable DISA STIGs that include CCIs 002475 and 002476.
- Natively supports two-factor authentication in both network connected and standalone/closed-loop environments. Note: The two factor authentication must meet DoD Risk Management Framework (RMF) [Ref 4] Controls: IA-5(2) PKI-Based Authentication, IA-5(11) Hardware Token-Based Authentication, IA-6 Authenticator Feedback, IA-7 Cryptographic Module Authentication.
- Delivers OS license activation execution that commonly supports connected and standalone environments or does not require license activation.
- Demonstrates compliance with DoD Memorandum "Clarifying Guidance Regarding Open Source Software (OSS)", dated 16 October, 2009 as well as guidelines from Navy DON CIO Memorandum "DEPARTMENT OF THE NAVY OPEN SOURCE SOFTWARE GUIDANCE" (5 JUN 2007).
- Demonstrates secure file transfer and validation, secure collaboration services, and web browser functionality.
- Supports display of PDF documents,
- Supports live operation in RAM (Secure Live Media),
- Enables hosting and execution of containerized applications,
- Supports Squashed File System high speed compression capabilities.
- Reduces costs related to software licensing relative to the Microsoft Windows Environment.

The OSS operating system should function on a ruggedized, clamshell form factor, 2-in-1 touchscreen/ keyboard configuration such as the Panasonic Toughbook currently employed as the PEMA hardware baseline. Ensure that the Open Source operating system architecture supports application containerization technology [Refs 6 and 7]. Provide an analysis of the potential for reducing the supportability and sustainability footprint with regard to patching. In comparison to Windows 10, describe the estimated benefit relative to:

1. Time and effort involved in patching applicable vulnerabilities on a monthly basis.
2. Typical file size for applicable patches (Identify if there is a patch file size typically smaller for the OSS operating system than Windows 10).
3. Relative frequency of required patching.

The analysis must provide an assessment of the ongoing requirements for patching and updating the system in comparison to the Microsoft Windows 10 environment and contrast the level of effort and risk relative to patching in the Windows environment versus the prototype-operating environment. The analysis must address system performance impacts for live operation in RAM.

PHASE I: Design and determine the technical feasibility of developing an OSS architecture OS that meets the guidelines established in References 8 and 9. With regard to supporting containerized applications identify if there is a significant difference in level-of-effort between the OSS operating system architecture and Windows 10. Provide an assessment of the technical feasibility of the OSS operating system architecture to support the capability requirements discussed in the Description section of this topic. Describe expected lifecycle support costs and tasking related to maintaining compliance with DoD and Navy Open Source Software guidelines identified in the Description. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a prototype 64-bit software architecture, including boot loader, kernel, and operating system to prove open-source concept meeting all requirements provided in the Description.

PHASE III DUAL USE APPLICATIONS: Demonstrate the ability to support containerized applications as discussed in the Description section of this topic. Demonstrate a process for updating a containerized application and the ability to save data from the containerized application to a USB hard drive. Provide design and related support and sustainment documentation. Transition developed technology to the PEMA program of record and field as the core software image which will serve as a potential baseline for all TMS programs to transition unique Windows dependent applications to open-source architectures. Support Risk Reduction Testing, Operational Testing, potential procurement, and pilot fielding to a squadron determined by the PEMA program. Support transition of unique TMS PEMA solutions to operate within this open-source architecture.

Technology development would benefit commercial applications supporting austere environments that require maintenance applications hosted on a ruggedized platform. Success would demonstrate how private companies can employ OSS to reduce costs related to software licensing as well as reduce costs related to ongoing requirements to maintain a strong cybersecurity posture throughout the lifecycle of a system by moving from a Microsoft Windows platform to an OSS platform. This same open source approach could be leveraged to meet other peculiar support equipment requirements in commercial and private sector environments such as commercial aircraft maintenance.

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KEYWORDS: Cyber Security, Windows as a Service, IAVM, Open Source Software, Open Source Architecture, Application Container, OSS, Operating System, OS

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N202-107 TITLE: Radio Communication with Hypersonic Aerial Vehicle

RT&L FOCUS AREA(S): Hypersonics, Network Command, Control and Communications;
TECHNOLOGY AREA(S): Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an effective radio frequency communication system solution for communicating through the plasma sheath surrounding a hypersonic aerial vehicle.

DESCRIPTION: When a vehicle is traveling at hypersonic speed through the atmosphere, a plasma sheath envelops the aerial vehicle because of the ionization and dissociation of the atmosphere surrounding the vehicle [Refs 1-3]. The plasma sheath prevents radio communication, telemetry, and Global Positioning System (GPS) signal reception for navigation [Ref 4].

This radio "blackout" period poses a serious challenge that hinders the use of hypersonic aerial vehicles for future naval applications. Development of an appropriate mitigation method to allow uninterrupted aerial vehicle to control station and control station to vehicle communications through the plasma sheath during the entire hypersonic flight is required.

Develop and demonstrate an effective blackout mitigation solution that enables continuous communication between a stationary or mobile platform and a hypersonic vehicle during hypersonic flight. Many mitigation techniques have been proposed, including but not limited to, aerodynamic shaping, magnetic windows, and liquid injection. Any innovative solution capable of eliminating any radio frequency communication disruptions due to the plasma sheath [Ref 4] will be considered.

PHASE I: Develop concepts for communication directly through the plasma sheath of a hypersonic aerial vehicle in the frequency band between 1.1 to 5.6 GHz for error-free GPS and radio communication for a separation distance up to 20,000 km. Perform modeling and simulation of the proposed concepts in the hypersonic environment to validate their feasibility. Complete design tradeoffs to predict the performance, size, weight, and power requirement of the most promising design. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop a hardware prototype based on the Phase I design. Demonstrate the prototype's radio frequency communication capability and characterize its communication performance in a terrestrial plasma chamber to establish proof of concept.

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the radio frequency communication system based on the final design from Phase II for Naval applications in the areas of reliable and error-free radio communication with hypersonic aerial vehicles.

The commercial sector would benefit from this research and development in the area of radio communication with hypersonic re-entry space vehicles.

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KEYWORDS: Radio Frequency, Communication, Plasma, Hypersonic, Black-Out, GPS

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N202-108 TITLE: Modeling Neuromorphic and Advanced Computing Architectures

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information 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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a software tool to optimize the signal processing chain across various sensors and systems, e.g., radar, electronic warfare (EW), electro-optical/infrared (EO/IR), and communications, that consists of functional models that can be assembled to produce an integrated network model used to predict overall detection/classification, power, and throughput performance to make design trade-off decisions.

DESCRIPTION: Conventional computing architectures are running up against a quantum limit in terms of transistor size and efficiency, sometimes referred to as the end of Moore’s Law. To regain our competitive edge, we need to find a way around this limit. This is especially relevant for small size, weight, and power (SWaP)-constrained platforms. For these systems, scaling Von Neumann computing becomes prohibitively expensive in terms of power and/or SWaP.

Biologically inspired neural networks provide the basis for modern signal processing and classification algorithms. Implementation of these algorithms on conventional computing hardware requires significant compromises in efficiency and latency due to fundamental design differences. A new class of hardware is emerging that more closely resembles the biological neuron model, also known as a spiking neuron model; mathematically describing the systems found in nature and may solve some of these limitations and bottlenecks. Recent work has demonstrated performance gains using these new hardware architectures and have shown equivalence to converge on a solution with the same accuracy [Ref 1].

The most promising of the new class are based on Spiking Neural Networks (SNN) and analog Processing in Memory (PiM) where information is spatially and temporally encoded onto the network. It can be shown that a simple spiking network can reproduce the complex behavior found in the neural cortex with significant reduction in complexity and power requirements [Ref 2]. Fundamentally, there should be no difference in algorithms based on neural networks. In fact, they can easily be transferred between hardware architectures [Ref 4]. Performance gains and the relative ease of transitioning current algorithms over to the new hardware motivates consideration of this SBIR topic.

Hardware based on SNN is currently under development at various stages of maturity. Two prominent examples are the IBM True North and the Intel Loihi chips. The IBM approach uses conventional Complementary Metal-Oxide Semiconductor (CMOS) technology and the IBM approach uses a less mature memristor architecture. Estimated efficiency performance increase is greater than 3 orders of magnitude better than state-of-the-art graphics processing units (GPU) or field-programmable gate arrays (FPGA). More advanced architectures based on an all optical or photonic-based SNN show even more promise. Nano-Photonic-based systems are estimated to achieve 6 orders of magnitude increase in efficiency and computational density, approaching the performance of a human neural cortex. Modeling these systems to make design and acquisition decisions is of great interest and importance. Validating these performance estimates and providing a modeling tool is the basis for this SBIR topic.

The primary goal of this effort is to create a software tool that captures the non-linear physics of these SNNs, and possibly other neuromorphic and related low-SWaP architectures, as well as functionally model their behavior. It is recommended to use open source languages, software, and hardware when possible. A similar approach [Ref 6] should be considered as a starting point, with the ultimate goal of producing a viable and flexible product for capturing, modeling, and understanding the behaviors of a composite system constructed to employ these adaptive learning systems, including all systems ranging from CMOS to photonics. Additionally, the model should be able to take an algorithm developed on a conventional neural network framework like Caffe, PyTorch, TensorFlow, etc. and run it through the functional model to predict performance criteria like latency and throughput. The secondary goal is to build up a network framework to model multi-step processing chains. For example, a hypothetical processing chain for a communications system might be filter, in-phase quadrature (IQ) demodulation, frequency decomposition, symbol detection, interference mitigation, filter, and decryption.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop the modeling approach and demonstrate feasibility to capture the relevant physics and computational complexity. Demonstrate a functional model of a SNN. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Validate the functional model using test cases from literature. Model validation with hardware is strongly encouraged, however, due to the limited availability of hardware this is not a requirement. The model will need to contain a network framework for various processing steps across multiple sensor areas using lower level functional models. Priorities sensor/functional areas are EW, radar, communications, and EO/IR.
Work in Phase II may become classified. Please see note in Description section.

PHASE III DUAL USE APPLICATIONS: Refine algorithms and test with hardware. Validate models with data provided by Naval Air Warfare Center (NAWC) Aircraft Division (AD)/Weapons Division (WD). Transition model to the warfare centers. Development of documentation, training manuals, and software maintenance may be required.

Heavy commercial investments in machine learning and artificial intelligence will likely continue for the foreseeable future. Adoption of hardware that can deliver on orders of magnitude in SWaP performance for intelligent mobile machine applications is estimated to be worth 10^9-10^12 global dollars annually.) Provide the software tools needed to optimize the algorithms and hardware integration. This effort would be a significant contribution to this requirement. Industries that would benefit from successful technology development include automotive (self-driving vehicles), personal robots, and a variety of intelligent sensors.

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KEYWORDS: Spiking Neural Network, Neuromorphic Computing, Modeling, Convolution Neural Network, Analog Memory, Processing in Memory

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N202-109 TITLE: Launch System for Group 3-5 Unmanned Aerial Vehicles for Land- and Sea-Based Operations

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Ground Sea

OBJECTIVE: Develop a reconfigurable Unmanned Aerial Vehicle (UAV) Launch System to add to an Expeditionary Sea Base (ESB) Navy Ship as a self-contained mission-driven kit. (The launch system is intended to enable UAVs such as the XQ-58A Valkyrie [Ref 5] to operate from ESBs.)

DESCRIPTION: The Navy needs to operate Group 3-5 [Ref 3] fixed wing UAVs from ships other than an aircraft carrier - a capability gap that, if overcome, would significantly increase lethality, project force, and increase the range of Intelligence/Surveillance/Reconnaissance (ISR). The UAV Launch System should be comprised of a launch technology capable of accelerating a fixed-wing, jet-powered UAV, with a wingspan of 30 feet and weight up to 6,000 pounds, up to 150 knots-indicated air speed (KIAS). The launch technology must reside, to the maximum extent possible, within the hull of the ESB. Coordination with NAVSEA/NAVAIR will be critical to understanding the most current available space(s) aboard ship, as well as any weight/power restrictions on the new launch system.

The Launch System must be designed to not interfere with top-side flight deck operations of the ESB, accommodate Group 3-5 UAVs with or without landing gear, and be reconfigurable such that it can conduct both shipboard launches (operationally aboard an ESB) and ground-based launches (during demonstration testing prior to installation aboard any ship). Should features of the Launch System exceed available space inboard, a stowable sponson assembly can be envisioned to extend from either side of the ESB, serving as the UAV “runway” and interfacing directly with the launch technology. The sponson may extend as far as 79 feet from the ESB and is limited to a length of 300 feet. Any design solution relying on a sponson must address impact on the ship’s performance, both pier-side and at sea, and may not interfere with basic ship or flight deck operations.

The UAV Launch System must be simple enough in design to allow for sustained operations at high sortie generation rates (i.e., rapid and repeated launchings of multiple UAVs, with a goal of a UAV launch every two minutes), with high reliability and little maintenance down time for 24 hour/7 day surge periods. Details of the Launch System kit need to include all the necessary subsystems and interface components required to permit their rapid installation aboard the ESB. Control and operation of the Launch System will be from the hangar bay of the ESB. Adhere to all applicable environmental standards of the latest version of MIL-STD-810 [Ref 4], such as shock, vibration, electromagnetic interference/emission, etc.

Work must be collaborative with NAVAIR and NAVSEA, to identify air-ship integration requirements, constraints, and compatibility between Group 3-5 UAVs and ESB.

PHASE I: Develop a proof-of-concept design to meet the Objective and details provided in the Description. Use a computer simulation tool, such as Solid Works, to provide analyses of the design features and projected operation of the Launch System and its major components. Provide schedule, technical challenges, and estimated ship alt costs. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the design from Phase I further and provide an additional detailed digital analyses of all components of the proposed Launch System, including fit checks aboard an ESB (if appropriate, structural/mechanical/functional details on any sponson utilized in the design) and functional/operational simulations. Demonstrate a 1/8 scale prototype of the Launch System, with adequate representation of the geometries and functioning major subsystems. Using a 100-pound UAV provided by the Government, conduct a ground demonstration of the prototype Launch System and report results.

PHASE III DUAL USE APPLICATIONS: Perform any final testing and transition complete Launch System kit(s) to Navy, Marine Corps, Air Force, and possibly some combatant commands (COCOMS) for full-scale ground testing of the technology involving Group 3-5 UAVs, and ultimate outfitting onto an ESB.

This type of technology could be useful for commercial UAV delivery systems in cities. The growing industry of aerial consumer package delivery could be profoundly impacted by advances in such UAV launch capabilities.

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KEYWORDS: Unmanned Aerial Vehicle, UAV, Unmanned Aerial System, UAS, Expeditionary Sea Base, ESB, XQ-58A, Sponson, Group 3-5 UAV

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N202-110 TITLE: Miniature 360-degree Multispectral/Hyperspectral Staring Imaging System

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Battlespace

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a miniature 360-degree Multispectral/Hyperspectral staring imaging system with discriminate classification capabilities for use on Navy manned and unmanned aircraft.

DESCRIPTION: U.S. Navy manned and unmanned aircraft platforms have a need for 4p steradian coverage for situational awareness while performing their required missions. In addition, airborne surveillance systems need to meet multiple mission requirements for automatic detection, track, and identification of a variety of objects to include aircraft, missiles, and obstructions hazardous to flight. There is a need for reduced size multispectral/hyperspectral imaging to provide a capability to conduct search, detection, classification, localization, tracking, and attack of surface ships and surfaced submarines in both clear and adverse weather, and in both the littoral and blue water environments. Small target examples are anti-aircraft missiles, Tier 1 Unmanned Aerial Systems (UAS), patrol craft, and submarines. Systems that are integrated onto airborne platforms need to meet stringent requirements for size, weight, power, and cost (SWaP-C); as well as aircraft requirements for environmental conditions such as vibration, shock, heat, altitude, etc. These requirements vary from aircraft to aircraft, but hold a common theme of reduced SWaP-C sensors to meet a number of aircraft requirements. The initial platform requirements will include the P-8A and MQ-4C platforms. The P-8A and MQ-4C will provide air defense capabilities to defend, identify, classify and track air targets and threats to the aircraft. In addition, the aircraft conducts Search and Rescue (SAR) missions. Current system concepts, such as large pods, are normally single purpose and impact mission performance by excessive SWaP-C that limits on-station time by increased drag counts and negative impacts to fuel consumption.

The multispectral/hyperspectral imaging system should provide 4p steradian coverage. The SWaP should be limited to approximately 100 pounds, total volume of 2 cubic feet, and have less than 500 Watts of input power required. Aircraft power requirements in accordance with MIL-STD-704 and MIL-STD-461 should be taken into consideration. Cost should be less than $300K per unit as manufactured. Aircraft environmental conditions in accordance with MIL-STD-810 should be taken into consideration. The sensors need to be external to the aircraft and be low drag as to not increase fuel consumption by more than 1%.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop a concept of a miniature spectral imaging digital system that can automatically search for air, surface targets and launch transients in littoral and blue water operations. The system should be able to automatically detect and classify multiple targets and provide threat warnings for 4p steradian coverage. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Further refine the architecture and algorithms developed in Phase I and develop a working prototype to include high-level surveillance requirements for automatic detection, tracking, and identification over 4p steradians of aircraft, missiles and flight obstructions, software development, initial system testing, and a lab or ground-based demonstration.

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

PHASE III DUAL USE APPLICATIONS: Perform final testing and transition the developed technology to appropriate Navy manned and unmanned aircraft platforms. Hyperspectral sensing has a multitude of application in commercial remote sensing. These include commercial aircraft and ground vehicle surveillance for collision avoidance, manufacturing safety systems, and inspection and surveillance systems.

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KEYWORDS: Multispectral, Hyperspectral, Remote Sensing, Optics, Imaging, Surveillance

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N202-111 TITLE: Desktop Tactics Trainer for Maritime Patrol Aircraft

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Human 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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a desktop trainer with a low-cost, computer-based, simulated environment where students can practice tactics learned in advance of discussions, simulator events, and flight events.

DESCRIPTION: Fleet Naval Flight Officers (NFOs) in the Maritime Patrol community are trained to: 1) conduct anti-submarine warfare first, 2) conduct intelligence, surveillance, and reconnaissance always, and 3) conduct anti-surface warfare, if needed. They use the multi-mission aircraft platform to accomplish these missions. The aircrew consist of multiple personnel (both enlisted and officers) operating a multitude of sensors. Using their training, and the complex yet effective aircraft, they are tasked with finding and tracking submarines and ships in the world’s oceans.

Current students work through a syllabus comprised of verbal knowledge discussion and quizzes, simulators, and flight events. Currently fleet students (upgraders) do not have any tool that allows them to try-out and practice learned tactics in a simulated environment without scheduling highly limited and valuable time in a multi-million-dollar simulator. This SBIR topic seeks to fill the gap between learning tactics from a book, and utilizing those tactics in a simulator event by providing a low-cost, computer based, simulated environment where students can try out what they learned and practice tactics in advance of discussions, as well as simulator and flight events. Low cost should be considered as a solution that is capable of running on a typical mid-range Windows computer (laptop or desktop), typical of what most training centers have organic to their building. By providing an additional "learn on your own" simulation tool, students can increase their knowledgebase before an event, and decrease the likelihood of event failure, maximizing the value of expensive crew simulator events, both in effectiveness and efficiency. The ultimate result of a basic computer-based simulation tool will be trainees who are more highly qualified at the end of their training, making them more ready and able to perform tasks.

The job is a difficult one and although the crew has a capable aircraft, they need to be proficient in their roles making the most use of the maritime platform. Although crewmembers conduct training flights and their qualifications primarily in live flights, they maintain a strong reliance on various training devices, as real ships and submarines are typically not available to train maritime aircraft crews. Additionally, when given real surface and subsurface platforms to train with, they are U.S. or allied friendly force units. Training against real-world adversaries would provide a higher fidelity of learning.

A computer-based tactics trainer is a cost-efficient and effective way to provide hands on tactics training on demand to NFOs in training, or as a means to maintain knowledge, skills, and abilities overtime. The idea of the computer-based tactics trainer was a Fleet born idea, specifically to address the eagerness of crewmembers to apply their classroom training in a practical way, and on their own time, rather than waiting for the next scheduled part-task trainer (PTT) or weapon tactics trainer (WTT) simulator event. The computer-based tactics trainer would allow them to load up a myriad of relevant pre-built scenarios, or create their own, to practice the tactical and decision-making aspect of prosecuting subsurface (or surface) entities. At first, this capability would look to replicate the Tactical Coordinator's (TACCOs) role, as mission commander. These NFOs receive inputs from the various sensor feeds and fellow crewmembers and compile the information to formulate a plan. The tactics trainer would then let the TACCO in training implement different tactics against the same target and see how each might turn out. Due to the tactical nature of the trainer, the trainee will need to see realistic outcomes and information from his or her inputs and actions. Through this, trainees that would like to practice their lessons to mastery, or close to it, can sit down at a standard computer, likely within the training center, load the computer-based tactics trainer, and run through scenario after scenario when they have time to do so. There are likely a few ways to accomplish the same goal when conducting a mission and the tactics trainer is the gateway to open those possibilities to a creative TACCO. The trainee can then try to implement their more effective tactics, techniques, and procedures once he or she gets to the high-fidelity simulator events with the rest of a crew. The tactics trainer can build confidence in new trainees, maintain Knowledge, Skills and Abilities (KSAs) of current crew members, and enable NFOs to use their valuable full simulator time in the most effective way.

Ensure Risk Management Framework (RMF) and Information Assurance (IA) guidelines [Ref 5] are considered during early software development to ensure future compliance.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop an innovative approach for a computer-based tactical trainer in the maritime patrol domain, or a similar domain for feasibility demonstration. All initial demonstrations will use publicly available data during Phase I. Demonstrate the feasibility of the proposed approach to be further developed in Phase II. Consider RMF and IA guidelines [Ref 5] during early software development to ensure future compliance. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Based upon the proposed solution in Phase I, develop and demonstrate a prototype using the maritime patrol domain, specifically targeting the role of the Tactical Coordinator. Several realistic scenarios will be developed, including a creative/sandbox mode where the trainee can design his or her own scenario to then engage with. Fleet stakeholders will assist with the identification of desired scenarios, first at the Unclassified level and later at the Classified level. A form of automated performance measurement will be included and pulled from fleet doctrine in order to inform trainees how they are performing based on the standard qualifications. Demonstrate the working prototype computer-based tactical trainer. Ensure that RMF guidelines to support IA compliance are met throughout software development.

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

PHASE III DUAL USE APPLICATIONS: Further develop and refine the system to suit the needs of end users based on Phase II feedback and testing. Develop additional scenarios based on fleet needs and finalize the sandbox/creative mode. Demonstrate the validity of the software for transition purposes defined by the end-user Subject Matter Experts in the maritime patrol community. Plan and execute final testing of the trainer to Fleet stakeholders. Transition the capability to Fleet stakeholders within their training environment. The final capability will require RMF, information assurance, and cybersecurity compliance with all relevant regulations and guidelines.

The architecture and design of the training tool, especially creative/sandbox mode, can be useful in professional industry and academic environments where planning and process implementation is warranted during lower fidelity training. This tool could be useful in dynamic environments such as aviation or maritime domains where the nature of tasks changes frequently.

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KEYWORDS: Training, Interactive, Desktop Trainer, Anti-Submarine Warfare, Tactics Trainer

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N202-112 TITLE: Multi-Domain Data Fusion Instructional Strategies and Methods for Pilot Training

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Human 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 section 3.5 of 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: Research and develop training objectives for the multi-domain environment and instructional strategies for manned-unmanned data fusion tactical decision making. Research and develop instructional tools that support defined strategies and methods to increase operator training effectiveness and mission readiness.

DESCRIPTION: Operator reliance on sensor fusion is becoming more prominent as platforms increase reliance on automated technology in next generation platforms. Further, as programs look to extend platform capabilities through off-board, unmanned sensor technology and capabilities, requirements for operator synthesis of data and decision-making based on manned-unmanned collaboration will become an essential part of operations. As these technologies advance, training systems must identify appropriate instructional strategies and training methods to ensure that operators understand the implications of automated technologies. Advanced platforms and systems, including Joint Strike Fighter and Strike Planning and Execution Systems, offer unique use cases facing these challenges. Additionally, interest has been expressed by programs such as Aerial Targets and Multi-Mission Tactical Unmanned Aerial Systems, and for long-term data fusion enhancements based on future system concept of operations for future helicopter platforms.

This SBIR topic seeks to identify unique instructional strategies necessary for supporting manned-unmanned teaming to ensure effective and efficient operator performance. Performance is measured using both automated measures derived from available data sources and observer-based measures. Significant increases from a baseline (pre-implementation of the technology) would constitute acceptable improvement, as well as impacts to expected relevant manned-unmanned teaming factors including communication, trust, and workload. Further, an analysis of crew resource management instructional methods is necessary to identify mechanisms for extending these well-established principles to manned-unmanned teaming environments to ensure training technologies and approaches best address these future requirements. As part of this effort, development and demonstration of a software technology prototype is desired that supports training built upon the instructional strategies and methods defined. The hardware and software must meet the system DoD accreditation and certification requirements to support processing approvals for use through the policy cited in Department of Defense Instruction (DoDI) 8510.01, Risk Management Framework (RMF) for DoD Information Technology (IT) [Ref 1], and comply with appropriate DoDI 8500.01, Cybersecurity [Ref 7]. Finally, research into the effectiveness of the instructional strategies and technologies developed based on these concepts is necessary to determine feasibility prior to transition.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Research and develop training objectives for the multi-domain environment and instructional strategies for manned-unmanned data fusion tactical decision making. Identify training technology to assist instructors with training and/or technologies to support instructorless training (e.g., scaffolding) that might provide beneficial uses in operational contexts for operator job aids when leveraging manned-unmanned data fusion for tactical decision making. Research and develop recommendations for automation transparency to support operator tactical decision making when leveraging manned-unmanned data fusion technology in multi-domain environments. The Phase I effort will include plans to be developed under Phase II.

PHASE II: Research and develop instructional tools that support defined strategies and methods to increase operator training effectiveness and mission readiness, including both technology to support instructor-led and instructorless training situations. Demonstrate operational utility of the technology for providing operator job aids and adjusting the level of transparency of automated data fusion systems to increase operator performance in manned-unmanned teaming environments. Demonstrate a prototype of the software technology that considers and adheres to Risk Management Framework guidelines to support cyber-security compliance in a lab or live environment.

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

PHASE III DUAL USE APPLICATIONS: Integrate instructional tools within a training system environment and/or transition technology via a Program Office to an operational system to provide operator job aids or enhancements to operator interfaces to increase performance. Attain Risk Management Framework certification for an authority to operate within operational/training systems. Data fusion technologies are increasingly beneficial in the commercial sector with the influx of data analytics and advances in technology. Industries that employ commercial logistics tracking, trucking, and commercial aviation (due to the likely increase of commercial drones) may all benefit from the SBIR-developed technology solutions.

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KEYWORDS: Training, Data Fusion, Sensor Fusion, Manned-unmanned Teaming, Instructional Strategies, Job Aids

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N202-113 TITLE: Mid-Body Range Safety Subsystem

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Electronics, Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and develop an innovative, automated, low-cost Mid-Body Range Safety Subsystem (MRSS) to meet range safety and platform engineering requirements for flight testing of the Tomahawk Weapons System launched from designated surface ships, submarines, and mobile ground launchers.

DESCRIPTION: The MRSS is an instrumentation package installed in the Tomahawk missile body prior to flight testing. In general, the MRSS provides three basic functions: telemetry, tracking, and flight override/flight terminate. The Tomahawk MRSS is comprised of an antenna, transmitter and a PCM Encoder that collects the missile data and puts it in a format to be transmitted. Currently, tracking is accomplished using a C-band transponder and an antenna. The flight override/flight terminate system will, typically, have an antenna, flight terminate receivers (FTRs), a control decoder (for flight override), and an electronics box that can sense the terminate command from the FTRs and interface with the missile methodology of crashing the missile.

The MRSS is required to meet data collection and range safety requirements. It provides the missile with a communications link with test ranges during flight tests and enables the missile to be tracked, monitored, and controlled or terminated by test range personnel during flight testing. This subsystem is only present during flight and related testing, and is comprised of a Range Safety Electronics Unit (RSEU) and a Tri-Band Antenna. The MRSS provides telemetry (TM) data at a rate of 2.5 megabits per second. The communications include missile instrumentation data, range command and control, flight termination, and position tracking. For submarine launch, selected missile data are stored and retransmitted to allow for missile performance evaluation from intent to launch (ITL) Command through broach. The RSEU sealing design (preventing JP-10 intrusion) satisfies the 60704 JP-10 compatibility requirement on internal RSEU components.

The solution cannot exceed the physical characteristics listed below and must fit in the mid-body section of a Tomahawk missile. Please note that the MRSS Spec and the TT-SRD-98-0058 System Safety Program Plan will be provided to the Phase I performers.

- Physical Characteristics (current MRSS):
    a. The current MRSS spec (PMA280-1208) does not list a weight nor any other physical and/or dimensional requirements. However, the existing design provides framework for the replacement kit. Any replacement kit will be constrained by the current design’s mechanical and electrical requirements/characteristics and interfaces with the missile.
    b. Power must be self-contained and independent from a Tomahawk missile
    c. The missile platform contractor will need to rework all center of gravity (CG) calculations based on new MRSS design.

- Transmitting Requirements:
  a. Transmit missile performance telemetry data and flight termination system status via S-band radio frequency (RF) link.
  b. Position tracking via C-band transponder.
  c. Demodulate an ultra-high frequency (UHF) RF link and provide for override command and control of the missile by a designated RF source.
  d. Provide a discrete signal to the Mission Control Processor (MC I/O) indicating loss-of-tone of Range Safety Carrier.
  e. Initiate missile flight termination action following receipt of any of the indications below:
     1. Receipt of a COMMAND TERMINATE
     2. Receipt of "Loss-of-tone/Initiate Flight Terminate" (SW 35) signal from the Pyro/Power Control Assembly (PPCA) within the missile Guidance Electronics Unit.
     3. CMA bus voltage drops below the specified low operating voltage for the flight terminate receivers.
  f. Provide a pre-launch BIT capability to verify presence of adequate flight termination back-up activation power and operation of flight termination receiver/decoders.

- Shock and Vibration: The MRSS environments must meet CMP3900 Rev B, Appendix E. The FTS components must meet RCC-319 [Ref 1]. RCC-319 typically adds 3-6 db to the expected flight levels. The qualification of the FTS is coordinated with the Range Safety Offices (RSOs) of the ranges where the missile is tested.
- Temperature: Temperature, pressure and other environment requirements are specified in PMA280-1208, para. 3.2.5.
  a. Material: As specified in PMA280-1208, para. 3.3.1.1.
  b. EMI/EMC/Stress: As specified in PMA280-1208, para. 3.3.2
  c. HERO: As specified in PMA280-1208, para. 3.3.2.3.
  d. Built-In-Test (BIT): PMA280-1208 specifies BIT requirements as follow:
     1. Para 3.2.1.1.f : Provide a pre-launch BIT capability to verify presence of adequate flight termination back-up activation power and operation of flight termination receiver/decoders.
     2. Para 3.2.1.7: Pre-launch BIT. When powered with pre-launch power, the MRSS system must provide a continuous BIT check until removal of bus power.
     3. As a minimum, the MRSS shall monitor the performance of the following items:
        - Flight termination backup activation power.
        - Dual receiver Automatic Gain Control (AGC) voltages.

(These requirements are only for a pre-launch BIT and not a continuous BIT post-launch – a continuous BIT would be "nice to have" and desirable but is not a hard requirement.)

The FTS must meet RCC-319 as negotiated with the RSOs. Telemetry standards are defined in IRIG Standard 109. C-Band Transponder Standards are defined in RCC 254. If launching from a submarine, S9510-AB-ATM-010 must be followed. For the current MRSS kit, this applies to the Lithium Thermal Battery.

For encryption, the MRSS or certain subsystems thereof must follow NSA requirements and procedures regarding accounting, handling and safeguarding the Controlled Cryptographic Item (CCI) and keys; i.e., the encryption chip is a CCI and key erasure is a required function.

Asset Recovery: Whereas the current Tomahawk testing requirement does not include a need to recover the missile by use of a parachute, that capability may be required in the future. Offerors are requested to consider innovative ways to include that potential capability if possible within the design constraints of the missile. Offerors should consider design options for land and deep-water recovery.

Other Key Requirements:

- The MRSS may not adversely impact or degrade operational performance of the Tomahawk missile
- The FTRs must meet redundancy requirements as outlined in RCC-319.
- The MRSS must meet MIL-STDs for shock and vibration, environmental, etc.
- The MRSS must ensure that any re-certification requirements of subsystem/parts are not less than 3 years.
- Service life must exceed 10 years.
- Unit cost must not exceed $1.0M

The RSO at each flight test range has ultimate authority on all Flight Terminate System matters. The current MRSS design has an embedded NSA encryption chip within the MRSS and keys utilized for operations that enable telemetry encryption. What these statements mean is there are two external Program Office organizations that could significantly affect the MRSS design.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design, develop, and demonstrate the feasibility of a range safety subsystem that supports flight testing of the Tomahawk Weapons System on capable Government open-air test ranges in accordance with the parameters provided in the Description. The MRSS Spec and the TT-SRD-98-0058 System Safety Program Plan will be provided to the Phase I awardees. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Based on the design developed in Phase I, produce a full-scale, operational prototype of the new MRSS. Develop test procedures for demonstrating and validating MRSS. Demonstrate and validate capability to meet range safety requirements.

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

PHASE III DUAL USE APPLICATIONS: Develop and provide a Product Level Technical Data Package according to MIL-STD-31000B for the MRSS that includes applicable drawings and any special tooling. Finalize and transition to applicable programs.

Successful technology development would benefit the commercial flight safety testing industry.

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KEYWORDS: Mid-Body Range Safety Subsystem, MRSS, Tomahawk Weapons System, RSEU, Flight Termination, Readiness, Lethality

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N202-114 TITLE: High Fidelity Electromagnetic Design, Prediction and Optimization of Airborne Radomes

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Define and develop a methodology by which high fidelity computation of antenna performance parameters of an installed system is utilized, and then apply that methodology to optimize the design of a radome covering an antenna.

DESCRIPTION: Currently, the computational tools used to design advanced airborne radomes are limited in their ability to predict and achieve installed performance over the full range of operating conditions [Ref 1]. The design and/or analysis of complex radomes with locally varying curvature and thickness, that incorporate metamaterials or frequency-selective surfaces (FSSs), is especially complex. Only full-wave electromagnetic analysis of the antenna cavity and radome structure can provide the required accuracy in predicting the variations in performance measures such as power transmission and reflection, boresight error, and sidelobe levels over the field of view. Such analyses can also reveal the levels of cross-polarization, grating lobes, and modifications of currents on the antenna structure resulting from electromagnetic coupling among the various structures in the antenna cavity. Providing that they can generate timely and accurate results, high fidelity predictions play a key role in extending the scope and accuracy of the design process for multilayer radome designs having complex internal structure, such as A-sandwich, C-sandwich, Prepreg, honeycomb/foam core, and Rohacell.

The Navy is interested in improving and optimizing the performance of radar systems already installed on Navy aircraft. The design of radomes currently covering such systems are to maximize transparency and beam quality at all viewing angles for in-band operation, and to minimize sidelobe levels. Structural, aerodynamic, and material-property considerations impose constraints that limit the design optimization process. Moreover, the optimization is performed using computational electromagnetics (CEM) tools with inherent approximations of the physical electromagnetic behaviors. Thus, the end-result is a less than optimal system that introduces uncertainties in the radar's modes.

Recent progress in the development of full-wave electromagnetic solvers provides an opportunity to apply the detailed predictions to optimize actual radome designs [Ref 2]. The goal of this SBIR topic is to establish one or more methodologies based on full-wave solvers that will have the following characteristics:

1. High fidelity in predicting all operational characteristics of radome-enclosed antenna arrays as installed on Navy aircraft including effects due to interaction with aircraft structures external to the antenna cavity. This entails precise descriptions of the elements and layers comprising the radome, as well as auxiliary structures such as lightning strips and pitot tubes inside the cavity.
2. Modelling of electrically large radomes that will require advancements in high-order, full-wave solvers in the following areas:
    a. high order curved meshing;
    b. cell sizes larger than a wavelength to fill the volume domain with fewer cells
    c. high-order absorbing boundary conditions (ABC) that can bring the outer boundary very close to the target extruded prism and mixed cells to model very thin radome structures.
3. Effective software support of volumetric grid generation from detailed computer-aided design (CAD) models of all relevant structures. These grids will typically be multi-resolution to model critical details according to the accuracy requirements of the solver.

4. Fast execution of the solver and post-processing algorithms on massively parallel computer platforms. This capability is a high priority, as the time and resources available to perform the repeated runs required for optimization are limited.
5. Development of a highly intuitive and intelligent Graphical User Interface (GUI) to assist the user in all phases of the CEM model development, import, export, preprocessing and post-processing.
6. Flexibility in supporting a wide variety of optimization strategies, including genetic algorithms, particle swarms, and surrogates based upon the original design tools [Ref 3].

PHASE I: Design, develop and demonstrate the feasibility of a methodology to exercise a full-wave CEM code on an approved radome. Evaluate the potential of this software to adjust key details in radome design to improve actual performance metrics for the installed radar system. Demonstrate that the method is able to model various structural and material features of a complex radome. Demonstrate that the code fulfills the requirements 1-6 stated above. If not, make persuasive arguments as to how modification of the code could fulfill these requirements. The Phase I effort will include plans to be developed under Phase II.

PHASE II: Validate and mature the approach from Phase I. Develop optimization and design approaches to improve radome performance with installed antennas and interaction with neighboring structures. Develop a GUI that encompasses the entire computational process, including: preprocessing tools for geometry import and generation of high order curved elements, high order processing tools, and a comprehensive set of post processing tools for data output and visualization.

PHASE III DUAL USE APPLICATIONS: Complete the development of the CEM software application. Perform final testing and transition into use on applicable platforms. The CEM software application will have a widespread use in the DoD, industry and academia for the design, optimization, and/or analysis of highly complex radomes and electromagnetic problems. The aerospace industry as well as universities such as Massachusetts Institute of Technology (MIT), The Ohio State University (OSU) and California Poly-Technical Institute (Cal Tech) could all benefit from, or be interested in, the resulting technology.

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KEYWORDS: Computational Electromagnetics, Radomes, Frequency Selective Surfaces, Curved Surfaces, Software Application, Aerospace.

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N202-115 TITLE: Monolithic Dual-Band Quantum Cascade Laser

RT&L FOCUS AREA(S): Quantum, Directed Energy
TECHNOLOGY AREA(S): Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a monolithic dual-band quantum cascade laser platform with almost beam diffraction limited output power >3 Watts each in the 4.6-5 and 3.6-4.2 micrometer bands.

DESCRIPTION: High-power, cost-effective, compact, and reliable mid-wave infrared (MWIR) Quantum Cascade Laser (QCL) platforms operating in the continuous wave (CW) regime are highly desirable for current and future Navy applications. Individual QCLs emitting within the 4.6-5 micrometer wavelength band with about 5 Watts CW output power and a wall-plug efficiency of about 20% at room temperature (RT) have been demonstrated [Ref. 1]. There is another, shorter MWIR spectral band between 3.6 and 4.2 micrometers [Ref. 2] that is also of interest for Naval applications. The atmospheric transmission in this band is about 45% to 50% higher than that of the 4.6-5 micron spectral band. Currently both QCLs emitting in both of the MWIR bands are beam-combined using external optical elements for current Naval applications.

While the current external beam combination configuration's size and weight may be adequate for current platform applications, other aerial platforms such as compact rotary-wing aircraft and/or smaller unmanned aerial vehicles can benefit from a laser source that is at least 20 times smaller and lighter. A monolithic laser chip platform with a single optical output aperture emitting in both wave bands using a single laser driver electronics would minimize the overall laser size, weight, and cost as stated in the specifications below. Therefore, the goal of this SBIR topic is to develop a monolithic dual-band QCL-based source that meets the following performance specifications:

1. Room-temperature CW optical power over 3W each in the 4.6-5 and 3.6-4.2 micrometer bands
2. QCL package volume less 1 cm3
3. QCL package weight less than 100 grams
4. Wallplug efficiency exceeding 15%
5. Almost diffraction limited beam quality factor with M2 < 1.5

Priority will be given to solutions minimizing weight and size, while meeting the optical power and efficiency requirement.

PHASE I: Develop and demonstrate the feasibility of a viable, robust, and manufacturable design for a single dual-band QCL source that meets or exceeds the requirements specified. Identify technological and reliability challenges of the design approach, and propose viable risk mitigation strategies. The Phase I effort will include prototype plans to be developed in Phase II.

PHASE II: Design, fabricate, and demonstrate a packaged dual-band laser prototype based on the design from Phase I. Test and fully characterize the laser prototype to assess its performance. Report performance results.

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the high performance QCL with the specifications stated in Phase II for DoD applications in the areas of Directed Infrared Countermeasures, advanced chemicals sensors, and Laser Detection and Ranging. The DoD has a need for advanced, compact, high performance MWIR QCL In Band IVA (3.8–4.1 micron) and Band IVB (4.6–5) micrometer bands combined emissions from a single laser aperture that can be readily scaled via beam combining for current and future generation DIRCMs, LIDARs, and chemicals/explosives sensing. The commercial sector can also benefit from this crucial, game-changing technology development in the areas of detection of toxic gases, environmental monitoring, and non-invasive health monitoring and sensing.

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KEYWORDS: Quantum Cascade Lasers, QCL, Band IVA, Band IVB, 3.8 Micron, 4.1 Micron, 4.6 Micron, Midwave-Infrared, Laser Array

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N202-117 TITLE: Optimized Subtractive Manufacturing - Right Parts, Right Time, Every Time

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Ground Sea, Weapons

OBJECTIVE: Develop the ability to produce optimized (strength/stiffness/weight) part geometry, using lathes and milling machines as constraints, to feed Computer Aided Manufacturing (CAM) software for machining centers.

DESCRIPTION: Currently, optimization software develops a mesh-based output for optimized parts. The user inputs the various parameters (required strength, stiffness, or weight) and the optimization code calculates the topology to meet the user requirements. This mesh-based output is not generally in a format directly usable to create a part by either additive manufacturing or subtractive manufacturing. For additive manufacturing, a second software suite is needed to process the mesh-based output into usable format to produce the part. The mesh-based output is unusable for subtractive manufacturing without significant engineering input.

Additively manufactured components have an advantage of being able to be created in complex shapes, which are unable to be made using subtractive methods. However, the use of multi-axis numerical control subtractive manufacturing machines allows similarly complex shapes to be created. The issue for subtractive based manufacturing centers around tool-path and access (e.g., can the tool get into a space and move in the same space).

The disadvantage of additive manufacturing is that both the process and material must be qualified and tested together in order to provide sufficient properties to be evaluated for airworthiness. Unlike additive manufacturing, components manufactured by subtractive manufacturing can be evaluated for airworthiness quickly by analysis. Analysis of subtractive manufactured components requires material properties from the manufacturer and part geometry in order to be evaluated for airworthiness.

This SBIR topic seeks to combine the strengths of material qualification associated with subtractive manufacturing and the benefits of optimization software to provide the best possible parts in the least amount of time. To accomplish these goals, the Navy seeks the development of a software package that performs optimization for strength, stiffness, and weight as goals while using machinability as a constraint. The output from the Computer Aided Design (CAD) in the form of a common platform independent file type (e.g., Parasolid, Standard for the Exchange of Product model data (STEP), Initial Graphics Exchange Specification (IGES), or ACIS). The output geometry should be optimized for the chosen objective and be machinable by multi-axis mill and/or lathe.

PHASE I: Design and develop a software to analyze/optimize a component for a particular objective (e.g. strength or stiffness or weight). Demonstrate the feasibility of the software to constrain the analysis/optimization using a multi-axis subtractive machine as a constraint (i.e. the component must manufactured on a multi-axis mill or lathe). The Phase I will include prototype plans to be developed in Phase II.

PHASE II: Develop and prototype the software design from Phase I and demonstrate its ability to analyze/optimize a component for multiple objectives (e.g., strength and stiffness). The software should constrain the analysis/optimization using a multi-axis subtractive machine as a constraint (i.e., the component must be manufactured on a multi-axis mill and/or lathe). Additionally, the software should incorporate “machinability” or ease/speed of manufacturing as a constraint. Lastly, use a design as agreed upon between the United States Navy and the performer to demonstrate the software, ending with the fabrication of a component optimized for strength, stiffness and/or weight to be made on a multi-axis mill and/or lathe. The output of the software will be a CAD file(s) of neutral file type (i.e., Parasolid, STEP, IGES, or ACIS) . The output geometry should be optimized for the chosen objectives (strength, stiffness, and/or weight) and be machinable by a multi-axis mill and/or lathe.

PHASE III DUAL USE APPLICATIONS: Validate previously developed parts optimized for multiple objectives through mechanical testing. Develop an interface to accept imported geometry from other CAD software packages. Develop a stand-alone interface or interface with an existing software company's package (e.g., Solidworks, ANSYS, ABAQUS, and/or Altair).

Successful development of this technology would benefit manufacturers and would speed the development of machined products, greatly reducing design cycles, and optimizing the performance of machined components for all industries. Both the aerospace industry and personal electronics manufacturing sector would benefit from this technology development.

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KEYWORDS: Optimization, Machining, Modeling, Simulation, Design, Manufacturing

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N202-118 TITLE: Passive System for Detection and Identification of UAVs Using Multispectral/Hyperspectral Imaging Technologies

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a passive multispectral/hyperspectral imaging system that can identify unmanned aerial vehicles (UAVs) with high probability of detection and low probability of false alarms by exploiting the unique combined signatures in both spatial and spectral domains.

DESCRIPTION: The proliferation of the use of unmanned aerial vehicles (UAVs) of various sizes and shapes for defense, commerce, monitoring, and other applications has increased at a very expeditious pace. Along with their advantages in ease of operation and low cost, the widespread availability of UAVs has posed significant security threats in both defense and civilian arenas.

Various approaches have been explored to interdict UAVs [Refs 1-3]. However, these interdiction strategies typically presume that the drone has already been detected. As part of the effective UAV threat mitigation, it is first necessary to have the ability to detect and track UAVs in the airspace. Straightforward adoption of currently fielded airspace surveillance technologies will not suffice as UAVs are much smaller in physical size and fly slowly at lower altitudes. For instance, a conventional air surveillance radar system (operating at L-band or S-band) rely on the radar cross section (RCS) of an aircraft for detection, but this may not always provide reliable detection in case of UAVs. Even if a dedicated system is sensitive enough to detect an object like a small UAV, just RCS information alone is not adequate. Some birds are similar in physical size to small UAVs and fly at similar altitudes and speeds. Visual detection of UAVs does not effectively discriminate between a small UAV, a bird or a plastic bag caught in the wind.

Recent technological advances have made long-wave infrared (LWIR) and mid-wave infrared (MWIR) hyperspectral imaging (HSI) in the 3-5 and 8-12 micrometer wavelength ranges a viable technology in many demanding military application areas where materials can be identified by their spectral signatures [Refs 5, 6]. Further, LWIR spectral range offers advantages that are unmatched by the visible and short-wave infrared range as LWIR is not susceptible to performance degradation from scattering by water-based aerosols, dense fog and clouds in the atmosphere. Hence, the operational utility of LWIR and MWIR HSI for detection, recognition and identification of hard-to-detect targets in environments cluttered with background noise is especially critical. HSI sensors provide image data containing both spatial and spectral information. The spectral information offers the additional modality to address such detection tasks that are unachievable by spatial information alone. The spectral information of an HSI stems from the fact that the amount of radiation reflected, absorbed, or emitted - i.e., the radiance - varies with wavelength. HSI sensors measure the radiance of the materials within each image pixel area over a very large number of contiguous spectral wavelength bands.

It is the objective of this program to explore and develop MWIR and LWIR HSI technologies for the detection, acquisition and tracking of a UAV or UAVs during counter UAV surveillance that cannot otherwise be detected using more conventional imaging or radar. The goal is to perform an exploration and investigation of both MWIR and LWIR hyperspectral signatures of UAVs against various environmental backgrounds, such as sky backgrounds both in day time and night time, to design an effective detection and tracking algorithm with high probability of detection and low probability of false alarm at a range up to 10 km. The detection and identification algorithm should be combined with system designs that employ either innovative sensors or commercial off-the-shelf (COTS) systems. The result should be an effective UAV detection and identification algorithm based on MWIR and LWIR HSI systems with probability of detection more than 90% and probability of false alarm less than 10% at the detection range up to 10 km even at the presence of common atmospheric obscurants, such as fog, clouds and aerosols, where atmospheric obscurants can reduce the visible transmission coefficient at detection distance down to less than 10% relative to that in vacuum. The identification algorithm of the system should incorporate a library of UAVs that will keep pace with those that are available.

PHASE I: Design, document and demonstrate feasibility of a detection and tracking algorithm based on the combined LWIR and MWIR HSI systems of the developer's choice that meet or exceed the requirements specified in the Description. Identify the technical risk elements in the detection and tracking algorithm design and provide viable risk mitigation strategies. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Construct, develop, and demonstrate a combined HSI system with the associated detection/tracking algorithm based on the design from Phase I. Conduct quantitative measurements and analysis of the system prototype and assess system performance against the stated requirements. Prepare a report that summarizes the experimental evaluation and validation of the performance characteristics of the developed system.

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the technology and methodology based on the research and development results developed during Phase II for DOD applications in the areas of UAV detection and identification, and other anomaly surveillance and reconnaissance applications.

Commercialize the detection and identification technology for commercial aviation enhanced vision, chemicals/explosives sensing, detection of toxic gases, environmental monitoring, and non-invasive health monitoring and sensing.

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KEYWORDS: Unmanned Aerial Vehicles, UAV, Image, Detection, Identification, Hyperspectral, Multi-Spectral

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N202-119 TITLE: Cross Deck Pendant Health Monitoring

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: Develop a Cross Deck Pendant (CDP) inspection device that provides a "GO / NO-GO" result based on automatic determination of cable health.

DESCRIPTION: Carrier aviation is dependent on the ability to recover aircraft expeditiously and safely aboard ship. The arresting gear system aboard aircraft carriers relies on a steel cable to transfer the energy from the landing aircraft to the arresting gear engines located below the deck. The arresting gear cable consists of two separate cables, the CDP and the purchase cable, connected via a terminal and pin. The CDP is the portion of the cable stretched across the landing area and interfaces with the aircraft tailhook.

Automated inspections of the CDP have proven to be problematic to implement due to the challenging operating environment of aircraft carrier flight decks (i.e., steel deck with a stationary steel wire rope). Current inspection procedures take approximately two minutes, requiring sailors to visually inspect, and slide a gloved hand looking for broken wires on the arresting cable, which is currently a 1-7/16” diameter 6x30 (6 strands made up of 30 wires each) right hand lang lay steel wire rope with a polyester core. This method is subjective and relies on the expertise of the maintainer to ascertain the health of the cable. The current replacement criteria is four broken wires in one cable lay.

A simple, compact but sophisticated "GO / NO-GO" inspection indicator device available for use by Navy maintenance technicians to help increase the accuracy/reliability of the CDP inspections and cable health is sought. Currently the health of the CDP is classified by the number of broken wires present, with four broken wires requiring the CDP to be removed from operation. Solutions need to meet the performance requirements for environmental ruggedness (MIL-STD-810) and should give a simple binary decision indication on cable health [Ref 2]. The inspection device will need to operate in the following environment: on a steel deck, in all weather conditions, day and night, flight deck electromagnetic interference (EMI) conditions, and greased/kinked cables. Any proposed method that requires cable removal or destroying the cable will not be considered.

The ability to predict the cable failure location is desired, as would an estimate of remaining service life. The Navy will consider both in-situ sensors (i.e., part of the cable) and inspection tools (with handheld preferred) that are not part of the cable. However, the inspection must be accomplished while the cable is in operation.

PHASE I: Develop and demonstrate feasibility of a design solution for a handheld steel cable life indicator that can detect a single broken wire without the need for human interpretation in a timeframe that doesn’t significantly exceed the current inspection time and provides a "GO / NO-GO" decision on the health of a CDP. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Build and demonstrate a prototype inspection device, and any interfacing electronics, to inspect the CDP. Final demonstration will be in a test environment representative of the CDP aboard ship.

PHASE III DUAL USE APPLICATIONS: Finalize a prototype for robustness and shock testing [Ref 2]. Test the prototype at Naval Air Warfare Center Aircraft Division, Lakehurst, New Jersey. Transition to appropriate end users.

Wire rope has a wide range of applications in industry, including bridges, elevators, cranes, overhead hoists, ski-lifts, ship moorings and off-shore oil rigs. Broken wire count is a standard method for determining when to replace cables in everything from cranes to winches, so a method of easily identifying broken wires could be beneficial in many non-naval applications.

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KEYWORDS: Wire Rope, Cross Deck Pendant, Arresting Gear, Health Monitoring, Nondestructive Inspection, NDI, Steel Rope, Cable Failure

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N202-120 TITLE: Improved and More Robust Automatic Target Classifiers

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information Systems, Battlespace

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 section 3.5 of 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 better and more robust automatic target classifiers capable of providing improved accuracy, identification, and classification of complex or subtle dynamics by leveraging advanced mathematical and machine learning tools.

DESCRIPTION: Current tactical platforms are challenged when it comes to target identification and classification algorithm development. They are unlikely to routinely encounter more complex dynamics of targets of interest and when they do, the raw data is not likely to be recorded. Therefore, data from other collection systems and/or computer models must be used to model and simulate the dynamics and build the required algorithms. The advancement of powerful super computers has made near-real physical modeling possible [Ref. 1], allowing modeling of almost any target with its environment and achieving very good agreement between models and observations. It is important to note though, some approximations are usually required but those terms are generally small and are usually considered insignificant.

Advanced mathematical and machine learning techniques may be used to resolve this apparent paradox between exploiting a high-dimensional feature space with data intensive machine learning and a lack of understanding of the underlying dynamics. With this approach, one could build and train equivalently effective algorithms with built-in physics, i.e., coupled non-linear differential expressions, to ensure the algorithms are robust. Finally, the learned physics-based models could be used to extend accurate classification to other objects of similar class using sparsely sampled data, computer models, and scaled model data.

Machine learning techniques, e.g., Support Vector Machines (SVM), Dynamic Mode Decomposition (DMD) [Ref. 5], Long Short-Term Memory (LSTM) Recurrent Neural Networks (RNN) or Convolutional Neural Networks (CNN), are effective at picking up and exploiting small differences in data, especially for spatiotemporal coupled systems where the feature space is very large in higher order dimensions. As a result, improved performance can be achieved with access to higher dimensional data with finer temporal resolution and higher fidelity. Getting this data can be difficult for a tactical platform and using traditional computer modeling may not be sufficient due to its data approximations. However, scaled model data might be used to better capture the underlying dynamics and provide a critical element for the advancement of machine learning algorithms. Scale modeling cannot be a complete alternative and may be dismissed in the development and test of classification systems because of the expense when scaling to large class.

One other important consideration when using machine learning algorithms are generalization errors or systematic biases. Because these algorithms are sensitive to high dimensional features, they can often key on intangible artifacts like non-real sensor phenomenon or peculiarities present in the data collection. The traditional black box approach sometimes makes it difficult to detect or completely eliminate these types of errors; but all attempts must be made to do so. One way to do this is to ensure the algorithms are grounded in a priori knowledge of physical laws. As with human intelligence, machine intelligence must also be confined to the realm of reality.

Recent mathematical tools have been developed that might be leveraged to resolve the apparent paradox of capturing the desired level of complexity in a machine learning algorithm and knowledge of the underlying physical mechanism it is exploiting. Examples of methods or techniques that may provide the desired results include the work by Raissi et al. [Refs. 2, 3], which has demonstrated the ability to translate noisy observations in space and time into non-linear partial differential equations. This was done by embedding a deep hidden physics layer in a Neural Network; it is able to learn the underlying dynamics during training [Ref. 2]. The resulting Neural Networks form the basis for new classes of algorithms with a priori built in knowledge of the underlying physical laws [Ref. 3]. This could allow better and more robust extrapolation to other objects within the same spatiotemporal framework using limited observations and/or augmented with computer and scaled model data. Another example of a technique used for complex dynamics is Dynamic Mode Decomposition [Ref. 5], which have shown the capability to extract governing equations of a dynamic system from sensor and image data collected on that system.

Combining new mathematical tools, hidden physics layers, scaled and computer models, and sparse observational data, it should be possible to build better and more robust intelligent machine learning algorithms. These new systems could process higher-dimensional input data at the same speeds or faster to achieve reduced missed identification or classification and increased correct identification and classification performance all the while providing higher confidence in those decisions. Existing data fusion metrics from Single Integrated Air Picture (SIAP) [Ref. 6] or the popular Stone Soup metrics package can be used to assess accuracy in identification and classification against existing systems as a baseline.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop a plan for implementing physics-based machine learning using sparsely sampled and noisy scaled laboratory data. Demonstrate feasibility of a sufficiently robust system to handle, and complex enough to leverage, spatial and temporal coupling and dynamic motion. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Based upon the plan from Phase I, develop a machine-learning classification algorithm for multiple targets with separate quarantined targets. The targets can be any class with spatial and temporal dynamics. Build a well-trained SVM, LSTM RNN, CNN classifier using physics-based hidden layers and scale model representations. Test and demonstrate the extent to which sparsely and/or noisy data from the quarantined target can be incorporated into the existing classifier. Test and demonstrate the extent to which the trained hidden physics layer can produce representative data that matches existing computer or scaled model data. Demonstrate the ability to generate data or a model that is robust against a well trained SVM or CNN classifier. The performance of the developed algorithm may be tested on an approved data set for validation.

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

PHASE III DUAL USE APPLICATIONS: Extend the work to include real world data and accurate representative models. Transition the algorithm to appropriate military and commercial users. Heavy commercial investments in machine learning and artificial intelligence will likely continue for the near future. Better and more robust machine learning signal processing and classification has a myriad of commercial uses including financial market prediction, self-driving cars, medicine, and environmental research.

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KEYWORDS: Scale Model, Machine Learning, Hidden Physics Layers, Non-Linear Differential Equation, Advanced Mathematics, Automatic Target Qualifier

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N202-121 TITLE: Identifying and Characterizing Cognitive Sensor Systems in Tactical Environments

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Information 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 section 3.5 of 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 methods to remotely probe an adversary's cognitive sensor system in order to characterize the nature of their response to changing stimulus.

DESCRIPTION: Our adversaries' fielding of cognitive sensor systems rapidly adapt in response to a challenging tactical environment. These cognitive systems employ a sense-learn-adapt loop. In many instantiations, these sensing systems train continuously while operational in an unsupervised fashion to gain maximum additivity to a dynamic threat environment. For example, concepts for true cognitive electronic warfare systems envision a neural network driven sensor that "should be able to enter into an environment not knowing anything about adversarial systems, understand them and even devise countermeasures rapidly" [Ref 1]. Obviously as our adversaries field these systems, we seek methods to detect their presence and characterize their response to a changing tactical environment. The Navy seeks to stimulate these responses through its own purposeful probing in order to observe their evolving sense-learn-adapt loop responses. This understanding is vital to assessing the threat these systems pose as their adaptability poses a significant military threat.

The solution must be applicable for both Navy airborne electronic warfare and radar systems.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Design and develop conceptual methods to remotely probe an adversary's cognitive sensor system for the purpose of characterizing the nature of their response to changing stimulus. The methods should be applicable to both electronic warfare and radar systems. Perform an unclassified proof of concept demonstration to show the scientific and technical merit of candidate approaches. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Perform detailed development and demonstrate the prototype techniques in terms of operational feasibility. Prepare a detailed concept of operations describing the implementation of the

approach in the field and potential challenges in its implementation for both electronic warfare and radar systems.
Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Complete development, perform final testing, and integrate and transition the final solution to Navy airborne platforms. The general techniques might be applicable to gaining insight into web-based applications, which are cognitive in nature.

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KEYWORDS: Cognitive, Sensors, Adaptivity, Countermeasures, Remote Sensing, Radar, Cognitive Sensor System

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N202-122 TITLE: Innovative Multi-Physics-based Tool to Minimize Residual Stress / Distortion in Large Aerospace Aluminum Forging Parts

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials

OBJECTIVE: Develop a tool to optimize the quenching process by understanding and addressing the multi-physics challenges in the inter-relationship among the stress/strain, heat, and phase transformation in order to control residual stress and reduce distortion in large aerospace aluminum forging parts.

DESCRIPTION: Naval Aviation aircraft procurement faces cost and schedule challenges where one of the major contributors is the high scrap rate of large airframe aluminum forging parts. For example, a 22% scrap rate was observed on a NAVAIR low rate initial production (LRIP) Helicopter program in 2017.

The parts were rejected for geometrical non-conformance, due to distortion induced during production stages, but mostly right after the quenching step, or post-quenching. Typical production stages start with rough machining of the forging, followed by quenching, aging, removing braces, chemical milling, semi-finish machining, finish machining, and final inspection.

To reduce the post-quenching distortion, there are two approaches: 1) Do trial-and-error runs, then pick the best one. This approach is cost prohibitive since there are endless combinations of quenching set ups, or 2) Use a prediction tool to run simulations with optimized quenching parameters yielding least distortion.

Currently available tools for reducing post-quenching distortion in large aircraft aluminum forging parts are often a set of Finite Element Analysis (FEA) software with input consist of a) geometry of parts and quench tank, and b) thermal characteristics of parts and quenching medium. Thermal parameters are entered to represent the heat transfer characteristics, but that is not sufficiently accurate, since the mechanical and metallurgical aspects of the parts are changing as well in the process, and need to be concurrently considered. Acceptable accuracy would be when all three input types (i.e., thermal, mechanical, and metallurgical) are entered into the FEA before the simulation process.

To effectively reduce post-quenching distortion in large aircraft aluminum forging parts, an innovative multi-physics-based and machine learning tool must be designed to optimize the quenching process, where the model inputs will cover all three fields: thermal, mechanical, and metallurgical, with a comprehensive understanding and control of residual stresses.

PHASE I: Develop the concept for one or more physics-based options where heat transfer, stress/strain evolution, and phase transformation can be modelled. Demonstrate feasibility of the model design. Perform a proof-of-concept demonstration that assesses the design's Technology Readiness Level (TRL)/Manufacturing Readiness Level (MRL). The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop the physics-based conceptual prototype model, and verify/validate the prototype with coupon/component/full-scale testing. Demonstrate the transition feasibility. Update TRL/MRL assessment.

PHASE III DUAL USE APPLICATIONS: Commercialize and transition the developed tool as an analytical software package. Detail a verification and validation plan, along with a demonstration of application capacity for the selected airframe components of any interested aircraft platform.

Methods and techniques developed can be included for broad use in the aerospace industry in a commercial software package for optimized quenching and to minimize residual stress/distortion in large aerospace aluminum forging parts.

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KEYWORDS: Optimized Quenching, Large Aerospace Aluminum Forging Parts, Computational Modelling, Residual Stress, Phase Transformation, Micro Structures

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N202-123 TITLE: Generation of Hydrogen from Seawater, Powered by Solar PV, Leading to Cogeneration of Electricity and Potable Water

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Chem Bio Defense, Materials

OBJECTIVE: Develop a shore-based system with durable components that can be used to generate hydrogen from seawater using variable solar photovoltaic (PV) power with the purpose of producing usable electricity and potable water. (Note: The system design should take into consideration lifecycle cost effectiveness and minimizing potential contaminants from the component material into the generation of water.)

DESCRIPTION: In order for renewable energy to provide greater resilience benefits to the Navy, Marine Corps, and throughout the U.S., its variable power output must be coupled with energy storage. Development in this area focuses on electric power and ignores potable water requirements, which are arguably a bigger limiter for continuation of mission operations when the utility supply is unavailable. Energy storage involving hydrogen often produces water as a byproduct of its power generation process. Hydrogen generated from seawater has yet to be commercially viable due to the high cost of materials, short product life of components, and low efficiency of the seawater-to-hydrogen evolution process. Studies and developments over the past 5-10 years have shown different yet effective ways of generating hydrogen that is compatible with seawater and address some of the major corrosion challenges [Refs 1, 2, 3]. Combining the two hydrogen-related processes into one system and utilizing variable renewable power can provide a greater resilience benefit for both island and coastal military installations, even for those that already have on-site power and water generation capabilities. Overcoming past and current issues with hydrogen generation, including corrosion, chlorine, and expensive materials, will improve lifecycle cost effectiveness. Designing the system to be used to generate potable water will affect its design as to reduce or eliminate potential water contamination.

PHASE I: Develop and demonstrate the subsystems capable of using real or simulated variable PV power and determine at least one source of real seawater from which to generate hydrogen and convert hydrogen into electricity and water. Evaluate attributes of the system, including energy density, power density, transient dynamics, system size and efficiency, water production rate and quality, component product life, and anticipated maintenance requirements using detailed models and subscale components. The U.S. Environmental Protection Agency (EPA) safe drinking water requirements for States and Public Water Systems shall be a starting point for establishing thresholds for defining potable water and target potable water production to at least 6 L/kW [Ref 4]. Finalize the systems integration and design for a 10kW-level test-bed prototype to be used for Phase II. Provide a Phase II development approach and schedule that contains discrete milestones for testing and further development.

PHASE II: Fabricate a test-bed 10 kW-level prototype. Validate prototype capabilities using laboratory testing and at least two sources of seawater with known major differences that can potentially affect the function and output of the system. Further evaluate attributes of the system from Phase I. Design a fully functional 10kW system that can be fabricated and tested in a non-laboratory environment. As funding permits, work toward fabrication of a fully functional system.

PHASE III DUAL USE APPLICATIONS: Fabricate and test a fully functional system in a real-world environment. Acquire certifications necessary to comply with connecting to a shore-based, utility grid system. Develop documentation, such as a DD-1391 and eROI (Energy Return on Investment), for sites with high potential for this application to enable the installation to request funding for construction. While this system will benefit island and coastal military installations, it can also find applications in municipalities and community microgrid systems especially where water and power are unreliable or require an alternate source. In addition, it can support a hydrogen economy or be applied to hydrogen powered vehicles.

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KEYWORDS: Seawater, Hydrogen, Fuel Cell, Solar Photovoltaic, Potable Water

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N202-124 TITLE: Thermal and Magnetic Packaging for Large Superconducting Systems

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Information Systems, Sensors, Electronics

OBJECTIVE: Invent and experimentally validate one or more schemes for packaging of Multi-Chip Modules (MCM) that simultaneously satisfies the system needs for volume conservation and for the thermal and magnetic field conditions that allow proper operation of complex superconducting MCM. The approach developed must be inherently notionally scalable to 1,000's of such MCM modules/"cards" in Phase III, although the work proposed here should start with a proof that a single MCM can be operated as well as a single chip. The packaging design may assume either or both electrically and photonically realized Input/Output cabling between MCM cards and across temperature gradient, but IO work is not included in this topic.

DESCRIPTION: Direct from RF superconducting Radio Frequency (RF) receivers already offer high sensitivity, extreme bandwidth, and outstanding time domain resolution all present in 1 digital data stream. Hence, they are candidates for such ultra-wideband applications as full spectrum situational awareness and cognitively adapting Low Probability of Detection (LPD) communications. However, numerous military applications such as full-spectrum active arrays (ideal for Electronic Support Measures (ESM) and Signal Intelligence (SIGINT)) require more digitizers than offered by today's limit of 3 Analog to Digital Converters on a single chip. Even larger scaling is required for the exascale computing applications (needed by future commercial data centers, a dual use). Such scaling of the system complexity will likely progress first to circuit board-like MCM and then to card case-like subassemblies. For systems with so many die to be successful, the proper magnetic and thermal environment must be simultaneously provided to each individual die, as well as including ways to plumb in power lines and data cables without causing stray magnetic fields or difficulties in servicing the final assembly.

Conductive cooling via thermal busses is a well-demonstrated technique in spacecraft design, but demonstrations of its successful use for multiple MCM constructed of 4K niobium circuits are missing. Proper electrical functionality requires no larger than 100mK variation in the effective electronic temperature across the multi-MCM assembly at a mean temperature of around 4.5K or colder.

Any total local magnetic field present at the functional superconducting switching elements is also potentially deleterious to its proper operation, but practically an upper limit of about 4 micro-Tesla may be sufficient to guarantee proper operation. Locally produced fields associated with magnetic flux trapped in moats, screening currents, circuit bias currents, and power distribution add to the more homogeneous ambient sources such as the earth's magnetic field. So far low frequency magnetic shielding only from the uniform fields have been seriously addressed and there has been little published about oscillating (AC, e.g., clock) field reduction.

Proposers should in their Phase I proposal clarify what operational functionality their MCMs will exhibit, define a notional program work time line through the end of the base of Phase II, and identify what if any Government assistance with active Nb JJ circuit die and passive MCM design/fabrication and MCM assembly their plans require as Government Furnished Property (GFP). Of the order of 2 active and 2 passive designs sites per Phase may be assumed as acceptable GFP. The SFQ5ee and MCM processes at MIT Lincoln Laboratory are the assumed sources of any new GFP materials. Active die from previous US Government programs may be supplied by the prime or possible subcontractors if the original sponsor approves. Such GFP assistance, if any, would be negotiated following Phase I selection and again following Phase II selection. In addition, how the success of the homogeneous temperature/magnetic field suppression will be experimentally documented should be described in the original Phase I proposal.

PHASE I: Base: Generate the final designs for an individual functional 20x20 mm (or larger) MCM based on either identical or distinct active Nb JJ chips (GFP), vendor-supplied supplementary chips/structures, and passive Si carriers. Either flip the vendor-supplied parts onto the carrier or wire bond them in place. Complete a desired risk reduction test of the packaging concept before the Initial Phase II Proposal is written at the end of the base effort. Perform Thermal/ B (magnetic) field modeling via numerical simulation that may be helpful, but is not required nor sufficient in the absence of experimental validation.

Option: Complete realization of the first functional prototype and begin to iterate the most problematic aspect of the realized packaging design.

PHASE II: Base: Complete a proof-of-concept demonstration. Prove the thermal and magnetic field limits can be met in a packaged single MCM assembly without any need to substantially complicate the wiring of input signal, output data, and power to/from the outside world.

Option: Refine the techniques developed and specialize the choice of chips included in the final demonstration to focus on the class of functionality desired by the transition funding sponsor. Conclude at TRL 4 or higher.

PHASE III DUAL USE APPLICATIONS: Transition the packaging techniques to a Government program and participate in further demonstrations using fully functional chips such as a proven computation accelerator for a multiple Teraflop CPU at a commercial data center or some specifically RF receiver functionality, such as correlation functions, digital beam forming, de-interleaving, or other Digital Signal Processing (DSP) operation.

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KEYWORDS: Thermal Conductivity, Thermal Boundary Resistance, Passive Magnetic Shielding, Active Magnetic Shielding, Magnetic Flux, Superconducting Flux Trapping

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N202-125 TITLE: Broadband Photoconductive Terahertz Focal Plane Arrays

RT&L FOCUS AREA(S): Network Command, Control and Communications
TECHNOLOGY AREA(S): Chem Bio Defense, Sensors, Electronics

OBJECTIVE: Develop photoconductive terahertz focal plane arrays that offer large pixel count, high dynamic range, and high speed over a broad terahertz (THz) frequency range.

DESCRIPTION: Electromagnetic waves in the THz spectral band (roughly covering the 0.1 - 3 THz frequency range) offer unique properties for chemical identification, non-destructive imaging, and remote sensing. However, existing THz devices, such as THz sources and detectors, have not yet provided all of the functionalities required to fulfill many of these applications. Although Complementary metal–oxide–semiconductor (CMOS) technologies have been offering robust solutions below 1 THz, the high-frequency portion of the THz band still lacks mature devices. For example, most of the THz imaging and spectroscopy systems utilize single-pixel detectors, which results in a severe trade-off between the measurement time and field-of-view.

To address this problem, a large pixel count, high dynamic range, high speed, and broadband THz focal plane array (THz-FPA) needs to be developed. The proposed THz-FPA can operate either as a frequency-tunable continuous-wave detector or a broadband-pulsed detector. It should be able to operate over a 1 - 3 THz frequency range, while offering above 30 dB dynamic range per pixel. It should have more than 1 kilo pixels and a frame rate of at least 1 Hz. Smart readout integrated circuits to increase the data collection efficiency and frame-rate can be investigated.

PHASE I: Demonstrate a proof-of-concept THz-FPA with at least 16 pixels. Show that each pixel of the THz-FPA meets the dynamic range and bandwidth requirements. Introduce a data readout method that can maintain the large dynamic range and broad bandwidth requirements for more than 1 kilo pixels and a frame rate of at least 1 Hz. Develop a Phase II plan that includes technology integration, test and validation with representative structures.

PHASE II: Realize the THz-FPA consisting of at least 1 kilo pixels integrated with the read-out circuits. Demonstrate the functionality of the final prototype to take THz images with more than a 30 dB dynamic range over a 1-3 THz bandwidth in less than 1 second. The prototype system will vary based on the proposed approach, but it may include hardware and software. Develop technology transition plan and business case assessment.

PHASE III DUAL USE APPLICATIONS: Broadband THz Imaging focal plane arrays enable sensors for detailed feature and frequency spectrum capture that support several DoD missions, among these are battlespace target assessment, surveillance in low-visibility conditions, and nondestructive material quality control (e.g., defects/corrosion in ship, aircraft, vehicle components), and law enforcement agencies for detection of illicit drugs and narcotics, and regulatory agencies (e.g., FDA, NIFA) for detection of toxins in drug, food, and agricultural products.

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KEYWORDS: Broadband Terahertz, Imaging, Focal Plane Array

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N202-126 TITLE: Scenario Development and Enhancement for Military Exercises

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning
TECHNOLOGY AREA(S): Information Systems, Human Systems

OBJECTIVE: Develop a user-friendly capability to create background information and long-form exercise injects derived from seeds, drawing from a catalogue of already extant background material for content.

DESCRIPTION: Information environments in situations of conflict and warfare are hectic, chaotic, and hard to predict. Military exercises and training capabilities currently lack realistic material to help them to develop Tactics, Techniques, and Procedures (TTPs) and blunt information attacks; and compete effectively in conflict situations. Warfighters require realistic training capabilities and the capability to develop, test and validate TTPs for information maneuver; this requires realistic, rapidly generated content to facilitate scenario development, enhancement and maintenance during an exercise or training experience.

Simulation of the information environment is a difficult problem. Simulating Facebook posts, blogs, and other long-form inputs (200 to 800 words) is labor-intensive and difficult to scale. Artificial intelligence breakthroughs have created new capabilities to generate realistic content that would be suitable to support an information environment simulation.

The GPT-2 model [Ref 1] and potentially other artificial intelligence solutions [Ref 2] provide useful starting points for realistic text simulation. This new language model and potentially other unsupervised multitask learners [Ref 3] have been demonstrated to perform downstream tasks in a "zero-shot" setting without any parameter or architecture modification.

The desired capability is the capacity to generate realistic information inputs for simulated training and exercise environments. The capability should be able to generate text to fit in multiple formats (Facebook, blog, other social media) - posts of 1-2 paragraphs, and long posts of 800 words (in English). The desired capability will have the ability to develop scenario materials for a refugee crisis, disaster scenario or a similar complex event; to edit and perform quality checks; to change and shift narratives; to add new events; and to catalog and index materials.

PHASE I: Define and develop an initial capability for generating 50 to 200 word (approximate) synthetically generated texts with a user interface to allow for review, editing, tagging, and flagging of the produced material for initial assessment. Produced texts should be packaged to enable the flow of the materials into databases for input into a synthetic environment reservoir for test and evaluation. Develop a Phase II plan. Phase I Option, if exercised, will expand materials to develop a catalogue of synthetic background data, improve the user interface, and institute a tagging, flagging, and automatic or semi-automatic indexing function.

PHASE II: Develop a data editor and visualization capability to assist White Cell scenario authors to create narratives, inject new discourses and gists, and review the gists, discourse material and narratives in the reservoir. Improve the fidelity and capability of the Phase I product to generate texts from background materials, created by scenario authors, that are sufficiently realistic and on topic to meet a minimum of realistic level of volume and velocity (10K tweets an hour, 100 longer (up to 800 word) posts per hour).

PHASE III DUAL USE APPLICATIONS: Develop the capability to attach discourses to personas and adjust texts to conform to target narratives and discourses, so that scenario creators can develop realistic stories for military exercises and training. Demonstrate the capability of flowing synthetic texts into simulation technologies and tools so that they can be used in an information conflict war game scenario, inject new material, and provide a realistic volume and velocity of data for a training exercise (50K tweets/hour, 1000 posts/hour). Investigate the feasibility of the capability to synthetize texts in other languages, to answer questions, and to perform translations.

Marketing and brand name companies also require new capabilities to train staff in information conflict to support their brands when dealing with trolling, meme conflicts, and other social cyber-attacks in the information environment. Non-profits such as the Red Cross and other Western aid agencies have problems similar to the U.S. Government in defending their message against foreign attackers, seeking to diminish their reputations among target audiences.

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KEYWORDS: National Language Processing, Artificial Intelligence, Information Operations, Military Exercises, Training

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N202-127 TITLE: Electrical Energy Sensing Device for EOD Detection, Location and Diagnosis of Electronic Safe & Armed Fuzes

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Sensors, Battlespace, Weapons

OBJECTIVE: Develop an electrical energy-sensing device for Explosive Ordnance Disposal (EOD) detection, location and diagnosis of Electronic Safe and Armed Fuzes (ESAF). The sensing device must be non-invasive and should interrogate the hazard from the furthest distance at which the solution can reliably function. It should be in a hand-held form factor that is below 15 pounds, including the power supply.

DESCRIPTION: Modern munitions are making increased use of ESAF which do not provide any external indications of their status (armed or not, energized or not, working or not, etc.). [Ref 1] These essentially unknown conditions pose increased risk to United States Explosive Ordnance Disposal (US EOD) technicians working on such items.

US EOD Forces have the need to non-invasively interrogate and diagnose the status of electronic components within fuzes from Unexploded Ordnance (UXO). Electronic fuzing can consist of electronic circuits, batteries, or charged capacitors within a metal fuze that initiate the firing train of the munition. In UXO situations, the ordnance fuze may not have functioned as designed, but still contains charged capacitors or a charged battery that can still function the munition, posing a threat to EOD technicians responsible for clearing the hazard.

US EOD Forces require the ability to determine the presence of a charged or depleted battery, firing capacitor, or active circuit within an electronic fuze. The fuze may be of an unknown type, with no previous knowledge of the internal fuze design or layout. The fuze body (ogive and housing) may be metallic or plastic. In addition, depending on design, electronic safe and armed fuzes fire in response to a variety of modalities, including but not limited to: radar, thermal, infrared (IR), acoustic or vibration effects. As such, US EOD Forces would interrogate the hazard from the furthest distance at which the solution can reliably function. The fuze cannot be touched or otherwise accessed. The following are essential characteristics:

Range: To minimize the exposure to a potential hazard, the EOD technician must be able to work without contacting the UXO. If the EOD technician must be close to the ordnance item in order to function successfully, then to the greatest extent possible, the sensor should not trigger a target's area denial, anti-tamper, or self-destruct features. Maximum standoff from the UXO for a reliable detection, location, and diagnosis is preferred.

Accuracy: Determination of the presence of stored or active electrical energy. The EOD technician must be able to make a charged or depleted determination and be confident that the information is correct. Determination of the magnitude of said energy is highly desirable. The device should provide the diagnostic capability for fuze status such as armed or not, energized or not, working or not, etc.

Size, Weight, and Power (SWaP): US EOD field units have limited capability to transport equipment; therefore, size and weight should be minimized. The device should have a form factor that is handheld, and weigh less than 15 pounds, including the power supply.

Environmental: The current need for the device is for surface munition applications with an expected operating temperature range of 0 to 125 °F.

PHASE I: Demonstrate the feasibility of the concept in meeting Navy needs for an Electrical Energy Sensing Device for EOD detection, location, and diagnosis of ESAF. Establish that the concept can be feasibly developed into a useful product for the Navy. Prepare a Phase II plan.

PHASE II: Develop a Phase II prototype for evaluation. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II Statement of Work (SoW) and the Navy need for Electrical Energy Sensing, in this case via a device that will enable US EOD technicians to detect, locate, and diagnose an Electronic Safe and Armed Device. Demonstrate the device capabilities on a variety of configurations including, but not limited to:

1) Known configurations: M762A1, M767A1, or M782 fuze for artillery rounds, the M7 spider anti-personnel munitions system, fuzes with area denial or anti-tamper features or self-destruct features [Ref 2],
2) Unknown configurations with a variety of battery sizes and unique circuitry (IED surrogates).

Deliver a minimum of five prototypes to the Navy for evaluation.

PHASE III DUAL USE APPLICATIONS: Apply the knowledge gained in Phase II to build an advanced Electrical Energy Sensing Device suitably packaged with a power source and portable configuration. Statistically characterize the device performance to determine confidence and reliability across a selection on known and unknown ESAF configurations. Meet the desired Objective values of 80% confidence and 85% reliability. Collaborating with EOD technical and military staff, support test and validation to certify and qualify the system for US EOD use. Explore the potential to transfer the device to other military and commercial applications. Use market research and analysis to identify the most promising technology areas. Develop manufacturing plans to facilitate a smooth transition to the US EOD.as well as other industries such as construction or manufacturing technology.

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KEYWORDS: Electrical-Energy-Sensor, Fuze, US EOD, Detect, Locate, Diagnose

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N202-128 TITLE: Innovative Approaches in Design and Fabrication of 3D Braided Ceramic Matrix Composites (CMC) Fasteners

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials

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 section 3.5 of 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 technologies to design and fabricate 3D CMC fasteners for mechanically attaching CMC Propulsion and/or Structural components to metals.

DESCRIPTION: Ceramic Matrix Composites (CMCs) are attractive for propulsion applications due to their potential for higher temperature capability, weight reduction, and durability improvements. However, CMCs present design challenges due to their anisotropic properties, generally low interlaminar shear strength, low bearing strength, limited strain tolerance, and their reaction with alloy components at CMC/alloy interfaces [Ref 1]. Currently the prevalent mode of joining CMC to metals is to use metallic fasteners. Since the CMC component has lower Coefficient of Thermal Expansion (CTE), and bearing strength, it is desirable to use CMC fasteners for the attachments.

The current baseline for a CMC fastener is the Miller fastener [Ref 2], which is a 2D, laminated CMC design with a rectangular cross-section. It is susceptible to stress concentrations at the corners and failure due to delamination. As such, it has not found wide acceptance in the industry. In this topic a 3D braided solution is sought which can be fabricated to near net-shape. This will eliminate delamination as a potential failure mode and reduce scrap during production.

Proposers to this topic have to address two areas in their response. The first is to make a textile preform without over braiding over an insert as is typically done for non-uniform cross-section. Use of inserts is not desirable even if it is removed prior to consolidation as it may result in unacceptable porosity in the fastener during Pyrolysis and Infiltration Process (PIP) to consolidate the fastener.

The second area that proposers must address is the interfacial coating of the 3D fastener preform. Typical fiber coating for SiC/SiC CMC is a two layer BN/$Si_3N_4$, it is usually applied through Chemical Vapor Deposition (CVD) or Atomic Layer Deposition (ALD). The coating protects the CMC fibers during high temperature CMC consolidation. Applying it to a 3D preform could pose a challenge due to the tortuous path the gases have to take through the preform and there is a risk some portions of the preform may not be coated. It is important that the proposers articulate their approach.

Successful completion of the program will result in an enabling technology to join CMC components to metals. This technology is targeted for future platforms but can provide retrofit solutions for existing platforms.

PHASE I: Develop an innovative attachment concept for a realistic propulsion component that would benefit from a CMC application, but where a joining approach to an alloy is required as a critical enabler.

Determine feasibility through analysis, fabrication, and testing of sub-element samples under thermal and mechanical environments.

To evaluate the proposed technologies, the successful Phase I companies will fabricate SiC/SiC CMC fasteners that are 2 in. long, 0.375 in. diameter with a 45 degree countersink angle at the head. To prove feasibility the performers will provide: (1) Braid architecture design and estimate of the mechanical strengths, (2) evidence of successful coating through appropriate testing using SEM and/or FTIR, (3) evidence of matrix infiltration through porosity measurements, and (4) mechanical, wear, and recession data for fastener strengths under tension and shear which will be compared against their initial predictions. Finally, since CMC fasteners are not typically threaded, the performer will demonstrate using a flat CMC panel and metal plate the attachment scheme for securing the CMC panel to metal plate.

PHASE II: Design, fabricate, and test prototype samples to a specific component to thoroughly validate the capability of the approach. Test an engine component employing the joining methodology in a representative rig or engine environment to validate the approach.

PHASE III DUAL USE APPLICATIONS: Optimize the attachment/restraint methodology. Productionize and qualify the improved component.

The commercial airline industry, military aircraft, aerospace industry, and high-performance automobile industry seek CMC joining as a critical enabler for reducing weight and increasing efficiencies.

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KEYWORDS: Ceramic Matrix Composite (CMC), Joining, Fastening, Attachments, 3D preforming

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N202-129 TITLE: Nosetip Ablation Sensor and Telemetry Interface Unit for Hypersonic Vehicle Thermal Protection Systems

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Materials, Sensors, Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an ablation rate sensor array and telemetry interface unit for fielding on Navy experimental hypersonic flight vehicles equipped with Extended Navy Test Bed (ENTB), or similar, telemetry units.

DESCRIPTION: The Navy performs many Submarine Launched Ballistic Missile (SLBM) flight tests. Some of these Navy SLBM test vehicles fly with an ENTB telemetry unit. The ENTB takes sensor outputs from on-board devices and transmits them to a ground station. The opportunity presented by this topic is to develop an ablation rate sensor technology for carbon/carbon nosetips, to package the sensor technology suitable for the Navy nosetip application, and to provide an electronic interface unit so as to pass the ablation rate data to an on-board telemetry unit such as an ENTB.

The ablation sensor array and interface unit electronics must be compatible with all Navy SLBM flight test requirements (size, weight, mass props, environment, shock/vibe, radiation, etc.). These requirements, as well as information for integration with the ENTB and any information necessary to demonstrate proof-of-concept, will be provided by the Navy to Phase I awardees at the time of award.

A non-intrusive ablation rate sensor technology is preferred over intrusive methods and should be able to resolve length changes to less than 0.01” (target) and 0.025” (threshold). As a non-intrusive method, ultrasonics have shown the ability to detect defects in carbon/carbon composites [Ref 4] and may be suitable for detecting length changes by use of front-face reflection. In the past an ultrasonic method has been used to measure length change of Tungsten nosetips due resonant frequency changes, as well as a bremstahlung radioactive gauge technique [Ref 5]. There has also been some recent work on a focused ultrasonic technique to measure surface loss [Ref 6]. However, proposals based on other non-intrusive methods are welcome.

Intrusive methods could include embedded wires or fiber optics such as cited in [Ref 7], but proposal of an intrusive method must demonstrate applicability to a 3D carbon/carbon composite via a pre or post manufacturing technique. Pre-manufacture must demonstrate survivability through the carbon/carbon manufacturing process. Post manufacture must demonstrate no impact on component performance or survivability.

The back face of ablating components, where it is assumed sensors will be located, will experience some short-term elevated temperature conditions. Sensors must have some degree of elevated temperature survivability.

Bulk graphite and mechanical ablation are acceptable as a means of demonstrating sensor technology during Phase I. The Navy has a limited amount of non-tactical carbon/carbon material that may be provided to the successful Phase II proposer(s). Suppliers proposing intrusive, pre-manufacture methods should provide their own materials and must demonstrate survivability through the extreme elevated temperature and highly reactive carbon/carbon process environment.

PHASE I: Identify ablation sensor technology and demonstrate bread-board ability to resolve length change on representative material within 0.025 (threshold) and 0.01” (target). Develop architectures and schematics for the interface unit of a sensor array to the ENTB. Prepare a Phase II plan.

PHASE II: Based on requirements provided by the Navy, develop a prototype unit suitable for proof of concept demonstration under Navy-funded extreme ground test environment (arc jet test for ablation rate) with Navy-supplied carbon/carbon ablative test materials. Ensure that the electronic devices used on prototype unit are suitable for the Navy flight test environment.

PHASE III DUAL USE APPLICATIONS: Develop and produce flight test units for fielding on Navy experimental flight tests. This ablation sensing technology will be applicable on reusable commercial rocket components such as carbon/carbon throats and/or nozzles.

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KEYWORDS: Carbon/carbon, Thermal Protection System, Ultrasonic Sensors, Ablation Rate, Hypersonic, Reentry

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N202-130 TITLE: Cold-water Diving Wetsuit

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials, Bio Medical

OBJECTIVE: Develop and demonstrate an insulated wetsuit for cold-water (35 °F) diving, capable of maintaining 75% of its surface insulation rating to 100 foot depth. Surface insulation rating equivalent to 2 air gaps is sought using new approaches, possibly sealed multiple layers and minimized flushing of ambient water in the wetsuit.

DESCRIPTION: Most Special Operations Forces (SOF) diver training and operations is still done in wetsuits. For cold-water operations, and with basically all wetsuits being neoprene, hypothermia is a serious risk. Neoprene wetsuits provide very limited time at the surface and provide roughly 1/4 the insulation at 100 feet depth. A new wetsuit construction is desired, one that has R ratings in the single digits, comparable to a double air-gap of roughly R3-5. An innovative multi-layer approach (e.g., drop-stitch, additive manufacturing, multiple coveralls, outer fur) is sought that maintains a smaller gap or has stop-gap materials, which minimize thermal bridging, such that the R-value at 100-foot depth is 75% of the value at the surface. Innovative solutions to minimize flushing inside the wetsuit with cold ambient water will be most important. Mobility, and don and doff times should be comparable or better to those of current wetsuits. Solutions should not focus on gases composition within the gap, other than air, for ease of usage, maintenance, and repair.

PHASE I: Define and develop a design for a cold-water (35 °F) wetsuit and analyze and specify the anticipated insulation value (R-value), where it arises from and how it improves on current COTS wetsuits. Prepare designs that are sufficiently detailed to specify all materials needed, their availability, how they will be implemented, and the overall wetsuit thickness. Specify how the design reduces flushing of external/ambient water through the wetsuit. The wetsuit material, its seams (both intergarment and at wrists, neck and feet),and any closing mechanisms must stand up to typical special operations underwater diver activities and approximately 100 dives. The design created in Phase I should lead to plans to build a prototype unit in Phase II.

PHASE II: Develop, fabricate, lab-test (R-value and chiller-tank performance), and provide two suits for form, fit, and function evaluation by operational Navy divers in cold-water maritime environments. Within the period of performance, revise the design and refabricate an additional 10 units based on feedback.

PHASE III DUAL USE APPLICATIONS: Assist the Navy in transitioning the technology to operational use by Naval Special Warfare, support the Navy for test, validation, and qualification of the system for use by Navy divers, and develop commercial variants suitable for recreational divers and use in the gas-oil industry or research community. Create a marketing plan for reaching recreational users and mass production, to bring the per unit cost down to under five hundred dollars.

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KEYWORDS: Diving, Wetsuit, Cold-water, Hypothermia, Insulation, Heat Loss

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N202-131 TITLE: Intelligent Laser System for CBM+ of Naval Platforms

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Air Platform, Ground Sea, Materials

OBJECTIVE: Develop an intelligent laser-based system for powering, sensing, and communicating between a centralized health management unit and all the different nodes, sensors, and actuators of a platform-wide distributed fiber optic network for Condition Based Maintenance Plus (CBM+) of Naval platforms.

DESCRIPTION: For predictive maintenance of Naval platforms (ships, aircraft, submarines, UXVs), the primary degradation modes (fatigue, micro-cracking, vibration, impact damage, delaminations, heat damage, etc.) of systems aboard platforms (Hull, Structural, Mechanical, Electrical, Propulsion, Drive, etc.) need to be detected, classified and monitored as early as possible within their life cycle (incubation, nucleation, coalescence, propagation, steady growth, unstable growth) to help plan appropriate maintenance action in a safe and cost-effective manner. To accomplish this in a reliable manner, these systems need to be monitored continuously during operations and/or while at rest to the finest resolution possible (from micro to macro scales). Until now such a feat would require a large number of electrical-based sensors of different types (thermocouples, strain gauges, accelerometers, acoustic emission sensors, ultrasonic transducers, etc.) - each one with its own power and shielded cables, signal conditioning boxes in close proximity, data loggers, and signal processors. A system of this type is not practical, with too many parts, too many cables, with requirements for electromagnetic (EMI) shielding, adding significant weight to the platform, and possible requiring more maintenance (sensor recalibration, re-soldering, prone to corrosion) than avoiding it.

Fiber optic technology offers the possibility of performing all those monitoring activities simultaneously with a single optical fiber in a distributed fashion without corrosion or EMI issues and in a safe and cost-effective manner. For this purpose, different types of Bragg grating (BG)-like sensors would be engraved in a single fiber and interrogated from one end with a multi-laser-based interrogation unit. Cost-competitive approaches already exist in the market and new ones are being developed that can monitor temperature and strain at frequencies of up a 100 Hz or impact events and vibration in the 100 Hz to 10 kHz range with BG grating sensors engraved in a single optical fiber of up to a kilometer and interrogated continuously with a single or multiple laser based system. The challenge is expanding the range of applicability to reliably detect small amplitude, high frequency (10kHz - 1MHz) acoustic emission events from growing cracks, spoliation, fretting from faying surfaces or other damaging mechanisms at many points in the same fiber in a cost-effective manner. A possible solution would be to engrave a large number (around 100 or as many as technically feasible) of very sensitive sensors in an optical fiber with very narrow spectral features (less than 10 picometer spectral width) such as BG Fabry-Perot, pi-BG, or other BG-like sensors. These sensors could then be interrogated with a small number (between 4 - 8 or the fewest possible consistent with reliability of detection) of low noise, high sensitivity (able to achieve a strain sensitivity of 100 femto-strain/sqrt(Hz) or better in the frequency range from 10 kHz – 1 MHz), tunable lasers (over an entire band or more) managed by an intelligent system (machine learning, neural network or neuromorphic processor) that is informed by all the sensors (low, mid and high frequency) in the network and that can position the tunable lasers dynamically on sensors near hot spots as they develop on the system being monitored. Neither the intelligent neural processor nor cost-effective (around $1,000/laser module or less), small footprint (4 sq. inches), low noise, high sensitivity, tunable lasers exist today. Most multichannel telecommunication lasers have poor frequency noise performance in the region of interest (10kHz - 1 MHz). Also, these lasers are only available in the C-band and L-band for long distance communications (100s of kilometers) but for CBM+ applications one typically only monitors distances of less than a few 100 meters where other bands could be used.

This topic seeks innovative approaches to develop and commercialize a cost-effective, intelligent, multi-laser based system for CBM applications. The intelligent laser based fiber optic (FO) CBM system will have high strain sensitivity to detect low amplitude, high frequency and short duration ultrasonic bursts of energy generated by growing cracks or other sources. The system should operate in one of the standard communication bands and monitor close to one hundred sensors in a long optical fiber. When designing a system, the team should be aware that the background temperature around the sensors can vary by 10's of degrees Fahrenheit in a few minutes thereby requiring feedback control to compensate for thermal drifts. Since the number of hot spots will increase over the operational life of the component/vehicle, it is desirable that the system is designed so that it can easily expand to incorporate and manage more intelligent lasers. Ultimately (not in this SBIR topic), the intelligent system should be able to learn and reconfigure itself not just based on the data from all the sensors in the fiber optic network, but also from the other sources of information such as platform operations, environmental conditions, maintenance actions, structural drawings, system changes and others.

PHASE I: Define and develop a concept for a cost-effective, intelligent, multi-laser based system operating in one of the standard communication bands for monitoring close to one hundred (or as many as technical feasible) fiber optic sensors in a single long optical fiber. These sensors will have high strain sensitivity to detect low amplitude, high frequency, low duration, ultrasonic bursts of energy generated by growing defects. For validation purposes, and to help with the down selection for the Phase II effort, the team will conduct a laboratory demonstration of a bench top system. (Note: Due to the cost restrictions of a Phase I effort, the laser system will have a minimum of one benchtop, narrow band, high sensitivity (able to achieve a strain sensitivity of 100 femto-strain/sqrt(Hz) or better in the frequency range between 100 kHz-1MHz), tunable (over an entire band), low-cost laser. The intelligent aspects of the system will also be kept to a minimum during the Phase I to maximize resources for the laser development.) Ensure that a minimum of three fiber optic sensors (more if the budget allows) are engraved in a long optical fiber (with the sensors effectively spatially and spectrally spaced to demonstrate performance). Prove that the three sensors can detect acoustic emissions (AE) events when coupled to a 3' x 3' x 1/8" square aluminum plate (more plates and sensors are desirable if the budget allows). Use pencil lead break tests (ASTM E976010 Standard) to simulate acoustic emissions from growing cracks. If the budget allows, perform multiple tests that demonstrate the intelligence of the system such as by showing how it can classify different sources of AE signals in real-time or by showing how it can preposition the laser or lasers among the sensors based on knowledge gained from previous measurements. The system that demonstrates the best performance and the capability to cost effectively expand further will be selected for Phase II.

PHASE II: Produce an integrated, ruggedized, cost-effective, intelligent, multi-laser based system prototype operating in one of the standard communication bands for monitoring close to one hundred (or as many as technically feasible) fiber optic sensors along a single long fiber to detect low amplitude, high frequency, low duration, ultrasonic burst of energy generated by growing defects. The final prototype will include a minimum of 8 tunable lasers. For validation purposes, a long optical fiber with a minimum of 24 fiber optic AE sensors will be attached to the perimeters of a minimum of three 3' x 3' x 1/8" square aluminum plates (more plates and sensors are desirable if the budget allows). If the budget allows it is desirable that other fiber optic sensors are engraved in the same optical fiber that simultaneously monitor parameter such for temperature, strain, vibration or others. The team will perform multiple experiments to demonstrate the sensitivity, adaptability and intelligent characteristics of the system.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology for fleet use through test and validation to qualify and certify the system. Further refine the prototype for production and determine its effectiveness in an operationally relevant environment. A system of this nature could have a large number of commercial applications such as for structural health monitoring of civil aviation aircraft, oil tankers, bridges, and oil and gas pipelines for both integrity and security-related needs.

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KEYWORDS: Condition Based Management Plus, Continuous Based Monitoring, Artificial Intelligence, Neuromorphic Processing, Structural Health Monitoring, Optical Fibers, Bragg Gratings, Acoustic Emission, Ultrasound Generation, Sensors and Actuators, Crack Detection

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N202-132 TITLE: Novel Methods to Mitigate Heat Exchanger Fouling

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Ground Sea

OBJECTIVE: Develop fouling mitigation techniques to prolong performance of seawater heat exchangers.

DESCRIPTION: Seawater heat exchangers are plagued by fouling, such as particulate and biological film formation, during operation. Fouling of heat exchangers is a serious and long-standing problem that can result in decreased heat transfer efficiency, higher resistance to fluid flow, increased energy consumption, decreased heat exchanger lifetime, and increased downtime necessary to replace or clean fouled parts. Biological fouling is the accumulation of microorganism, plants, algae or animals on the interior of the tube and is the type of fouling most experienced. Turf-like algae growths are increasingly found when operating in warm seawater environments. The Navy currently uses a combination of periodic chlorination and periodic seawater flush to mitigate fouling in titanium seawater heat exchangers. Seawater flushing at velocities of 3 m/s is sufficient to remove most particulates. However, electrolytic chlorinator systems used to remove biological fouling are expensive, difficult to maintain, and ineffective in warm water.

This topic seeks new passive or active environmental-friendly fouling mitigation techniques that would prolong heat exchanger performance and availability. Potential solutions include, but are not limited to, active controls that could periodically scrub small groups of tubes using high flow rates; head re-design to eliminate flow dead zones; and the application of novel coatings on fouling-prone areas within heat exchanger to prevent adhesion of particles or microbes with minimum degradation in heat transfer.

PHASE I: Develop concepts to mitigate biological fouling in seawater heat exchangers. Validate feasibility by modeling and subscale demonstration at seawater temperatures up to 38 °C. Prepare a Phase II plan.

PHASE II: Develop a prototype system capable of eliminating biological fouling in a representative titanium shell and tube heat exchanger sized for a 200 refrigeration ton chiller. Evaluate performance in a relevant seawater environment (warm water port). Validate and expand analytic models (developed in Phase I) that must comply with Navy's Hazardous Material Control and Management program.

PHASE III DUAL USE APPLICATIONS: Develop final design and manufacturing plans using the knowledge gained during Phases I and II in order to support transition of system to Navy platforms. Ensure that the final system meets Navy-unique requirements, e.g., shock, vibration and EMI. Explore dual-use applications in seawater cooled power plants, as well as commercial marine vessels.

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KEYWORDS: Thermal Management, Heat Exchangers, Biofouling, Coatings

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N202-133 TITLE: Multimodal Interaction Technologies to Support Small Unit Leaders

RT&L FOCUS AREA(S): Autonomy
TECHNOLOGY AREA(S): Human Systems

OBJECTIVE: Develop a prototype system that leverages the current state-of-the-art in multimodal input/output (I/O) methodologies to control unmanned systems (UxS) at varying levels (i.e., from issuing broad tasking down to teleoperation) and to monitor status (i.e., see video from cameras, position on a map). This system will enable a graceful transition between Human-computer Interaction (HCI) technologies, including gesture [Ref 1], speech, eyetracking [Ref 2], manual control, teleoperation, and more [Ref 3]. This transition can be initiated by the user or by the system itself detecting environmental or operational circumstances.

DESCRIPTION: A number of unmanned systems are being deployed to the Fleet and Force, including Naval Special Warfare (NSW) operators and U.S. Marine Corps small unit leaders. UxS can provide enhanced command & control (C2) and Intelligence, Surveillance, and Reconnaissance (ISR) capabilities, but there remains an open question on how to effectively control these systems. There are many use cases that demand different control schemes. For example, if remotely surveilling a building, direct teleoperation and monitoring through a tablet may suffice. However, in room clearance operations, the warfighter's hands will be occupied, so a speech interface and monitoring through a HUD is ideal. In yet another scenario, eyetracking or a gestural interface may be required. How to gracefully transition between these interaction modalities is unknown, and human-machine teaming is ripe for the integration of interface technologies to support a variety of operations.

One solution is to draw from the communications domain, which uses the Primary, Alternate, Contingency, and Emergency (PACE) model to allow for failover between communications systems. While human-machine interfaces cannot be ranked like communications protocols (e.g., by available bandwidth), there are advantages and disadvantages to different input (control) methods (teleoperation, eyetracking, speech, gestures, etc.) and output (monitoring) methods (weapon-attached screen, tablet, HUD, etc.). It is critical to understand the operator- and environment-centered circumstances that lend themselves to specific I/O methods working better than others.

This SBIR topic seeks to integrate existing human-machine interface technologies, minimize the amount of extra equipment needed to be carried by the warfighter, and develop a prototype system that allows for graceful transition between I/O methodologies based on a number of factors (user preference, operational circumstances, system recommendation, etc.). The system should be easy to use by the warfighter and provide flexible interaction modalities with UxS(s) as missions and situations rapidly change.

PHASE I: Determine requirements for how warfighters will use companion UxS(s) in missions, focusing on NSW and Marine Corps squad leader use cases. Collect information on various I/O methodologies and determine how they can be integrated into a holistic UxS control and monitoring system. Phase I deliverables will include: (1) use cases for warfighter and UxS teaming, (2) identification of control and monitoring systems for integration, (3) an understanding of the pros and cons of each I/O modality and associated human factors principles for design, and (4) mock-ups or a prototype of the system.

The Phase I Option, if exercised, should also include the processing and submission of all required human subjects use protocols, should these be required. Due to the long review times involved, human subject research is not allowed during Phase I. Phase II plans should include key component technological milestones and plans for at least one operational test and evaluation, to include user testing.

PHASE II: Develop a prototype system based on Phase I effort and conduct a field demonstration between a user and UxS(s). Specifically, the target audience (e.g., NSW operator or Marine Corps squad team leader) will be identified, along with a relevant UxS(s). Technologies identified in Phase I will be integrated with the user's standard equipment. Additional software will be created to manage the various I/O modalities, allowing for smooth user-initiated transition or software-automated transition based on detection of environmental or operator workload circumstances. System design will occur in an iterative fashion, with multiple user group interactions feeding back into development. Phase II deliverables include: (1) a working prototype of the system that a user is able to control and switch between modalities, and (2) a field demonstration of a complete or near-complete system to users and stakeholders with users completing a variety of scenarios, easily switching between input (control) and output (monitoring) methods.

PHASE III DUAL USE APPLICATIONS: Support the customer (NSW or Marine Corps) in transitioning the technology for use. Further develop the software and hardware system for evaluation to determine its effectiveness in the field for NSW or Marine Corps scenarios. As appropriate, focus on broadening capabilities and commercialization plans.

Commercially, there are many explorations of different human-machine interface modalities. Companies are developing augmented reality technologies (e.g., Microsoft and Apple), eyetracking (e.g., Tobii and some Samsung Galaxy phones), speech interfaces (e.g., Amazon, Google, and Apple), and gesture control (e.g., Google Pixel phones, Microsoft Kinect). Development of affordable, scalable, and non-proprietary human-machine interfaces is not a current priority in the private sector. However, as new phones, tablets, smart watches, wireless earbuds, AR glasses, and more come to market, the commercial world will need to develop an integrated control scheme to manage these devices without overwhelming the user. Therefore, technology developed will have broad application to the private sector.

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KEYWORDS: Human-computer Interaction, Eyetracking, Speech Interfaces, Gesture Interfaces, Augmented Reality

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N202-134 TITLE: Radio Frequency Buoyant Cable Antenna Transfer Mechanism

RT&L FOCUS AREA(S): Network Command, Control and Communications, Nuclear
TECHNOLOGY AREA(S): Information Systems, Ground Sea, Materials

OBJECTIVE: Develop a Buoyant Cable Antenna (BCA) handling/transfer mechanism that can provide sufficient pushing and pulling force to cabled antennas at depth while limiting wear and stress to the cable.

DESCRIPTION: The submarine fleet within the U.S. Navy has been successful in a wide range of missions. For many of these missions, success or failure depends on the submarine's ability to be stealthy and remain undetected by opposing forces. While submerged, maintaining stealth when communicating can be done through the use of towed horizontal floating wire RF antennas. However, new antenna and situational awareness sensor designs are not compatible with current floating wire antenna submarine deployment mechanisms. Furthermore, current antenna designs rely on deployment mechanisms designed in the 1960s and 1970s. Technological advancements in material and manufacturing processes since the 1960s create an opportunity to design a newer innovative handler with increased capability. Newer mechanical developments and innovations, such as linear transaction drives, have been proven for use in similar applications on other nations' submarines and may offer improvements over existing push/pull pulley systems.

The goal of this SBIR topic is to produce a BCA transfer mechanism capable of deploying, towing, and retrieving a BCA at speed and depth with minimal wear on the BCA. Minimal wear is considered as 2000 feet of BCA is deployed and retrieved 40 or more times. The size and layout shall be suitable to enable replacement of the existing submarine system. The final product will be a BCA transfer mechanism that is able to provide sufficient pushing and pulling force while limiting cable stress and enabling the use of additional sensors. The effort shall demonstrate the following capabilities:

- Demonstrate the BCA transfer mechanism's capability of deploying, towing and retrieving a BCA with cable diameter between 0.85 to 0.95 inches. A sample cable can be provided by the Government upon contract award.
- Demonstrate the transfer mechanism can deploy and retrieve a BCA at a speed of 0 to 20 feet per minute or faster.
- Demonstrate the transfer mechanism can generate a threshold minimum pulling force of 2000 pound-force (lbf) on the cable.
- Demonstrate the transfer mechanism can generate a threshold minimum pushing force of 150 lbf on the cable.
- Demonstrate the mechanism does not bend the BCA at less than 8.3 inches of bending radius in order to limit mechanical stress and wear on BCA.
- Demonstrate the handling system will fit within the space and arrangement constraints of the legacy system. Approximate available space for system are shown in Table One.

Table One
Transfer Mechanism: Height (in) 33; Width (in) 18; Depth (in) 14; Vol (cu. Ft.) 4.8; Weight (lbs) 400
Cable Stowage Reel: Height (in) 47; Width (in) 42; Depth (in) 38; Vol (cu. Ft.) 43.4; Weight (lbs) 950

- Demonstrate the transfer mechanism's housing can sustain internal water pressures up to 900 psi.
- Demonstrate the transfer mechanism can be primarily driven using existing ships hydraulic system.

PHASE I: Conduct a feasibility study and develop concept designs for a BCA transfer mechanism. Identify BCA handling system design specifications that are critical for meeting functional requirements.

Compare and contrast concept designs with the legacy transfer mechanism. Verify through modeling and simulation that the BCA transfer mechanism will enable the deployment, tow, and retirement of the antenna at a range of operating speeds and depth. Define the process for building the antenna transfer mechanism. Develop prototype plans for Phase II.

PHASE II: Develop or optimize the prototype antenna transfer mechanism identified in Phase I. The final antenna transfer mechanism should meet the functional requirements while staying within the bounds of external requirements such as ship spec requirements, size, etc. Conduct benchtop and land-based tests. Compare simulated results to benchtop and land-based results to demonstrate credibility of the model. Work performed during the Phase II will not be classified, but a DD254 will be required because the performer will need to be able to review classified technical drawings of the current Navy system.

PHASE III DUAL USE APPLICATIONS: Deliver final BCA transfer mechanism to a Navy facility in sufficient quantity for testing with buoyant cable antenna. Support Government laboratory testing and Environmental Qualification Testing.

Commercial uses of this antenna transfer mechanism could include: (1) undersea communications cable deployment/ repair, and (2) undersea oil exploration and related equipment.

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2. Rivera, David and Bansal, R. "Submarine Towed Communication Antennas: Past, Present, and Future." IEEE, August 2002. https://ieeexplore.ieee.org/document/959753.

KEYWORDS: Antenna Deployment, VLF, VHF, Communications, Stealth, Buoyant Cable Antenna, BCA

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N202-135 TITLE: Model Based Systems Engineering for Tactical Data Link Systems

RT&L FOCUS AREA(S): Microelectronics, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Information Systems, Materials, Electronics

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate ability to identify, aggregate, and analyze distinct data types and formats to enhance the decision-making process during the technology assessment and trade-offs, design, development, testing, and qualification phases of tactical data link systems using Model Based Systems Engineering (MBSE).

DESCRIPTION: The goal of this SBIR topic is to develop a Systems Modeling Language (SysML) digital twin system model of the Multi-Functional Information Distribution System (MIDS) Joint Tactical Radio System (JTRS) terminal configurations. The MIDS Program Office (MPO) is interested in significantly improving and expanding its engineering support infrastructure to enable deployment of more efficient, agile, and resilient tactical data links systems models to expedite capability to the fleet. The MPO intends to implement a Model-Based System Engineering approach for all engineering activities that uses models as an integral part of the technical baseline including requirements generation and validation, analysis, technology trade-offs, design, implementation, and verification of a capability, system, product and/or technology throughout the acquisition lifecycle. A model-based system will enable unprecedented levels of systems understanding that can be achieved through integrated analytics, tied to a model-centric technical baseline and will support new DoD acquisition initiatives to expedite warfighting capabilities to the fleet [Refs 1, 2, 3].

Implementing this type of capability would expedite correlation of relevant technical data, software, information, knowledge and technology trade-offs to enhance tactical data link development. This environment would provide substantial acceleration of development of solutions and technology transition resulting in reduced time and significant cost reduction of critical capabilities to the warfighter.

Work produced in Phase II will likely become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and NAVWAR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract. NAVWAR will process the DD254 to support the contractor for personnel and facility certification for secure access.

PHASE I: Define solution(s) to develop digital twin system model of the MIDS JTRS terminal configuration. Outline model elements, including characterizing behavior, structure, requirements, and parametrics, that further refine trades in developing tactical data link systems. Solution must specify data storage and computational requirements and will identify existing DoD capabilities that may contribute to the desired end-state capability, identify capability gaps and establish a methodology to deliver needed capability. Information absorption and temporal requirements will be baselined during Phase I. Propose model simulations are strongly encouraged and could take several forms such as augmentations/plug-ins to existing SySML tools. Partnership with MIDS prime vendors is encouraged to help understanding of MIDS design and potential models they use. Partnership with NAVWAR 5.0 Digital Engineering Transformation Division is encouraged. Phase I will be UNCLASSIFIED, and the contractor will not require access to any classified data. Develop a Phase II plan.

PHASE II: Develop a prototype model based on the learning of Phase I effort. Validate and demonstrate the proposed data analytic capability leveraging existing DoD tactical data link infrastructure. Demonstrate the prototype system using MBSE tools identified in Phase I. Include, at a minimum, demonstration of a prototype tool or methodology on a small system(s) application that is representative of a portion of the tactical data link infrastructure, and documentation describing anticipated use of the tool. Ensure model adherence to SysML and Unified Architecture Framework (UAF) specifications, as well as eXtensible Markup Language (XML) Metadata Interchange (XMI) Standard, is desired. Endstate should ensure model can be used to inform tactical data link analysis including (but not limited to) requirements, impact, trade-off, behavior, interoperability or data flow.

The expected TRL for this project is 5 to 6. Partnership with MIDS prime vendors is encouraged, but not required. Partnership with NAVWAR 5.0 Digital Engineering Transformation Division is encouraged. It is likely that the work under this Phase II effort will be classified (see Description section for details). Though Phase II work may become classified, the proposal for Phase II work will be UNCLASSIFIED. If the selected Phase II contractor does not have the required certification for classified work, the related DON program office will work with the contractor to facilitate certification of related personnel and facility.

PHASE III DUAL USE APPLICATIONS: Mature the model and extend use to multiple data link centric platforms within the Navy and private sector. Support or license the final product (s) and transition to the Government. The technology will have application throughout government and industry. Performers from component developers (e.g., Intel, Texas Instrument, etc.) to system integrators (e.g., LM, Boeing, BAE, etc.) could use these models to reduce costs in data link development. Partnership with prime vendors is encouraged, but not required. Navy seeks selected vendor to support transitioning of MBSE solution(s) across the Services.

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KEYWORDS: Model Based Systems Engineering, MBSE, SysML, Digital Twin, Tactical Data Links, MIDS, XMI

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N202-137 TITLE: Sensor Embedding Procedures in Candidate Hypersonic Material Specimens

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Materials

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 section 3.5 of 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 noncontact measurement techniques, or sensor embedding procedures in candidate hypersonic material specimens whose size scale is on the order of millimeters, and high throughput (100s of test per day) measurement protocols under candidate hypersonic ablative shock boundary conditions.

DESCRIPTION: Hypersonic materials operate in extreme environments of pressure and temperature. Design of new materials and structures for hypersonic applications, as well as testing of existing materials and structures requires detailed examination of critical feature effects as a function of environmental variables. Per test cost for current materials runs into millions, with throughputs of approximately 5-10 specimen per day (e.g., Arc Jet tests). Such large-scale tests also fail to capture the effect of material specific, small scale features. Having a capability to understand/examine key feature effects as a function of these extreme environments utilizing extremely low volume sample sizes would allow for high throughput material testing (~300 tests per day) at low cost enabling more rapid material development. This research will increase mission capability and performance, while decreasing lifecycle costs by allowing for accurate and rapid evaluation of new and existing hypersonic/extreme environment materials and designs.

The desired outcome of this work is the development of a system to measure material surface pressure, stress, and temperature under shock loading and at laser ablation temperatures to examine effectiveness of hypersonic materials under realistic plasma, flow, and thermal shock conditions with micrometer scale resolution. This can be accomplished via noncontact or embedded, preferably passive, sensors embedded in hypersonic materials to predict material surface pressure in realistic flight conditions. The developed system must have a robust calibration technique and small scale spatial and temporal resolution, preferably down to the micrometer and microsecond scale. Ultimately, the sensors and materials to be examined must be evaluated in realistic flow conditions.

The outcomes of the proposed work are:

1) Non-contact or passive (wireless) embedded sensors, which are inexpensive for remote monitoring of surface pressure, temperature, and stress in hypersonic materials subjected to realistic flow conditions;
2) Calibration of sensors for predicting surface pressure during in-situ measurements; and
3) Wind-tunnel measurements to put calibrated sensors in realistic flow conditions for evaluating sensor performance at various flow conditions that are appropriate to the hypersonic regime.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Conduct a feasibility study, focusing on non-contact and/or embedded passive sensors. Demonstrate proof of concept of the measurement system in a laboratory environment using laser ablation or other means of generating representative temperatures, stress, etc. High throughput capability should be demonstrated (order of magnitude increase over state-of-the-art) with a clear path to increase the number of tests per day by approximately two orders of magnitude over the current state-of-the-art, while also demonstrating the improved spatial and temporal measurement resolution. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II. Prepare a Phase II plan.

PHASE II: Produce a prototype system capable of high throughput (approximately two orders of magnitude increase over current state of the art) measurements, which is achieved via a non-contact or embedded passive sensor array, including improved spatial and temporal resolution. Demonstrate the prototype in a hypersonic flow environment. Correlate the results with current state-of-the-art test results. Prepare a Phase III development plan to transition the technology for Navy use and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: High throughput, high fidelity testing of high temperature materials will allow for materials and structures to be evaluated more rapidly and at lower cost. Other systems, such as those associated with space propulsion could benefit from this type of high throughput testing.

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3. “Hypervelocity testing at 600 shots/year.” NASA.
https://www.nasa.gov/centers/wstf/testing_and_analysis/hypervelocity_impact/index.html

KEYWORDS: High Throughput Testing, Hypersonic Materials, Embedded Sensing, Non-contact Sensing, Extreme Temperature Environments, Ablative Shock Boundary Conditions

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N202-139 TITLE: Probability of Kill Modeling for Hypersonic Vehicle Missions

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of 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: Create an optimization/sensitivity model that utilizes kill probability as the basis for assessment of alternative hypersonic system technologies.

DESCRIPTION: Hypersonic vehicles (HV) are designed to travel at high speeds pursuing deeply protected targets and seeking to impact them with sufficiently high energy. Thus, the Probability of Kill for a hypersonic weapon depends on both the ability to arrive at the target and to sufficiently damage it. Mathematically, the Probability of Kill (P_k) for a HV can be expressed as the product of the Probability of Arrival (P_a) multiplied by the Probability of Damage (P_d): P_k=P_a*P_d. The main challenge for developing an effective HV is that there are many vehicle performance and mission scenario parameters that influence P_k. Innovation is needed to develop a ‘system of systems’ analysis capability that models the many interdependent components and sub-components of P_k as a function of new technologies on the HV and then optimizes the family of technologies that maximizes P_k across relevant mission sets. The desired system of systems model will provide a framework to capture P_a and P_d under a variety of technology infusion scenarios and integrate these into assessments into the optimization of P_k of a new HV. The prototype framework should leverage both low- and high-fidelity models to robustly estimate the cost-benefit proposition (on P_k) from the injection of new technologies into the HV development and justify the robustness of the estimates with extensive sensitivity analysis.

Estimating the P_a hinges on the ability to capture the behaviors and physical limitations of the HV itself, the supporting role of other blue-force systems, and the efficacy of any non-target red-force systems and their behaviors. In uncontested scenarios, this may be simply a function of time and geometry; however, in more complex scenarios that represent real-world scenarios, producing such a model requires incorporating capabilities of multiple interdependent systems. Estimating the P_d can be accomplished by a statistical model obtained by aggregating high-fidelity models and inputs. P_d can be calculated separately from the P_a by capturing the state information of the HV and pairing that with accepted models of threat systems. However, for any given mission and any given time, the state of HV at impact, again, is dependent on the blue-force support systems and the effect from red-force counter systems.

The Phase II effort will likely require secure access, and SSP will process the DD254 to support the contractor for personnel and facility certification for secure access. The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Define and develop a conceptual framework for calculating P_k of HV based on modeling probability of arrival and probability of damage.

Develop a concept for a system of systems modeling and simulation capability that can be flexibly and iteratively refined to include models of increasing fidelity blue and red force assets, including new and novel technologies within the major systems of HVs.

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

PHASE II: Deliver P_d models and P_A models that can be used to determine P_k for HVs. This will provide a framework to build a model for P_k that can be used to evaluate more complex systems. Validate the subsequent P_k results by comparison to field test data from HV flights.

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

PHASE III DUAL USE APPLICATIONS: Deliver an integrated toolset that assesses both P_d and P_A by integrating a representative set of low- and high-fidelity models of interest. Demonstrate P_k for real world scenarios by incorporating operational model HV and system of systems.

The inherent functionality of the proposed analysis toolset would be applicable to any complex hypersonic vehicle application. For example, the design of planetary entry systems requiring precise targeting for landing would benefit from these innovations.

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KEYWORDS: Probability of Kill, Probability of Damage, Probability of Arrival, Hypersonic Vehicles, System of Systems Analysis, Mission Effectiveness, Technology Assessments, Vehicle Design

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N202-141 TITLE: Investigate the use of Discrete Patterned Roughness for Turbulent Transition Control in a Hypersonic Boundary Layer

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of 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: Model and investigate the use of discrete patterned roughness for turbulent transition control with rough surface conditions that result from manufacturing, or wear and ablation during hypersonic flight.

DESCRIPTION: Discrete patterned roughness has been successful in suppressing laminar-turbulent transition on hypersonic lift-generating configurations involving cross-flow. In these cases, the surfaces have been hydrodynamically smooth. Experiments are needed to evaluate the effect of rough surfaces on the transition control. This should involve experiments in multiple (at least two) quiet hypersonic wind tunnels. Test articles would be lift-generating geometries in which a cross-flow instability is the dominant mechanism of turbulent transition. These articles would include a number of documentable surface roughness conditions, including a baseline smooth surface. The roughness descriptions will be used in simulations of boundary layer turbulent transition with the experiments providing validation. These experiments will document the sensitivity of transition Reynolds number and the level of discrete roughness transition control on the background roughness. In the event of a reduction in transition control, approaches to overcome this should be proposed.

Wind tunnel experiments at Mach 3.5 and 6.0 have demonstrated the ability of patterned discrete roughness to delay turbulence transition on lifting bodies where the dominant mechanism is through a cross-flow instability and is applicable to circular cones at angles of attack and elliptic cross-section cones such as the HiFiRE-5 (Hypersonic International Flight Research Experimentation Program) design. The approach is based on seeding less-amplified (subcritical) stationary cross-flow modes that suppress the growth of the more-amplified (critical) cross-flow modes, and thereby delay transition. Experiments on circular cones at angles of attack have increased the transition Reynolds number by as much as 40%. These experiments have been in idealized flows without extreme surface heating or ablation. The model surfaces were also highly polished so that the discrete roughness height or depth could be extremely small (O40µm). For transition control, the necessary roughness height or depth will depend on the background surface roughness. A more critical scale is the spacing between the discrete roughness that determines the spanwise wavenumber of the excited subcritical cross-flow modes. The background surface roughness spectrum will therefore be a factor.

Given the number of benefits of delaying transition on hypersonic vehicles, and the successful demonstrations of this technology, investigation into realistic flight geometries with surface roughness that takes into account wear and ablation is needed. This would involve wind tunnel experiments in multiple quiet hypersonic tunnels. The surface roughness of the test articles should range from a baseline smooth (O40µm) surface to varying degrees of distributed roughness.

Descriptions of the roughness could likely come from surface impressions of past flight test vehicles, or possibly surfaces generated on test articles placed in high-enthalpy hypersonic facilities. In all cases, the roughness needs to be quantified through highly resolved 3-D surface measurements. The roughness descriptions would be used in simulations that predict turbulence transition and will be validated through comparisons to the experiments. Ultimately for practical implementation, the sensitivity of the discrete roughness transition control on the level of background roughness needs to be determined. In the event that a reduction in transition control is observed, approaches that overcome the reduction need to be investigated.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop an initial concept design of a model geometry with cross-flow dominated laminar-turbulent transition and the generation of surface roughness representing pre-flight and post-flight conditions using a smooth surface to provide a baseline condition. Fabricate a model of a scale that will operate within the quiet zone of at least two quiet hypersonic wind tunnels. Employ wind tunnel conditions that are sufficient to achieve turbulent transition on the model, and roughness that is interchangeable, with documented characteristics.

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

PHASE II: Fully develop a model for the effectiveness of discrete roughness to suppress turbulent transition and ensure the validation of test articles in wind tunnel tests that will involve a test article that is large enough to provide better measurement of spatial resolution and reduce edge effects. Use the quantitatively same background surface roughness from Phase I. For the different roughness cases, perform experiments that measure the turbulent transition location, verify that the mechanism of transition involves a cross-flow instability, and includes both surface visualization and off-wall measurements in 3-D space within the boundary layer. With the added spatial resolution of the larger model, place special emphasis on off-wall measurements within the boundary layer. Specifically focus experiments on interaction between stationary and traveling cross-flow modes, with the latter possibly energized by the higher disturbance levels produced by the roughness. Use these results to form the basis for the design of discrete roughness model to suppress turbulent transition.

In addition to the experiments, develop simulations that are intended to be an analog to the wind tunnel experiments. Ensure that the simulations' initial conditions match the experimental conditions, and include descriptions of the background roughness from Phase I. Compare the results of the simulations directly with those in the experiments. Assuming experimental validation of the simulations, use it to further optimize the discrete roughness transition control. Prepare a Phase III development plan to transition the technology for Navy use and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: Conduct necessary qualification testing of the laminar-transition control method to merit further investment and consideration for military HV platforms. Work together with an OEM (original equipment manufacturer) to develop a business plan and seek necessary investment to support the product/process/service for the OEM military provider. This effort may have application to reentry vehicles operated by NASA or other organizations in addition to vehicles operating at trans-sonic and supersonic velocities.

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1. Corke, T.,A.,E and Semper, M. “Control of stationary cross-Flow modes in a mach 6 boundary layer using patterned roughness.” J. Fluid Mech., 856, 2018, pp. 822-849. DOI: https://doi.org/10.1017/jfm.2018.636

2. Schuele, C.Y. Corke, T. and Matlis, E. “Control of Stationary Cross-Flow Modes in a Mach 3.5 Boundary Layer Using Patterned Passive and Active Roughness.” J. Fluid Mech., 718, 2013, pp. 5-38. DOI: https://doi.org/10.1017/jfm.2012.579

KEYWORDS: Hypersonic Vehicles, Laminar-Turbulent Transition, Transition Control, Surface Roughness, Wind Tunnel, Transition Reynolds Number

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N202-143 TITLE: Plasma Switches and Antennas for Contested Electromagnetic Environments

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

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 section 3.5 of 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 novel compact and inexpensive plasma-based widely tunable frequency impedance elements (plasma switches) and antennas capable of sustained high-power operation in contested/denied electromagnetic (L- and S-bands) environments.

DESCRIPTION: In the increasingly contested electromagnetic environment, Navy communication and guidance systems must have the capability to rapidly close the transmission “frequency window” when faced with electromagnetic threats, such as jamming or high-power microwave (HPM) weapons. Additionally, when faced with high-power electromagnetic threats, the communication and guidance systems should have the capability of being rapidly tuned to a different frequency outside the frequency range of the threat.

While various technologies, including those based on semiconductors, ferrites, mechanical devices, etc., have been proposed to address these needs, the devices based on those technologies are bulky, have generally high insertion losses, and have either slow responses or are easily damaged when operating at high power levels.

Devices based on low-temperature plasmas are promising for tunable high-power limiters and impedance elements. Plasma discharges can be turned on and their properties can be changed rapidly, on a nanosecond time scale. Insertion losses of such devices can be very low. Commercially available sealed plasma devices are also compact and inexpensive and have been shown to be robust in prolonged operation at Very High Frequency (VHF) to gigahertz (GHz) range frequencies; however, the characteristics of the gas mixtures are proprietary, and limited to a few commercially available sources with limited information on the plasma characteristics. The electromagnetic properties of plasma discharges are quite rich, combining resistive, inductive, and capacitive behavior, and those properties can be varied widely by, e.g., controlling the excitation waveform and power, applying a bias, and placing the plasma discharge in a resonant structure. Research aimed at understanding, characterizing, and evaluating such behavior is critical for the development of plasma-based limiters and switches, focused on improving performance and flexibility in a contested Radio Frequency (RF) environment.

Based on previous research and development (References 1-3), the plasma-based switches and antennas should be frequency-tunable in a wide range (over an octave) and operate at a power level of over 100 Watts (W), but capabilities that have not yet been demonstrated. Radiation at this power level would enable multiple use-cases relevant to Navy operations.

The Phase II effort will likely require secure access, and NAVSEA will process the DD254 to support the contractor for personnel and facility certification for secure access. The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Determine the technical feasibility of a concept by designing (a) an octave-tunable plasma switch capable of operation at 100 W, and (b) an octave-tunable antenna and/or antenna array that would effectively utilize such a switch. Begin characterization of radiation properties at this power level within the tunable frequency range.

The Phase I Option, if exercised, will include the initial design specifications and identify risks and propose a plan to mitigate the risks in Phase II. Prepare a Phase II plan.

PHASE II: Develop, characterize, and demonstrate a frequency-tunable plasma antenna and/or antenna array operating above 100 W and with a plasma switch that enables an octave frequency tuning at all power levels. Develop and validate a model to describe the plasma behavior in these devices. Develop optimal designs for both the switch and antenna using the model, given relevant use cases. Characterize the device lifetime under extreme thermal and shock conditions expected in applications. Prepare a Phase III development plan to transition the technology for Navy use and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: Refine the designs developed in Phase II. Work with the Navy on integration of the devices into the application platforms and testing their performance in the relevant conditions. Based on the integration and testing, further refine the designs.

The tunable high-power plasma switches and antennas are expected to be applicable for non-military applications such as cell phone towers.

REFERENCES:
1. Semnani, A., Peroulis, D. and Macheret, S. “Plasma-Enabled Tuning of a Resonant LC Circuit.” IEEE Transactions on Plasma Science, Vol. 44, No. 8, Part 2, 2016, pp. 1396-1404. https://ieeexplore.ieee.org/document/7516629

2. Semnani, A., Peroulis, D. and Macheret, S. “A High-Power Widely Tunable Limiter Utilizing an Evanescent-Mode Cavity Resonator Loaded With a Gas Discharge Tube.” IEEE Transactions on Plasma Science, Vol. 44, No. 12, 2016, pp. 3271 3280. https://ieeexplore.ieee.org/document/7756341

3. Semnani, A., Macheret, S. and Peroulis, D. “A Quasi-Absorptive Microwave Resonant Plasma Switch for High-Power Applications.” IEEE Transactions on Microwave Theory and Techniques, Vol. 44, No. 12, May 2018, pp. 1 9. doi: 10.1109/TMTT.2018.2834925

4. Khomenko A. and Macheret, S. "Capacitively coupled radio-frequency discharge in alpha-mode as a variable capacitor." Journal of Physics D: Applied Physics, Vol. 52, No. 44. https://doi.org/10.1088/1361-6463/ab3367

KEYWORDS: Rapidly Tuned Impedance Elements, Plasma, Plasma Discharges, Plasma-based Switch, Plasma-based Limiter, Antennas, Antenna Arrays

TPOC-1: SSP SBIR POC
Email: ssp.sbir@ssp.navy.mil

N202-144 TITLE: Predictive Physics-Based Model for Projectile Trajectory Instability

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a physics-based model to predict trajectory instability of a long rod penetrating semi-infinite targets.

DESCRIPTION: There is an urgent need to develop a physics-based model to predict this trajectory instability. In the transition zone near the point of maximum penetration depth and the onset of the semi-hydrodynamic regime, projectiles were observed to bend and yaw violently without significant mass loss. While prior works exist to model the impact response in the transition zone [Ref 1], these studies typically focused purely on the penetration depth via semi-empirical methods.

The penetration depth of cylindrical projectiles into targets across a broad range of impact velocities typically exhibits three distinct regimes. At lower impact velocities, the projectile undergoes nearly rigid body penetration within the target. Towards the high end of the velocities in this regime, the maximum penetration depth is achieved. With further increasing striking velocities, the projectile begins to experience erosion and the penetration depth starts to saturate. This regime is known as the semi-hydrodynamic regime. At even higher velocities, the impact phenomenon becomes hydrodynamic where the projectile strength becomes practically negligible.

This phenomenon has been observed experimentally across a range of different target materials, including metals [Ref 2], geomaterials [Ref 3], and fluids [Ref 4], and across several different types of projectiles and shapes. This yawing and bending instability causes severe deviation from the desired trajectory, and severely limits projectile penetrating performance [Ref 2]. Stability and vibration dynamics models have long been established for slender rods moving axially in fluid [Ref 5]. Depth of penetration models focused most on solid targets.

The proposed model aims to identify critical conditions and parameters resulting in this instability across different targets in order to optimize the penetrative capabilities of projectiles. The parameters of interest may include, but not be limited to, projectile aspect ratio, nose shape, velocity, and strength of materials that are interacting under conditions of different soil types or hardened materials, e.g., reinforced concrete.

The Phase II effort will likely require secure access, and SSP will process the DD254 to support the contractor for personnel and facility certification for secure access. The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security

Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop a physics-based model for long rod penetration. Identify critical conditions and parameters that affect long rod penetration into different soil types or hardened materials, e.g., reinforced concrete. Assess the viability of the model for long rod penetration to include mechanisms not inherent just in fluid flow or solid cavity expansion, such that the stability of the trajectory can be predicted, together with dominating parameters dictating the onset of instability. Compare the model prediction with typical penetration cases in this and subsequent phases to assess the feasibility of the model. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II. Develop a Phase II plan.

PHASE II: Model validation and critical condition determination. Design and conduct penetration experiments with flash X-ray sequence imaging for global trajectory response and Synchrotron X-ray high-speed imaging for local projectile-target interactions to validate the model. Simultaneously, document existing experimental data in literature and conduct numerical simulations on different semi-infinite target media to fine-tune the model and identify parameter critical ranges. Validate the model within the scope of the physical and numerical experiments and literature data, and that it is ready to be further developed into a design tool.

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

PHASE III DUAL USE APPLICATIONS: Develop the model into a predictive tool, together with the resulting stability criteria and critical parameters, for applications involving long-rod penetration into semi-infinite targets. Perform systematic penetration experiments to expand the model application range over a variety of projectile/target combinations. Ensure that the final product is an efficient, low-cost method of design projectiles and predicting their capabilities in penetrating various semi-infinite targets. Applications of the final product are not limited to defense applications, as the developed model may be extended to other fields such as pile-driving in civil engineering fields.

REFERENCES:
1. Chen, X. & Li, Q. “Transition from nondeformable projectile penetration to semihydrodynamic penetration.” J. Eng. Mech., 2003, pp. 123-127. https://www.scribd.com/document/439663186/Transition-From-Non-Deformable-Projectile-Penetration-to-Semi-Hydrodynamic-Penetration

2. Piekutowski, A. J., Forrestal, M. J., Poormon, K. L. & Warren, T. L. “Penetration of 6061-T6511 aluminum targets by ogive-nose steel projectiles with striking velocities between 0.5 and 3.0 km/s.” Int. J. Impact Eng., 23, 1999, pp. 723-734. https://doi.org/10.1016/S0734-743X(99)00117-7

3. Bivin, Y. K. & Simonov, I. V. “Mechanics of dynamic penetration into soil medium.” Mech. Solids, 45, 2010, pp. 892–920. https://www.semanticscholar.org/paper/Mechanics-of-dynamic-penetration-into-soil-medium-Bivin-Simonov/d8a935cc3e78d8c1f6847f93d6c8080c0c079596

4. Roecker, E. T. & Ricchiazzi, A. J. "Stability of penetrators in dense fluids." Int. J. Eng. Sci. 16, 1978, pp. 917-920. https://www.sciencedirect.com/science/article/abs/pii/0020722578900757

5. Gosselin, F., Païdoussis, M. P. & Misra, A. K. "Stability of a deploying/extruding beam in dense fluid." J. Sound Vib. 299, 2007, pp. 123-142. https://www.researchgate.net/publication/220004058_Stability_of_a_deployingextruding_beam_in_dense_fluid

KEYWORDS: Trajectory of Cylindrical Projectiles, Instability of Cylindrical Projectiles, Penetration of Hardened Targets, Physics-based Model, Semi-hydrodynamic Regime

TPOC-1: SSP SBIR POC
Email: ssp.sbir@ssp.navy.mil

N202-145 TITLE: Hypersonic Wake Detection with High Enthalpy Capabilities

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Sensors

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a hypersonic vehicle tracking system based on analysis of the wake turbulence and chemiluminescence.

DESCRIPTION: The distribution of observable markers in hypersonic wakes is the result of a complex interaction of body shape, chemical kinetics, and laminar-turbulent transition mechanisms. At hypersonic speeds in a gas, electrons and radiating species are generated by viscous heating that are entrained into the wake and are responsible for observable effects up to distances of hundreds or even thousands of body diameters. Clearly an understanding of the radiation signature of reentry vehicles is of fundamental importance to high-speed-flight research. During a brief period in the early 1960s, a number of experiments were conducted on this problem that involved performing both velocity measurements to characterize the turbulence development in the wake and spectroscopic techniques to identify the chemical kinetics of reacting species [Refs 1, 2, 3, 4, 5].

A general conclusion from this early body of work was that theoretical models were insufficient to adequately predict the structure of the wake and additional experiments were required. Improving the understanding of the laminar-to-turbulence transition, separation dynamics just behind the body, and turbulence statistics and structure in the wake was needed. Uncertainty in the estimations of enthalpy made it difficult to predict the temperature in the wake, which affects kinetics and generation of reacting species, crucial to the complete characterization of a hypersonic wake. A principle limitation was the unavailability of point-wise sensors with high-bandwidth sensitivity to mass-flux, temperature, and gas species with the required robustness and small measurement volumes.

Optical diagnostic tools do not provide point-wise capability and often involve path integration and are limited by the need for optical access. A new sensor is required that overcomes these limitations while providing both high bandwidth velocity and species detection capabilities. This sensor should be able to survive in harsh conditions involving exposed plasmas, an environment at temperatures of 1100 °C or greater, and high turbulence levels of 10% or greater in particulate-laden flows. The sensor should not require optical access, and should provide good spatial resolution with measurement volumes under 0.25 cu cm.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop a concept for velocity and gas mixture composition sensing capable of withstanding 1100 °C environments. Demonstrate the feasibility of the proposed sensor type and the packaging approach suitable to satellite payloads less than 1000 cu cm. Describe the manufacturing feasibility of the sensor and packaging necessary for commercialization efforts. Experimentally demonstrate feasibility of the proposed sensor at a laboratory scale at hypersonic Mach numbers. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II. Develop a Phase II plan.

PHASE II: Fabricate and characterize several full prototype devices in a low enthalpy hypersonic quiet tunnel and high enthalpy high Mach number flow field facilities. Prepare a Phase III development plan to transition the technology for Navy use and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use. Conduct necessary qualification testing of the device to merit further investment and consideration for military hypersonic vehicle platforms. Work together with original equipment manufacturer (OEM) to develop a business plan and necessary IP, and seek necessary investment to support the product/process/service for the OEM military provider. The use of chemiluminescence has potential applications in welding and plasma processing where the environments do not support physical interaction with the objects of interest.

REFERENCES:
1. Bayes, K., and Kistiakowsky, G.B. "On the Mechanism of the Lewis-Rayleigh Nitrogen Afterglow." Chemical Physics, 32, 4, March 1960, pp. 992-1000. https://aip.scitation.org/doi/10.1063/1.1730909

2. Hundley, R. "Air Radiation From Nonequilibrium Wakes of Blunt Hypersonic Reentry Vehicles." Memorandum RM-4071-ARPA, June 1964. https://www.rand.org/content/dam/rand/pubs/research_memoranda/2008/RM4071.pdf

3. Lees, L. "Hypersonic Wakes and Trails." AIAA Journal 2, 3, 1964, pp. 417-428. https://arc.aiaa.org/doi/abs/10.2514/3.2356?journalCode=aiaaj"

4. Levensteins, Z., and Krumins, M. "Aerodynamic Characteristics of Hypersonic Wakes.", AIAA Journal 5, 9, 1967, pp. 1596-1602. https://arc.aiaa.org/doi/10.2514/3.4256

5. Tanaka, Y., Innes, F., Jursa, A., and Nakamura, M. "Absorption Spectra of the Pink and Lweis-Rayleigh Afterglows of Nitrogen in the Vacuum-uv Region." J. Chem. Phys. 42, 4, 1965, pp. 1183-1198. https://doi.org/10.1063/1.1696100

KEYWORDS: Reentry Vehicles, Chemiluminescence, Hypersonic, Wake Turbulence, High Enthalpy, Laminar-turbulent Transition

TPOC-1: SSP SBIR POC
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**DEPARTMENT OF THE NAVY (DON)**

**20.2 Small Business Innovation Research (SBIR)**

**Direct to Phase II Announcement and Proposal Submission Instructions**

**IMPORTANT**

- **The following instructions apply to Direct to Phase II (DP2) SBIR topics only:**
  - **N202-D02**
- **The information provided in the DON Proposal Submission Instruction document takes precedence over the DoD Instructions posted for this Broad Agency Announcement (BAA).**
- A DP2 Phase I Feasibility proposal template, unique to DP2 topics, will be available to assist small businesses to generate a Phase I Technical Volume (Volume 2). The template will be located on https://www.navysbir.com/links_forms.htm.
- DON provides notice that Basic Ordering Agreements (BOAs) or Other Transaction Agreements (OTAs) may be used for Phase II awards.
- The optional Supporting Documents Volume (Volume 5) is available for the SBIR 20.2 BAA cycle. The optional Supporting Documents Volume is provided for small businesses to submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. DON will not be using any of the information in Volume 5 during the evaluation.

## INTRODUCTION

The Director of the DON SBIR/STTR Programs is Mr. Robert Smith. For program and administrative questions, contact the Program Manager listed in Table 1; **do not** contact them for technical questions. For technical questions about a topic, contact the Topic Authors listed within the topic during the period **6 May through 2 June 2020.** Beginning **3 June 2020,** the SBIR/STTR Interactive Technical Information System (SITIS) (https://www.dodsbirsttr.mil/submissions) listed in Section 4.14.d of the Department of Defense (DoD) SBIR/STTR Program Broad Agency Announcement (BAA) must be used for any technical inquiry. For general inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-703-214-1333 (Monday through Friday, 9:00 a.m. to 5:00 p.m. ET) or via email at dodsbirsupport@reisystems.com.

**TABLE 1: DON SYSTEMS COMMAND (SYSCOM) SBIR PROGRAM MANAGERS**

| Topic Numbers | Point of Contact | SYSCOM | Email |
|---|---|---|---|
| N202-D02 | Mr. Jeffrey Kent | Marine Corps Systems Command (MCSC) | jeffrey.a.kent@usmc.mil |

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 pertaining to the DON's mission can be obtained from the DON website at www.navy.mil.

During government fiscal years (FY) 2012 through 2022, the Department of Defense (DoD) including the Department of the Navy (DON) may issue an award to a small business firm under Phase II of the SBIR program with respect to a project, without regard to whether the firm was provided an award under Phase I of an SBIR program with respect to such project. Prior to such an award, the head of the agency, or their designee, must issue a written determination that the firm has demonstrated the scientific and technical merit and feasibility of the technology solution that appears to have commercial potential (for use by the government or in the public sector). The determination must be submitted to the Small Business Administration (SBA) prior to issuing the Phase II award. As such, DON issues this portion of the BAA in accordance with the requirements of the Direct to Phase II (DP2) authority. Only those firms that are capable of meeting the DP2 proposal requirements may participate in this DP2 BAA. No Phase I awards will be issued to the designated DP2 topic.

Each eligible topic requires documentation to determine that Phase I feasibility described in the Phase I section of the topic has been met.

The DON SBIR DP2 is a two-step process:

> STEP ONE: Prepare and Submit a Phase I Feasibility Proposal (instructions and link to template provided below). The purpose of the Phase I Feasibility Proposal is for the firm to provide documentation to substantiate that both Phase I feasibility and the scientific and technical merit described in the topic have been met. The Phase I Feasibility Proposal must: demonstrate that the firm performed Phase I-type research and development (R&D) and provide a concise summary of Phase II objectives, work plan, related research, key personnel, transition/commercialization plan, and estimated costs. Feasibility documentation MUST NOT be solely based on work performed under prior or ongoing federally funded SBIR/STTR work. The government will evaluate Phase I Feasibility Proposals and select firms to submit a Full DP2 Proposal. Demonstrating proof of feasibility is a requirement for a DP2 award. The firm must submit a Phase I Feasibility Proposal to be considered for selection to submit a Full DP2 Proposal.

> STEP TWO: Prepare and Submit a Full DP2 Proposal. If selected, the cognizant SYSCOM Program Office will contact the firm directly to provide instructions on how to submit a Full DP2 Proposal.

DON SBIR reserves the right to refuse to make any awards under this DP2 BAA. All awards are subject to availability of funds and successful negotiations. Proposers are to read the topic requirements carefully. The Government is not responsible for expenditures by the proposer prior to award of a contract. For 20.2 topics designated as DP2, DON will accept only Phase I Feasibility Proposals (described below).

**DP2 PROPOSAL SUBMISSION REQUIREMENTS**

The following MUST BE MET or the proposal will be deemed noncompliant and may be REJECTED.

- **Eligibility.** Each proposing firm must:
  - Have demonstrated feasibility of Phase I-type R&D work
  - Have submitted a Phase I Feasibility Proposal for evaluation
  - Meet Offeror Eligibility and Performance Requirements as defined in section 4.2 of the DoD SBIR/STTR Program BAA
  - During the Phase II award, primary employment of the principal investigator (PI) must be with the firm at the time of award and during the conduct of the proposed project. Primary employment means that more than one-half of the PI's time is spent in the employ of the firm
  - Register in the System for Award Management (SAM) as defined in section 4.15 of the DoD SBIR/STTR Program BAA. To register, visit https://beta.sam.gov

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR BAA section 5.4(a).

- **Technical Volume (Volume 2).** Technical Volume (Volume 2) must meet the following requirements:
  - Content is responsive to evaluation criteria as specified in DoD SBIR/STTR Program BAA section 6.0
  - Not to exceed **50** 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*

  *For headers, footers, listed references, and imbedded tables, figures, images, or graphics that include text, a font size smaller than 10-point is allowable; however, proposers are cautioned that the text may be unreadable by evaluators.

  Volume 2 is the technical proposal. Additional documents may be submitted to support Volume 2 in accordance with the instructions for Supporting Documents Volume (Volume 5) as detailed below.

  The Technical Volume (Volume 2) should include the following sections:
  - Phase I Proof of Feasibility (NTE 35 pages)
    1. Introductory Statement
    2. Phase I Proof of Feasibility
    3. Assertions
    4. Commercialization Potential/Transition Plan Summary

  - Snapshot of Proposed Phase II Effort (NTE 15 pages)
    1. Description of Proposed DP2 Technical Effort and Objectives
    2. DP2 Work Plan

3. Key Personnel Resumes – should be submitted for the Principal Investigator and up to 4 additional individuals. Resumes are limited to one page per person, and should be limited to only information relevant to the work to be performed under the project
4. Subcontractors/Consultants
5. Order of Magnitude Cost Estimate Table (example provided below in the Cost Volume (Volume 3) section).

It is recommended that proposers follow the DP2 Phase I Feasibility Template as a guide for structuring the DP2 Phase I Feasibility proposal. The template is located on https://www.navysbir.com/links_forms.htm.

**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 or any subsequent award, the proposer shall identify and describe all fundamental research to be performed under its proposal, including subcontracted work, with sufficient specificity to demonstrate that the work qualifies as fundamental research. Fundamental research means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons. Simply identifying fundamental research in the proposal does NOT constitute acceptance of the exclusion. All exclusions will be reviewed and noted in the award. NOTE: Fundamental research included in the technical proposal that the proposer is requesting be eliminated from the requirements for prior approval of public disclosure of information, must be uploaded in a separate document (under “Other”) in the Supporting Documents Volume (Volume 5).

- **Cost Volume (Volume 3).** The text fields related to costs for the proposed effort must be answered in the Cost Volume of the DoD Submission system (at https://www.dodsbirsttr.mil/submissions/), however, proposers DO NOT need to download and complete the separate cost volume template for the DON SBIR Phase I Feasibility Proposal. Proposers are to include a cost estimate in the Order of Magnitude Cost Estimate Table (example below) within the Technical Volume (Volume 2). Please refer to Table 2 below for guidance on cost and period of performance. Costs for the Base and Option are to be separate and identified on the Proposal Cover Sheet and in the Order of Magnitude Cost Estimate Table in the Technical Volume (Volume 2).

| **Order of Magnitude Cost Estimate Table** | | | |
|---|---|---|---|
| **Line Item - Details** | **Estimated Base Amount** | **Estimated Option Amount** | **Total Estimated Amount**<br><br>**Base + Option** |
| Direct Labor (fully burdened) – Prime | | | |
| Subcontractors/Consultants | | | |

| | | | |
|---|---|---|---|
| Material | | | |
| Travel & ODC | | | |
| G&A | | | |
| FCCM | | | |
| Fee/Profit | | | |
| TABA (NTE $25K, included in total amount) | | | |
| Total Estimated Costs | | | |

**TABLE 2: COST & PERIOD OF PERFORMANCE**

| Base | | Option One | | Total (NTE) |
|---|---|---|---|---|
| Cost (NTE) | POP (NTE) | Cost (NTE) | POP (NTE) | |
| $1,000,000 | 24 mos. | $500,000 | 12 mos. | $1,500,000 |

- **Company Commercialization Report (Volume 4)**. As specified in DoD SBIR/STTR Program BAA section 5.4(e).

- **Supporting Documents Volume (Volume 5)**. The optional Volume 5 is provided for small businesses to submit additional documentation to support the Technical Proposal (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. A template for Volume is available on https://navysbir.com/links_forms.htm. DON will not be using any of the information in Volume 5 during the evaluation.

  Note: Even if you are not providing documentation within Volume 5, DSIP will require you to respond to a "yes" or "no" question regarding the volume. Failure to respond may stop you from submitting and certifying your proposal.

  - Letters of Support relevant to this project
  - Additional Cost Information
  - SBIR/STTR Funding Agreement Certification
  - Technical Data Rights (Assertions)
  - 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

  NOTE: The inclusion of documents or information other than that listed above (e.g., resumes, test data, technical reports, publications) may result in the proposal being deemed "Non-compliant" and REJECTED.

A font size smaller than 10-point is allowable for documents in Volume 5; however, proposers are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD has implemented the optional Fraud, Waste and Abuse Training Certification (Volume 6). DON does not require evidence of Fraud, Waste and Abuse Training at the time of proposal submission. Therefore, DON will not require proposers to use Volume 6.

**DON SBIR PHASE I PROPOSAL SUBMISSION CHECKLIST**

- **Subcontractor, Material, and Travel Cost Detail.** In the Cost Volume (Volume 3), proposers must provide sufficient detail for subcontractor, material and travel costs. Enter this information in the "Explanatory Material" field in the online DoD Volume 3. 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. 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).

- **Performance Benchmarks.** Proposers must meet the two benchmark requirements for progress toward Commercialization as determined by the Small Business Administration (SBA) on June 1 each year. Please note that the DON applies performance benchmarks at time of proposal submission, not at time of contract award.

- **Discretionary Technical and Business Assistance (TABA).** If TABA is proposed, the information required to support TABA (as specified in the TABA section below) must be added in the "Explanatory Material" field of the online DoD Volume 3. If the supporting information exceeds the character limits of the Explanatory Material field of Volume 3, this information must be included in Volume 5 as "Additional Cost Information" as noted above. Failure to add the required information in the online DoD Volume 3 and, if necessary, Volume 5 will result in the denial of TABA. TABA may be proposed for a DP2 effort, but the total value may not exceed $25,000 under this DP2 contract.

**DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)**

The SBIR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Firms may request to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase II TABA amount is up to $25,000 per award. The TABA amount, of up to $25,000, is to be included as part of the award amount and is limited by the established award values for Phase II by the SYSCOM (i.e. within the $1,700,000 or lower limit specified by the SYSCOM). The amount proposed for TABA cannot include any profit/fee application by the SBIR/STTR awardee and must be inclusive of all applicable indirect costs. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project.

Approval of direct funding for TABA will be evaluated by the DON SBIR/STTR Program Office. A detailed request for TABA must include:

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

TABA must NOT:

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

TABA must be included in the Cost Volume (Volume 3) as follows:

- Phase II: The value of the TABA request must be included in the Order of Magnitude Cost Estimate Table in the Snapshot of Proposal Phase II Effort section of the Technical Volume (Volume 2). The detailed request for TABA (as specified above) must be included as a note in the Order of Magnitude Cost Estimate Table and be specifically identified as "Discretionary Technical and Business Assistance".

Proposed values for TABA must NOT exceed:

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

NOTE: Section 9(b)(5) of the SBIR and STTR Policy Directive requires that a firm receiving technical or business assistance from a vendor during a fiscal year submit a report with a description of the technical or business assistance received and the benefits and results of the technical or business assistance provided. More information on the reporting requirements of awardees that receive TABA funding through the DON can be found on https://www.navysbir.com/links_forms.htm. Awardees that receive TABA funding through the DON will upload the report to https://www.navysbirprogram.com/navydeliverables/.

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

All Phase II awardees not receiving funds for TABA in their awards must attend a one-day DON STP meeting during the first or second year of the Phase II contract. This meeting is typically held in the spring/summer in the Washington, D.C. area. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

## EVALUATION AND SELECTION

The DON will evaluate and select Phase I Feasibility and DP2 proposals using the evaluation criteria in Sections 6.0 and 8.0 of the DoD SBIR/STTR Program BAA respectively, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. As noted in the sections of the aforementioned Announcement on proposal submission requirements, proposals exceeding the total costs established for the Base and/or any Options as specified by the sponsoring DON SYSCOM will be rejected without evaluation or consideration for award. Due to limited funding, the DON reserves the right to limit awards under any topic.

Approximately one week after the DP2 BAA closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, the e-mail address on the proposal Cover Sheet must be correct.

Selected Phase I Feasibility proposers will be notified to submit Full DP2 Proposals. SYSCOM-specific Full DP2 Proposal guidance will be provided at the time of this notification.

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

Protests of the Phase I Feasibility evaluations and DP2 selections and awards must be directed to the cognizant Contracting Officer for the DON Topic Number, or filed directly with the Government Accountability Office (GAO). Contact information for Contracting Officers may be obtained from the DON SYSCOM Program Managers listed in Table 1. If the protest is to be filed with the GAO, please refer to instructions provided in section 4.11 of the DoD SBIR/STTR Program BAA.

Protests to this BAA and proposal submission must be directed to the DoD SBIR/STTR BAA Contracting Officer, or filed with the GAO. Contact information for the DoD SBIR/STTR BAA Contracting Officer can be found in section 4.11 of the DoD SBIR/STTR Program BAA.

## CONTRACT DELIVERABLES

Contract deliverables are typically progress reports and final reports. Required contract deliverables must be uploaded to https://www.navysbirprogram.com/navydeliverables/.

## AWARD AND FUNDING LIMITATIONS

Awards. The DON typically awards a Cost Plus Fixed Fee contract for DP2; but, may consider other types of agreement vehicles, such as an Other Transaction Agreement (OTA) or a Basic Ordering Agreement (BOA) 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 II awards. DP2 awards can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR/STTR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the firms (e.g., the DON STP).

**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. Please refer to instructions provided in section 7.2 of the DoD SBIR/STTR Program BAA.

**ADDITIONAL NOTES**

Human Subjects, Animal Testing, and Recombinant DNA. If the use of human, animal, and recombinant DNA is included under a DP2 proposal, please carefully review the requirements at: http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

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).

**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, which includes assigning SBIR/STTR Technical Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR/STTR Phase I/II effort(s). Government prime contractors and/or 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

## NAVY SBIR Direct to Phase II 20.2 Topic Index

N202-D02 TITLE: DIRECT TO PHASE II Exportable Power for Ultra Lightweight Tactical Vehicle (ULTV)

RT&L FOCUS AREA(S): General Warfighting Requirements
TECHNOLOGY AREA(S): Ground/Sea Vehicles

ACQUISITION PROGRAM: USMC PEO Land Systems, PM Ground Based Air Defense (GBAD), SMC PEO Land Systems, PM LTV

OBJECTIVE: Develop a compact, lightweight, engine-driven power generation system for vehicle and export electrical power with high specific power (kilowatts per kilogram) that fits within the confines of the chassis of recreational off-highway vehicles (ROVs) to meet expected power and energy demands and allow for future mission growth.

DESCRIPTION: Currently available vehicles capable of being internally transported in rotary wing aircraft have insufficient export power capabilities to meet power and energy demands of current Counter-Unmanned Aerial Systems (C-UASs) and allow for future mission growth. The current Light Marine Air Defense Integrated System (LMADIS) uses a 5 kilowatts (kW) diesel generator weighing 300 lbs. that results in the vehicle weighing 15 lbs. over the maximum gross vehicle weight (GVW) of the current ULTV. Future mission growth to add additional communications equipment to LMADIS is expected to increase the power demands to 10 kW. Currently available diesel generators that meet the higher power requirements weigh close to 500 pounds (lbs). and would result in the vehicle weighing 100 to 150 lbs. over maximum GVW. Compact and lightweight power generation systems are needed to power C-UAS and C2 systems and keep the vehicle safely within its allowable GVW. The system requirements are:

- Integrated system using the existing vehicle engine (current engine is approximately 85 horsepower)
- Export power output of 5 kW at idle Threshold (T); 10 kW at idle Objective (O) at 28 volts direct current (VDC)
- Reduced physical size of export power system (same approximate size as an alternator, 8 inches wide x 10 inches long x 8 inches high)
- Physical weight of export power system less than 225 lbs.
- Compatible with 24/28VDC tactical electrical systems and 12/14VDC vehicle electrical systems
- Electrical component and connections with an ingress protection rating of Ingress Protection( IP67) or higher in accordance with (IAW) American National Standards Institute (ANSI) / International Electrotechnical Commission (IEC) 60529-2004
- Modular design that can be inspected, serviced, and repaired in the field
- Full power output across the range of engine speeds, 1000-4,000 Revolutions Per Minute (RPM)

PHASE I: For this Direct to Phase II (DP2) topic, the Government expects that the small business would have accomplished the following in a Phase I-type effort. It must have developed a concept for a workable prototype or design to address at a minimum the basic requirements of the stated objective above.

Documentation showing an engine driven power generation system concept is feasible and that the system requirements discussed in the description are in the realm of possible. The small business should have produced a model to evaluate different approaches to optimize on vehicle generator technologies. The small business should show they have identified higher power density electrical generator/alternator designs to at least double power output in a similar form factor when compared to existing military alternators.

FEASIBILITY DOCUMENTATION: Proposers interested in participating in Direct to Phase II must include in their responses to this topic Phase I feasibility documentation that substantiates the scientific and technical merit and Phase I feasibility described in Phase I above has been met (i.e., the small business must have performed Phase I-type research and development related to the topic, but feasibility documentation MUST NOT be solely based on work performed under prior or ongoing federally funded SBIR/STTR work) and describe the potential commercialization applications. The documentation provided must validate that the proposer has completed development of technology as stated in Phase I above. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Work submitted within the feasibility documentation must have been substantially performed by the proposer and/or the principal investigator (PI). Read and follow all of the DON SBIR 20.2 Direct to Phase II Broad Area Announcement (BAA) Instructions. Phase I proposals will NOT be accepted for this BAA.

PHASE II: Based on the Phase I equivalent effort and the Phase II plan, develop and use analytical modeling to assist in design and integration. Build prototypes for both fitment and functionality of power generation system. Support evaluation of prototypes to determine if the performance goals defined in the Phase II development plan and the requirements outlined in MIL-STD-1275E, MIL-STD-1332B, and MIL-STD-810H have been met. Demonstrate system performance through modeling and dynamometer testing. Refine the design based on the results of testing/modeling and support on vehicle testing. Prepare a Phase III plan to transition the technology to the Marine Corps and the commercial marketplace.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of Phase II, provide support to the Marine Corps in transitioning the technology for Marine Corps use. Refine a power generation system for evaluation and determine its effectiveness in an operationally relevant environment. .Support the Marine Corps test and evaluation program to qualify the system for the Marine Corps use.

Commercial applications include law enforcement vehicles, search and rescue vehicles, tractor trailers, and general automotive to reduce vehicle weight and improve fuel economy.

REFERENCES:
1. "MIL-STD-810H - Environmental Engineering Considerations and Laboratory Tests". U.S. Army Test and Evaluation Command, January 31, 2019. https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=35978

2. "MIL-STD-1275E Characteristics of 28 Volt DC Input Power to Utilization Equipment in Military Vehicles." U.S. Army Tank automotive and Armaments Command, March 22, 2013. https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=36186

3. "Test Operations Procedure (TOP) 2-2-601 Electrical Systems (Vehicles and Weapon Subsystems)". U.S. Army Developmental Test Command Test Operations Procedure, US Army Aberdeen Test Center, June 20, 1977. https://apps.dtic.mil/dtic/tr/fulltext/u2/a045343.pdf

4. “ANSI/IEC 60529-2004 Degrees of Protection Provided by Enclosures (IP Code)”. https://www.nema.org/Standards/ComplimentaryDocuments/ANSI-IEC-60529.pdf

5. “MIL-STD-1332B Definitions of Tactical, Prime, Precise, And Utility Terminologies For Classification Of The DoD Mobile Electric Power Engine Generator Set Family”. Naval Facilities Engineering Command, US Naval Construction Battalion Center, March 13, 1973. https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=36687

KEYWORDS: Tactical Vehicle; Power Generation; Weight Reduction; Size Reduction; ULTV; UTV; LMADIS; NOTM-UTV; Permanent Magnet Generator; Exportable Power; Power

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**CHEMICAL AND BIOLOGICAL DEFENSE PROGRAM**
**FY20.2 Small Business Innovation Research (SBIR)**
**Proposal Submission Instructions**

The approved FY20.2 topics included in the Chemical and Biological Defense (CBD) Small Business Innovation Research (SBIR) Program is listed below. Offerors responding to this Announcement must follow all general instructions provided in the Department of Defense (DoD) Program Announcement. Specific CBD SBIR requirements that add to or deviate from the DoD Program Announcement instructions are provided below.

***General Information***

In response to Congressional interest in the readiness and effectiveness of U.S. Nuclear, Biological and Chemical (NBC) warfare defenses, Title XVII of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) requires the Department of Defense (DoD) to consolidate management and oversight of the Chemical and Biological Defense (CBD) Program into a single office – Office of the Assistant Secretary of Defense for Nuclear, Chemical and Biological Defense Programs. The Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD), Defense Threat Reduction Agency (DTRA) provides the management for the Science and Technology component of the Chemical and Biological Defense Program. Technologies developed under the Small Business Innovation Research (SBIR) Program have the potential to transition to the Joint Program Executive Office for Chemical Biological Radiological and Nuclear Defense (JPEO-CBRND) if the appropriate level of technology maturity is demonstrated. The JSTO-CBD Science & Technology programs and initiatives improve defensive capabilities against Chemical and Biological Weapons of Mass Destruction. The SBIR portion of the CBD Program is managed by the JSTO-CBD.

The mission of the Chemical and Biological Defense Program is to ensure that the U.S. Military has the capability to operate effectively and decisively in the face of chemical or biological warfare threats at home or abroad. Numerous factors continually influence the program and its technology development priorities. Improved defensive capabilities are essential in order to mitigate the impact of Chemical and Biological Weapons. The U.S. military requires the finest state-of-the-art equipment and instrumentation available to permit our warfighters to 'detect to warn' and avoid contamination, if possible – and to be able to sustain operations in a potentially contaminated environment. Further information is available at the Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs homepage at https://www.acq.osd.mil/ncbdp/cbd/

The overall objective of the CBD SBIR Program is to improve the transition or transfer of innovative Chem-Bio technologies to the end user – the warfighter – in addition to commercializing technologies within the private sector for mutual benefit. The CBD SBIR Program targets those technology efforts that maximize a strong defensive posture in a biological or chemical environment using passive and active means as deterrents. These technologies include chemical and biological detection for both point and stand-off capabilities; individual and collective protection; hazard mitigation (decontamination); medical pre-treatments (e.g., vaccine development and delivery); medical therapeutics (chemical countermeasures and biological countermeasures); medical diagnostics; Digital Battlespace Management (aka information systems technology) to include but not limited to modeling and simulation (e.g., meteorological dispersion), disease surveillance, data fusion, and health & human effects.

***Submitting Your Phase I CBD SBIR Proposal***

**Your entire proposal submission must be submitted electronically through the Defense**

**SBIR/STTR Innovation Portal (DSIP) located at: https://www.dodsbirsttr.mil**
**A hardcopy is NOT required and will not be accepted by the Chemical and Biological Defense SBIR Program. Hand or electronic signature on the proposal is NOT required.**

The Proposal Technical Volume must be 20 pages or less in length. No other information included in the other proposal volumes counts against the 20-page Proposal Technical Volume page limit. Pages provided in excess of this length will not be evaluated or considered for review. The proposal must not contain any type smaller than 10-point font size (except as legend on reduced drawings, but not tables).

The maximum dollar amount for a Phase I proof-of-concept/feasibility study is $167,500 for a period of performance of up to six (6) months. **The CBD SBIR Program will not accept Phase I proposals which exceed $167,500 for the Phase I effort**. The total SBIR funding amount available for Phase II activities from a resulting Phase II contract is not to exceed $1,100,000.

Selection of Phase I proposals will be based upon the three evaluation criteria discussed in this Program Announcement. The CBD SBIR Program reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality in the judgment of the technical evaluation team will be funded. All SBIR contract awards, both Phase I and Phase II, are subject to availability of funding.

Companies should plan carefully for any research involving animal or human subjects, chemical agents, biological agents, etc. The brief Period of Performance available for a Phase I project precludes plans that include these elements, as all DoD requirements and necessary approvals associated with animal and/or human use must be strictly adhered to and require considerable coordination and significant time for final protocol approvals. See Section below for further information regarding animal and/or human subjects.

Proposals not conforming to the terms of this Announcement, and any unsolicited proposals, will not be considered. All awards are subject to the availability of funding and successful completion of contract negotiations. The Chemical and Biological Defense Program is not responsible for any funds expended by the proposer prior to contract award.

***CBD Program Phase II Proposal Guidelines***

Phase II is the demonstration of the technology that was found feasible in Phase I. Phase I awardees may submit a Phase II proposal without invitation; however, it is strongly encouraged that a Phase II proposal not be submitted until sufficient Phase I progress can be evaluated and assessed based on results of the Phase I proof-of-concept/feasibility study Work Plan and no sooner than a recommended five months from date of contract award. **All Phase II proposal submissions must be submitted electronically through the Defense SBIR/STTR Innovation Portal system at: https://www.dodsbirsttr.mil**

At the proposal submission website, Phase II proposals MUST be submitted to '**CBD** SBIR' regardless of which DoD contracting office negotiated and awarded the Phase I contract. Additional instructions regarding the Phase II proposal submission process including submission key dates will be provided to Phase I awardees after the Phase I contract is awarded; additional information may also be found at http://www.cbdsbir.net.

All proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing and manufacturing the developed technology. Proposers are required to submit a budget for the entire 24-month Phase II Period of Performance. During contract negotiation, the Contracting Officer may require a Cost Volume for a base year and an option year; thus, proposers are advised to be aware of this possibility. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD SBIR/STTR submission site). The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. At the Contracting Officer's discretion, Phase II projects may be evaluated for technical progress prior to the end of the base year, prior to extending funding for the option (second) year.

The CBD SBIR Program is committed to minimizing the funding gap between Phase I and Phase II activities. The CBD SBIR Program typically funds a cost plus fixed fee Phase II award, but may award a firm fixed price contract at the discretion of the Contracting Officer.

***Technical Assistance***

At this time, the CBD SBIR Program is not participating in the Technical and Business Assistance (TABA) Program.

***Protest Procedures***

Refer to the DoD SBIR Program Announcement 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: Mr. Larry Pollack, Chem-Bio Defense (CBD) SBIR Program Manager, Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD), lawrence.p.pollack2.civ@mail.mil

***CBD SBIR Projects Requiring Animal and Human Subjects***

Companies should plan carefully for any research involving animal and/or human subjects in addition to the use of any chemical or biological warfare agents, and use of any agents associated with "Dual Use Research of Concern (DURC)". The brief Phase I Period of Performance precludes plans requiring the use of many of these materials as well as animal and/or human subjects prior to obtaining all necessary DoD approvals.

The offeror is expressly forbidden to use or subcontract for the use of laboratory animals in any manner without the express written approval of the U.S. Army Medical Research and Material Command's (USAMRMC), Animal Care and Use Review Office (ACURO). Written authorization to begin research under the applicable protocol(s) proposed as part of the CBD SBIR program will be issued after contract award in the form of an approval letter from the USAMRMC ACURO to the recipient. Furthermore, modifications to already approved protocols require approval by ACURO prior to implementation.

Research under CBD SBIR awards involving the use of human subjects, to include the use of human anatomical substances or human data, shall not be proposed for any Phase I Period of Performance. If Human Subjects research is proposed during the Phase II Period of Performance, the studies may not begin until the DTRA Research Oversight Board (ROB) provides authorization that the research protocol may proceed. Written approval to begin research protocol will be issued from the ROB, under separate notification to the recipient. Written approval from the ROB is also required for any sub-recipient that will use funds obtained from any CBD SBIR awards to conduct research involving human subjects.

Changes in research involving human subjects shall be conducted in accordance with the protocol submitted to and approved by the ROB. Non-compliance with any provision may result in withholding of funds and or termination of the award.

## CBD SBIR FY20.2 Topic Index

**CBD SBIR 20.2 Topic Descriptions**

TOPIC: CBD202-001

TITLE: Engineered Beads for Chem-Bio Defense (CBD) Personal Protective Equipment (PPE)

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
KEY TECHNOLOGY AREA(S): Chemical/Biological Defense; Materials/Processes

OBJECTIVE: The Joint Chemical and Biological Defense Program seeks innovative solutions for engineering robust spherical beads containing metal-organic frameworks (MOFs) and/or metal oxyhydroxides (MOs) for use in chemical-biological (CB) personal protective equipment (PPE).

DESCRIPTION: Current military CB suits utilize activated carbon as a protective barrier against chemical warfare agents (CWAs). While effective, carbon does not efficiently detoxify CWAs. The ability to integrate a reactive material into suits represents an advantage for mitigating the chemical hazard. MOFs and MOs in particular have shown promise for decomposing and detoxifying CWAs and toxic industrial chemicals (TICs).[1-7] However, integration into uniforms has lagged due to the difficulty of making MOF/MO beads. This is particularly difficult with MOFs and MOs, especially when considering traditional techniques such as emulsion polymerization followed by polymerization and carbonization, which would render the MOFs and MOs inactive towards CWAs. Thus, this topic seeks novel and innovative techniques for engineering MOFs and MOs into spherical beads.

The engineered beads should be high mass loading of MOF or MO without significant attrition of the particle. The polymer used should be such that the MOF or MO is accessible to toxic compounds, that is, the polymer should not interact with active sites or block pores of the MOF or MO. Successful approaches will focus on engineering design principles and develop methods (and materials) in a variety of spherical diameters, focusing primarily on 100-500 µm (micrometers). Beads that are developed will be robust enough such that further processing into suits and other applications using techniques such as hot pressing, use with adhesives, and even extrusion are feasible.

PHASE I: Demonstrate the ability to make spherical particles containing high (>80%) MOF/MO materials in a variety of sizes (focus on 100-500 µm). Demonstrate activity using probe molecules and Chemical Weapon Agents (CWA) and/or simulants, as appropriate, with minimal loss in activity as compared to the native powder.

PHASE II: Fully optimize bead processing. Scale the process of bead manufacturing (> 1 kg quantities) and develop techniques for integrating beads into/onto textiles. Understand structure-activity-processing relationships, especially pertaining to bead size, MOF/MO loading, and barrier properties (e.g., permeation of simulants, air/moisture permeability, etc.). Achieve 100% reactivity of CWAs/simulants after 24 hours.

PHASE III: Collaborate with industry partners to develop full protective suits and ensembles for military applications. Determine additional use applications for the MOF/MO materials, such as filtration and decontamination.

PHASE III DUAL USE APPLICATIONS: First responder personnel, pesticide applications personnel, etc. would all benefit from a health & safety perspective resulting from the proposed technology

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KEYWORDS: Metal-organic framework, MOF, metal oxyhydroxides, zirconium hydroxide, polymer, bead, protective suit

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TOPIC: CBD202-002

TITLE: Plume Characterization and Differentiation in Multimodal Threat Sensing

RT&L FOCUS AREA(S): Network Command, Control and Commuinications
KEY TECHNOLOGY AREAS: Chemical/Biological Defense

OBJECTIVE: Develop analytical formalisms and algorithms to support reconnaissance and surveillance and integrated early warning of possible chemical or biological attacks

DESCRIPTION: Advanced sensor suites incorporated onto reconnaissance and force protection systems including the Nuclear, Biological, and Chemical Reconnaissance Vehicle and on installations, bases, and logistics support areas that support sustained maneuver are increasingly being integrated to develop great volumes of plume data in order to achieve situational awareness and immediate warning in the event of an adversary use of chemical and/or biological threat agents. A key technology component in such sensing systems is a light detection and ranging (LIDAR) system that develops geospatially accurate renderings of airborne particulate plumes in the battlefield environment. In pristine test environments, the plume data generated by elastic backscatter LIDAR measurements provides an intuitive diagnostic and metric to enable the localization and tracking of the challenge aerosol plume as it evolves from the point of release to evolve by mass transport and dispersion and (in the case of volatile aerosols) evaporation. However, in the anticipated land and/or maritime component operational space during ground maneuver and high-intensity conflict, the environment would be expected to be replete with airborne particulates caused by vehicle movement and weapons effects. Against such a backdrop of extensive clutter, the efficacy of a LIDAR plume detection and tracking capability set would be reduced if not rendered ineffective. This issue could be mitigated by exploiting the unique characteristics of a deliberate dissemination mechanism, such as a spraying device, liquid or solid aerosol dispersing shell or bomblet, or a missile or rocket incorporating a release mechanism to disseminate liquid or solid particulate matter. The effectiveness of such a signature or morphological characterization approach would be defined by the performance of a plume characterization algorithm that would tease out certain peculiar features of deliberate dissemination events that help distinguish them from more common kinetic events that would be ubiquitous in the battlefield environment.

PHASE I: The Phase I feasibility/proof-of-concept study will develop a machine learning and/or artificial intelligence-based logic approach that identifies plume features that would be expected to be peculiar to a deliberate dissemination mechanism vis-à-vis the routine and commonplace plumes that would be expected as a result of movement and kinetic events. Referee test data, to include LIDAR plume tracking measurements, from decades of release events at Army and Defense Threat Reduction Agency test facilities will be made available for the purposes of the Phase I study to develop a sufficiently robust volume of training and cross-validation data to demonstrate the bona-fides of the analytic procedure that would recognize subtle characteristics of the deliberate dissemination situation as distinguishable from the more routine plumes generated by movement or kinetic events.

Machine learning approaches must be sufficiently efficient to afford real time computational analysis of LIDAR data using ordinary platform-portable computational processing.

- Must be operable on a single rack-mounted computer system.
- Must operate continuously and generate decisions on plume data in real time when presented with a cluttered rendition of multiple (three or more) simultaneous plumes, one of which is a representative deliberate dissemination event.

PHASE II: The Phase II Period of Performance will engineer, integrate, test, and optimize the performance of a real-time analytic software engine based on the outcome of the Phase I feasibility study.

PHASE III: A real time analytic engine that employs an artificial intelligence approach to recognize and distinguish elements among a highly cluttered LIDAR data stream in real time would be extremely useful for a variety of military unmanned systems.

PHASE III DUAL USE APPLICATIONS: The real time analytic recognition and differentiation technology developed in conjunction with this topic would enable a wide variety of applications to include autonomous vehicle sensing system enhancements to recognize obstacles and pedestrians, industrial security, and agricultural autonomy control. Such algorithms may also prove to have applicability to medical diagnostic systems such as computational tomography and magnetic resonance imaging data analysis. Small business offerors should enunciate a clearly-defined commercialization strategy for the data feature recognition algorithms that includes an analysis of the market for such capabilities in industrial autonomy, environmental surveillance, diagnostic, and industrial monitoring applications.

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KEYWORDS: light-induced detection and ranging, LIDAR, aerosol discrimination, plume recognition, plume morphology, artificial intelligence, machine learning, mass transport and dispersion, pattern recognition, autonomy



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TOPIC: CBD202-003

TITLE: Design, Testing and Production of Shatter Resistant Autoinjector Formula Containers

RT&L FOCUS AREA(S): Biotechnology
KEY TECHNOLOGY AREA(S): Chemical/Biological Defense; Biomedical

OBJECTIVE: To design, develop, and manufacture appropriate sized autoinjector containers that are able to contain and deliver greater than or equal to ( $\geq 0.7$ mL ) and less than or equal to ( $\leq 2.0$ mL ) formulation volumes. Containers must be chemically inert to prevent drug formulation interactions and potential degradation of active ingredients. The containers need to resist damage during manufacturing and improved field survivability. Containers may be composed of strengthened glass or made with reinforcing coatings or other barrier coating systems over traditional glass or plastic. The containers will facilitate the generation of drug autoinjectors with a minimal rate of failure, and able to meet rigorous FDA medical device standards and requirements.

DESCRIPTION: Chemical agents, such as organophosphorus nerve agents (OPNAs) and other non-traditional chemical agents of concern, can exert their life threatening effects within a short period of time after exposure. Exposed individuals require immediate delivery of medical countermeasures to improve the chances of survival after a chemical attack. Medical countermeasure autoinjectors are critical medical devices that allow timely delivery of lifesaving medications in austere environments, outside of the medical care setting. While civilian autoinjector devices can be stored properly to ensure maintenance of device integrity and medication stability, fielded military autoinjector devices must be sufficiently robust to ensure the device is available at a critical time point. Hence, improvements are needed in autoinjector device design, to include both components and materials, to increase reliability and ruggedness. Military medical countermeasure autoinjectors rely on chemically inert containers to hold the drug formula being delivered in parenteral injections. Additionally, the FDA requirements for the reliability of combination drug/device products fit for purpose are stringent. However, currently available glass containers can be damaged either in shipment, or handling during manufacture, or while the autoinjector is being deployed or operated. This damage can contribute to container failure during the assembly process or potentially contribute to a failure of a fielded device. Improved, chemically inert containers that are resistant to these failures would aid in generating military autoinjectors that are more reliable and rugged.

Low internal energy following annealing has been identified as the root cause of cracked glass parenteral containers (1). The glass breakage mechanism is crack propagation by tensile stress concentration at a damaged point on the glass. This point serves as an origin of the breakage (2). The objective is to create containers that are resistant to these known failure mechanisms. The desired parenteral container should withstand insults from the manufacturing, filling, and assembly processes but still be conducive to an autoinjector design. The Department of Defense (DoD) is interested in identifying various potential solutions to achieve this objective. Innovative solutions may include, but are not limited to: 1) Changing the dimensions and thickness of the glass container. Making the areas of the envelope less vulnerable to damage by making them thicker may provide the needed strength to withstand manufacturing assembly, abuse in handling the device during operations, and the subsequent firing of the product when and as needed. 2) Treatment of the container, or the vulnerable areas of the glass container, with strengthening procedures. This can include well developed treatment approaches such as strengthening, tempering and ionic treatments; as well as novel/technology solutions that can be successfully applied to the containers. 3) Change container materials to stronger glass or adding barrier coating systems, such as polymer films, to augment strength. A pharmaceutical glass is reported to provide superior resistance to damage (1). 4) Change the container materials to plastic and treat the drug contact areas with a barrier coating system such as silica. An important parameter to consider is that changes in dimensions should take into consideration the availability of standard components that are used in the assembly of autoinjectors, such as plungers that push the drug out of the container and container sealing caps. Containers used for injection of medical countermeasures typically follow an ISO 11608-1 D1 single dose container system designation. ISO 11608-3 specifies the functional and design considerations for containers to be used with needle-based injection systems (NIS) that fulfil the specifications of ISO 11608-1 (4). In Section 4.4.2 of ISO 11608-3; 2012 (E), Figure 2 shows the dimensions for typical cartridges used as D1 containers for these military systems. For containers that are able to contain and deliver greater than or equal to ( $\geq$ ) 0.7 mL and less than or equal to ( $\leq$ ) 2.0 mL, the dimensions $d_6$, $d_2$ and $l_3$ in Figure 2 need to be adjusted to satisfy the volume ranges, but provide adequate serviceable strength without evidence of damage.

PHASE I: Due to the range of potential solutions/approaches that can be explored, there will be some flexibility in the milestones that will be accepted for this Phase. Objectives for this Phase are: 1) Determine if vulnerable areas of glass container can be sufficiently strengthened by thickening the glass to prevent catastrophic failure of the container closure system while staying within a maximum dimension $l_3$ of 53.3 mm (2.1") and diameter $d_6$ of 8.7 mm (0.34") for the smaller, and a maximum dimension $l_3$ of 53.3 mm (2.1") and diameter $d_6$ of 11.6 mm (0.46") for the larger. The containers to be designed, should be able to contain and deliver ≥ 0.7 mL and ≤ 2.0 mL formulation volumes. Final lengths and outer diameters may need to vary slightly to match existing designs. Alternatively, a design can be advanced that focuses on plastic containers treated with a barrier coating system such as silica to prevent interactions with the pharmaceutical product. 2) Advance towards generating prototypes that can be tested to demonstrate higher reliability and ruggedness than the current military container closure systems. 3) Plan to advance from prototype generation (Phase II) to rigorous testing. 4) Provide an estimate cost per unit to determine how the container will impact cost per autoinjector unit. Objectives may be met using mechanical simulations that model the physical behavior of a container incorporating the proposed solution/material/treatment versus the current container design/materials.

PHASE II: Strengthen currently used containers (stay within maximum $l_3$ and $d_6$ dimensions) using toughening treatments such as thermal ionic transfer, or laser surface modification, or other technologies identified/selected. Alternatively, continue development and testing of plastic containers treated with a barrier coating system such as silica. The optimized container configurations, reinforced or new prototypes, should be tested to military standards to quantify the degree of shatter resistance each approach offers. In addition to prototype and test data, the small business offeror should perform a cost impact assessment for the method(s) being employed to update the preliminary estimate. An additional objective for this Phase is to provide a plan to achieve production levels required to support autoinjector manufacturing.

PHASE III: Coordinate with multiple autoinjector manufacturers that supply, or will be supplying in the future, autoinjectors to the DoD, to incorporate improved container design into the assembly process. The improved container will demonstrate the ability to provide superior container closure system performance to help to satisfy the Food and Drug Administration's (FDA) rigorous reliability requirements for the assembled autoinjectors. This will require sufficient quantities of the improved container necessary to conduct stability testing and determine with appropriate test methods at industry standard time-points if regulatory requirements and standards are achieved.

PHASE III DUAL USE APPLICATIONS: The improved/strengthened autoinjector vials have multiple applications and multiple end-users. Specifically, in forward fielded medical encampments during natural disaster responses, this product will be extremely useful to minimize failures currently encountered during long-distance, expedited shipments. These types of supplies are critical for patient care, and maximizing 100% of product shipped must be available for use at the Point-of-Care. This is also true for the first responder/Emergency Medical Technical (EMT) communities when responding to a variety of medical emergencies include administering antidotes in the field for drug overdoses.

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3. A Method to Quantitatively Define and Assess the Risk of Cosmetic Glass Defects on Tubing Glass Vials. Loui A. PDA, Inc. (2011).

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KEYWORDS: autoinjector, glass strengthening, drug containers, glass ionic transfer, pharmaceutical glass, glass coating, glass treatment, chemically inert polymer, drug delivery

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**DEFENSE HEALTH AGENCY**
**20.2 Small Business Innovation Research (SBIR) Program**
**Proposal Submission Instructions**

The Defense Health Agency (DHA) SBIR Program seeks small businesses with strong research and development capabilities to pursue and commercialize medical technologies.

Broad Agency Announcement (BAA), topic, and general questions regarding the SBIR Program should be addressed according to the DoD SBIR Program BAA. For technical questions about a topic during the pre-release period, contact the Topic Author(s) listed for each topic in the BAA. To obtain answers to technical questions during the formal BAA period, visit https://www.dodsbirsttr.mil/submissions/login

Specific questions pertaining to the DHA SBIR Program should be submitted to the DHA SBIR Program Management Office (PMO) at:

E-mail - usarmy.detrick.medcom-usamrmc.mbx.dhpsbir@mail.mil
Phone - (301) 619-7296

The DHA Program participates in three DoD SBIR BAAs each year. Proposals not conforming to the terms of this BAA will not be considered. Only Government personnel will evaluate proposals with the exception of technical personnel from General Dynamics Information Technology (GDIT) and Allied Technologies and Consulting (ATC) who will provide technical analysis in the evaluation of proposals submitted against DHA topic number:

- DHA202-004 On-Site Creation of Dialysate Fluid

## PHASE I PROPOSAL SUBMISSION

Follow the instructions in the DoD SBIR Program BAA for program requirements and online proposal submission instructions.

DHA SBIR Phase I Proposals have four Volumes: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. **Please note that the DHA SBIR will not be accepting a Volume Five (Supporting Documents) as noted at the DoD SBIR website.** The Technical Volume has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments. Do not duplicate the electronically generated Cover Sheets or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 20-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. The CCR is generated by the proposal submission website, based on information provided by small businesses through the Company Commercialization Report tool. Technical Volumes that exceed the 20-page limit will be reviewed only to the last word on the $20^{th}$ page. Information beyond the $20^{th}$ page will not be reviewed or considered in evaluating the offeror's proposal. To the extent that mandatory technical content is not contained in the first 20 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

Companies submitting a Phase I proposal under this BAA must complete the Cost Volume using the on-line form, within a total cost not to exceed $250,000 over a period of up to six months.

The DHA SBIR Program will evaluate and select Phase I proposals using the evaluation criteria in Section 6.0 of the DoD SBIR Program BAA. Due to limited funding, the DHA SBIR Program reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

Proposals not conforming to the terms of this BAA, and unsolicited proposals, will not be considered. Awards are subject to the availability of funding and successful completion of contract negotiations.

## RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

**The DHA SBIR Program discourages offerors from proposing to conduct human subject or animal research during Phase I due to the significant lead time required to prepare regulatory documentation and secure approval, which will significantly delay the performance of the Phase I award.**

The offeror is expressly forbidden to use or subcontract for the use of laboratory animals in any manner without the express written approval of the US Army Medical Research and Development Command's (USAMRDC) Animal Care and Use Review Office (ACURO). Written authorization to begin research under the applicable protocol(s) proposed for this award will be issued in the form of an approval letter from the USAMRDC ACURO to the recipient. Furthermore, modifications to already approved protocols require approval by ACURO prior to implementation.

Research under this award involving the use of human subjects, to include the use of human anatomical substances or human data, shall not begin until the USAMRDC's Office of Research Protections (ORP) provides authorization that the research protocol may proceed. Written approval to begin research protocol will be issued from the USAMRDC ORP, under separate notification to the recipient. Written approval from the USAMRDC ORP is also required for any sub-recipient that will use funds from this award to conduct research involving human subjects.

Research involving human subjects shall be conducted in accordance with the protocol submitted to and approved by the USAMRDC ORP. Non-compliance with any provision may result in withholding of funds and or termination of the award.

## PHASE II PROPOSAL SUBMISSION

Phase II is the demonstration of the technology found feasible in Phase I. All DHA SBIR Phase I awardees from this BAA will be allowed to submit a Phase II proposal for evaluation and possible selection. The details on the due date, content, and submission requirements of the Phase II proposal will be provided by the DHA SBIR PMO. Submission instructions are typically sent toward the end of month five of the phase I contract. The awardees will receive a Phase II window notification via email with details on when, how and where to submit their Phase II proposal.

Small businesses submitting a Phase II Proposal must use the DoD SBIR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/login). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheets, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR/STTR Help Desk (1-703-214-1333) or Help Desk email at DoDSBIRSupport@reisystems.com.

The DHA SBIR Program will evaluate and select Phase II proposals using the evaluation criteria in Section 8.0 of the DoD SBIR Program BAA. Due to limited funding, the DHA SBIR Program reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

Small businesses submitting a proposal are required to develop and submit a Commercialization Strategy (please refer to DoD Instructions, section 7.4) describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal. This plan should be included in the Technical Volume.

The Cost Volume must contain a budget for the entire 24-month Phase II period not to exceed the maximum dollar amount of $1,100,000. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet.

DHA SBIR Phase II Proposals have four Volumes: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 40-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any attachments. Do not include blank pages, duplicate the electronically generated Cover Sheets or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 40-page limit.

Technical Volumes that exceed the 40-page limit will be reviewed only to the last word on the 40th page. Information beyond the 40th page will not be reviewed or considered in evaluating the offeror's proposal. To the extent that mandatory technical content is not contained in the first 40 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

## PHASE II ENHANCEMENTS

The DHA SBIR Program has a Phase II Enhancement Program which provides matching SBIR funds to expand an existing Phase II contract that attracts investment funds from a DoD Acquisition Program, a non-SBIR government program or eligible private sector investments. Phase II Enhancements allow for an existing DHA SBIR Phase II contract to be extended for up to one year per Phase II Enhancement application, and perform additional research and development. Phase II Enhancement matching funds will be provided on a dollar-for-dollar basis up to a maximum $550,000 of SBIR funds. All Phase II Enhancement awards are subject to acceptance, review, and selection of candidate projects, are subject to availability of funding, and successful negotiation and award of a Phase II Enhancement contract modification.

## TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The DHA 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.

The DHA SBIR Program has a Technical Assistance Advocate (TAA) who provides technical and commercialization assistance to small businesses that have Phase I and Phase II projects.

**PROTEST PROCEDURES**

Please refer to the DoD Program Announcement for procedures to protest an Announcement. As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to:

Ms. Micaela Bowers
SBIR/STTR Contracting Officer
U.S. Army Medical Research Acquisition Activity
Phone: (301)-619-2173
Email: micaela.l.bowers.civ@mail.mil

**DEFENSE HEALTH AGENCY SBIR 20.2 Phase I Topic Index**

DHA202-001 TITLE: Companion Diagnostic Platform for Rapid Assessment of Bacteriophage Susceptibility in Antibiotic-Resistant Bacterial Pathogens

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio medical

OBJECTIVE: Develop state-of-the-art diagnostic technology for rapid detection of antimicrobial susceptibility in pathogens from infected wounds that can be used to guide clinical decisions for use of non-traditional antimicrobials.

DESCRIPTION: U.S. military service members who are medically evacuated from theatre due to combat-related injuries have sustained high impact insults such as explosions, gunshot wounds and motor vehicle accidents, leading to significant skin and soft tissue injuries that may be frequently contaminated. A large proportion of these service members are at increased risk for infectious complications of their traumatic injuries, and the most common infections involve skin and soft tissue, wound infections, and osteomyelitis and sepsis if not treated in a timely manner. Acinetobacter baumannii has been identified as one of the most frequently associated organisms with skin and soft tissue infections among wounded warriors, occurring in 35% of wound infections. Within this 35%, up to 90% of the culture isolates were assessed to be antimicrobial resistant (AMR) [1]. Community-acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) is a well-recognized cause of skin and soft tissue infections (SSTI) in US military hospitals with a reported prevalence of 68% to 70% in selected military hospital emergency rooms [2]. High rates of MRSA skin and soft tissue infections have been observed among soldiers in training [3]. In addition to skin and soft tissue infection, MRSA is the most frequently isolated organism late in infection in traumatically injured service members [2]. Late infection in this population often results in limb salvaging amputation. Pseudomonas aeruginosa and Klebsiella pneumoniae are responsible for significant morbidity and mortality among both civilian and military populations, often colonizing mucosal surfaces, wounds, and foreign devices such as catheters and endotracheal tubes with biofilms that are highly resistant to antibiotic penetration and clearance by the immune system. In civilian and veteran populations these same types of infections frequently occur in individuals that have skin and soft tissue and prosthetic joint infections [4]. In a patient infected with multi-drug resistant organisms, the treatment choices often become limited due to waning approvals of new antibiotics. Frequently, these patients are hospitalized for prolonged periods of time and subsequently experience multiple episodes of hospital readmissions related to infectious complications of their wound or orthopedic implants. In addition to increased patient morbidity, provision of medical care for service members with infected traumatic wounds can be very costly and lead to intense resource utilization.

Furthermore, the prolonged systemic administration of broad spectrum antibiotics to soldiers and sailors escalates the risk of selecting for bacterial organisms with increased antibiotic resistance profiles. The dwindling arsenal of antibiotics active against multidrug-resistant organisms urgently necessitates novel therapeutics such as phage to decrease the rates of mortality and morbidity associated with MDR infections and maintain current standards of medical practice in the future. However, the clinical utility of novel antimicrobials, such as bacteriophage [5], will be limited by the inability to monitor the bacterial susceptibility in real time to guide clinical decisions and therapeutic use. Current antibiotic susceptibility testing systems are closed both from hardware and reagents to the software analytic pieces that prevent evaluation of alternative antimicrobials such as phage. This topic seeks an open standards system (easily expandable or modified for evaluation of different antimicrobial types) that can monitor individual bacterial susceptibility to bacteriophage and eventually other non-traditional antimicrobial agents to support preclinical development and evaluation of therapeutic candidates and for future use as a companion diagnostic in the clinics to guide treatment decisions.

PHASE I: Selected performer determines the feasibility of the concept by developing a prototype diagnostic susceptibility-based assay that has the potential to meet the broad needs discussed in this topic description. Currently there are no FDA-cleared, field-capable assays that can be used to rapidly identify the most common bacterial pathogens causing wound and sepsis infections as described in references 1-6 (to include but not limited to the ESKAPE group of pathogens: Enterococcus spp., Staphylococcus aureus, Klebsiella pneumonia, Acinetobacter baumannii, Pseudomonas aeruginosa, Enterobacter spp, and Escherichia coli), as well as an ability to determine the respective susceptibility of the detected pathogen to bacteriophage. Development of an assay for that can rapidly determine the susceptibility of AMR bacteria to bacteriophage is therefore a high priority for development and eventual clinical use of these promising therapeutics. Assay run time should be congruent with or more rapid (less than or equal to overnight culture; 16-18h) than current automated antibiotic susceptibility testing systems in order to provide results within a clinically relevant timeframe to guide therapeutic use.

PHASE II: Based on the results from Phase I, the selected performer provides up to 3 initial lots of at least 50 prototype assays (tests or plates) each to the COR. These initial lots will be evaluated for sensitivity and specificity using a diversity set of bacterial strains and cognate bacteriophage for evaluation in vitro. Can coordinate with WRAIR/NMRC for materials and assistance with preclinical evaluation if needed. Feedback regarding the sensitivity/specificity of each lot of prototype assays will be provided to the performer. This data will then be used to optimize each subsequent lot of assays. The goal in Phase II is the development of a prototype assay that provides 85% sensitivity and 85% specificity when compared to phage plaque assays. Once sensitivity and specificity requirements have been met in preclinical tests, the selected performer will confirm the performance characteristics of the assay (sensitivity, specificity, positive and negative predictive value, accuracy and reliability) using preclinical or clinical specimens. The elected performer will require a Federal-Wide Assurance of Compliance before government funds can be provided for any effort that requires human testing or uses of clinical samples. The selected performer will also conduct stability testing of the prototype device in Phase II. Stability testing will follow both real-time and accelerated (attempt to force the product to fail under a broad range of temperature and humidity conditions and extremes) testing in accordance with FDA requirements. The data package plan required for application to the U.S. Food and Drug Administration will be prepared at the end of phase II.

PHASE III: During this phase the performance of the assay should be evaluated in field studies or clinical trials that will conclusively demonstrate that the assay meets the requirements of this topic. The performer may coordinate with WRAIR/NMRC for this objective. Military applications: AMR bacterial infections occur worldwide. The diagnosis of these wound infections and sepsis cases are often delayed, because the currently available tests, mostly reliant on bacterial culture or high-complexity nucleic acid amplification, are not field-capable, not rapid, and can vary considerably among different laboratories even when using the same procedure or method. With the availability of an easy and rapid assay developed under this topic, wounded and ill soldiers can be treated with more effective antimicrobials such as bacteriophage, alongside traditional antibiotics, in a timely manner in any military medical organization (such as a Battalion Aid Station, a Combat Support Hospital, Forward operation base, or a fixed medical facility). The performer should coordinate with WRAIR/NMRC to establish a National Stock Number (NSN) for potential inclusion in into appropriate "Sets, Kits and Outfits" that are used by deployed medical forces. Civilian applications: MDR bacterial infections occur in communities and hospitals, in wounds, skin and soft tissue infections, pneumonia, and blood stream infections. We envision that the performer that develops the rapid diagnostic assay and will be able to sell and/or market this assay to a variety of civilian medical organizations, and that this market will be adequate to sustain the continued production of this device.

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5. Kutter, E., et al., Phage therapy in clinical practice: treatment of human infections. Curr Pharm Biotechnol, 2010. 11(1): p. 69-86.

KEYWORDS: Wound Infections, ESKAPE, AMR, MDR, Diagnostic, Bacteriophage, Phage therapy, antimicrobial, susceptibility testing

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DHA202-002 TITLE: A Multiplexed, Functional Assay to Determine the Bactericidal Activity of Antibodies Against Multiple Enteric Bacterial Pathogens

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio medical

OBJECTIVE: Develop a qualified, multiplexed, functional assay that can be used to evaluate bactericidal activity of antibodies against an array of Shigella enabling high-throughput sample analysis.

DESCRIPTION: Bacterial pathogens that cause diarrhea are a significant threat to the warfighter on a global scale and consistently rank at the top of the list of infectious agents for which the Army requires countermeasures. Infection with these pathogens leads to a reduction in warfighter readiness, morale, lost duty days. Shigella is a major cause of diarrhea in children and adults in low- to middle-income countries (LMICs), and among travelers and US Service Members (1). Shigella infection can lead to persistent diarrhea (≥14 days) in travelers to endemic areas, and can also have long-term health impacts including irritable bowel syndrome and reactive arthritis (2). The high incidence of infection, the rise of antibiotic resistance, the long duration of illness and the potential long-term side effects make prevention of Shigella infection a high priority for US Service Members deployed to endemic areas.

One of the major technical issues facing the field when developing prophylactic or therapeutic products is the board species diversity (3) and the serotype specific immune responses that are generated after infection (4). The focus of the Shigella research has been on the development of countermeasures that are capable of protecting against multiple serotypes of Shigella. These countermeasures most often target four Shigella species, S. flexneri 2a, S. flexneri 3a, S. flexneri 6 and S. sonnei. A countermeasure that was capable of protecting against these serotypes would significantly reduce global disease burden. The need for effective prophylactic and therapeutic products to combat Shigella also requires immunological methods to evaluate these products and their efficacy. Many of the current Shigella-specific immunological assays are only quantititave, and do not offer any qualitative information about the immune response being investigated. Functional immunological assays to assess immune responses to Shigella do exist (5), but these are typically specific for only a single serotype. Evaluating responses to multiple serotypes in a single-plex assay is time consuming and also requires greater quantities of serum and mucosal samples, many of which are limited.

An assay to evaluate the shigellacidal activity of antibodies is imperative for the vaccine development field, but the new push for non-vaccine countermeasures to combat Shigella will also require robust functional assays. Both vaccine and non-vaccine countermeasures will need reliable, validated assays to show product efficacy, and this will include qualitative analysis of immune responses and immunoprophylactic products. Any successful countermeasure product will need to protect against or treat infection with multiple Shigella serotypes to be highly efficacious, so the development of multiplexed immunoassays will save time, supplies, and biological sample volumes. The development and validation of a multiplexed, Shigella¬-specific, functional assay will support the rapid development and evaluation of efficacious prophylactic and therapeutic countermeasures to prevent and treat Shigella infections. The ultimate problem to be solved, and the central focus of this topic, is the development of an assay platform to measure functional antibody activity and immune responses to Shigella and other enteric bacterial pathogens.

PHASE I: Phase I will focus on assay conceptualization including assay parameters, internal controls, and data analysis package. A major component of phase I will be concept design of the multiplex assay format to include discrete readouts for each bacterial serotype to be analyzed (e.g. fluorescence, antibiotic resistance cassettes). The concept design will also require that assay qualification parameters are defined including: a) bio-specimen types (e.g. blood, sera, fecal), bio-specimen volume required (e.g. finger-stick, 500 ul sera derived from venipuncture; b) generation of positive and negative controls (e.g. monoclonal antibodies, pooled sera). Specifically, the awardee will have performed the assay in a research laboratory setting and demonstrated that it can be repeated by additional users. In order to demonstrate the feasibility of multiplexing, a minimum of two Shigella serotypes will be evaluated using the proof-of-concept prototype assay and a pilot panel of control samples and monoclonal antibodies that target Shigella serotypes in the assay.

PHASE II: Phase II will focus on finalizing and refining the optimal multiplex assay approach from Phase I. The workflow from Phase I should be refined to expand on the proof-of-concept into a product that enables high-throughput screening of serum or other clinical samples against multiple Shigella targets. The assay will be performed in a research laboratory setting to demonstrate the feasibility of multiplexing using a minimum of four Shigella serotypes. In addition to execution of the assay, a qualification of the inter- and intra-assay reproducibility in-house should be performed. This qualification will include metrics of assay precision, repeatability and reproducibility, with estimates of uncertainly around these metrics. The assay should be specific for at least four Shigella targets, but the platform should also be flexible and allow expansion to other enteric bacterial pathogens such as ETEC, Cholera, Campylobacter or Salmonella. A detailed plan for assay qualification should be developed across multiple laboratory sites. This phase should also demonstrate evidence of commercial viability of the product.

PHASE III: The expected Phase II end-state is a qualified, easy to use, multiplexed, functional assay kit which can be used on a relatively low volume of biological sample of varying types and evaluates bactericidal activity to at least five Shigella serotypes simultaneously. This assay platform should also be under development for expansion to measure responses to other bacterial enteric pathogens beyond Shigella. This assay kit represents a method to evaluate functional antibody responses targeting Shigella. The development of effective anti-Shigella countermeasures relies heavily on the identification of products that are effective at functionally inhibiting bacterial infection. The assay kit described here is unique to anything currently in development, as it is multiplexed to include many cynically relevant strains of Shigella and it measures functional activity of antibodies. This end-product has the potential to be used by research laboratories to examine the potency of enteric countermeasures. These countermeasures may include hyper-immune bovine colostrum products, monoclonal antibodies, and passive vaccine strategies; all of which are aimed at preventing or treating disease caused by Shigella. A validated functional assay would help to harmonize immunological assessment of Shigella-specific countermeasures globally, which will allow for accurate comparisons between products and speed the production of efficacious prophylactics. This product would also likely be used in the immunological analysis of controlled human infection models (CHIMs) for Shigella to understand the development of serotype specific immunity, and facilitate development and evaluation of pan-Shigella countermeasures. A potential method of transition for this product will be through the Army futures command following the decision gate process. This product may also be attractive to private industry, as this multiplexed assay kit is ideally suited to evaluate immunoprophylactic products as well as commercial vaccines. Assays that evaluate functional antibody activity are essential for vaccine licensure in many current vaccines including seasonal influenza and meningococcal polysaccharide vaccines. Civilian commercialization of this product is likely to include GLP production and GMP manufacture and distribution.

REFERENCES:


1. Porter CK, Olson S, Hall A, & Riddle MS (2017) Travelers' Diarrhea: An Update on the Incidence, Etiology, and Risk in Military Deployments and Similar Travel Populations. Mil Med 182(S2):4-10.
2. Connor BA & Riddle MS (2013) Post-infectious sequelae of travelers' diarrhea. J Travel Med 20(5):303-312.
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4. Formal SB, et al. (1991) Effect of prior infection with virulent Shigella flexneri 2a on the resistance of monkeys to subsequent infection with Shigella sonnei. J Infect Dis 164(3):533-537.
5. Nahm MH, et al. (2018) Development, interlaboratory evaluations, and application of a simple, high-throughput Shigella serum bactericidal assay. mSphere 3(3).

KEYWORDS: Shigella, Bacterial Diarrhea, Diagnostic Assay, Immunoassay, Multiplex, Validation, Antibody

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DHA202-003 TITLE: Development of Human Monoclonal Antibody Therapeutic against Klebsiella pneumoniae Infection

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio medical

OBJECTIVE: Develop human monoclonal antibodies against K. pneumoniae for therapeutic use. Candidate antibodies will be tested for binding to the surface of the target bacterium and evaluated for efficacy as a prophylactic and therapeutic with and without standard of care antibiotics in relevant animal models and downstream human clinical trials. Infection rates occur in 20-35% of combat-associated traumatic injuries; K. pneumoniae has been responsible for 8-10% of these infections resulting loss of life, limb, and delayed or prohibited return to duty at an estimated cost of $1M-$2M per injured military member. A monoclonal antibody therapeutic is a promising solution to prevent these infections, deaths, amputations, and to enhance return to duty.

DESCRIPTION: U.S. military members medically evacuated from theater because of combat injuries sustain high impact insults such as explosions, gunshot wounds and motor vehicle accidents, leading to significant injuries that are frequently contaminated. Without timely treatment, injuries are at increased risk for infectious complications, especially skin and soft tissue, wound, osteomyelitis and sepsis1. K. pneumoniae poses a serious threat and will be a threat in future conflicts because:

1) K. pneumoniae has grown significantly resistant to antibiotics, and there are now multidrug-resistant (MDR), extensively drug-resistant (XDR) and even pandrug-resistant (PDR) strains leaving clinicians in the military health system (MHS) with few or no treatment options.
2) Although antibiotic discovery has caught up with drug-resistant Gram-positive pathogens, such as S. aureus, the same is not true for drug-resistant Gram-negatives. Specifically, the recently approved antibiotic, ceftolozane-tazobactam, provides coverage against P. aeruginosa infections, but is not effective against K. pneumoniae. Similarly, although ceftazidime-avibactam is effective against most serine carbapenemase-producing bacteria, but not many K. pneumoniae isolates.
3) Irrespective, monotherapy is subject to resistance.

Therefore, because of the looming threat of drug resistance and a paucity of effective antibiotics, wound infections caused by K. pneumoniae will not be resolved by traditional antibiotics, and investment in alternative strategies is paramount. Monoclonal antibody therapy is a non-traditional, antibacterial approach, which works on its own or as an adjunct to antibiotics, both prophylactically or as treatment, to resolve infection. In the 19th century, serum was successfully used to treat bacterial infections2. Now, with 21st century technology, generation of human monoclonal antibodies (Hu-mAb) is a viable and attractive antibacterial strategy that can be somewhat fast-tracked through clinical trials given the inherent lack of toxicity and stability issues, which often accompany other traditional antibacterial approaches. Other advantages of Hu-mAb therapy are: (1) longevity, as this product is not cleared by the immune system as fast as mAbs from other animal sources; (2) confers inherent pathogen specificity without disrupting the microbiome; (3) potentiates rapid and sustained killing via multiple mechanisms including: direct killing, anti-virulence, neutralization, complement deposition, and opsonization by phagocytes2. Furthermore, mAbs with Fc domains that bind to the host phagocyte receptor FcγRII result in downstream suppression of inflammation and sepsis caused by Gram-negative bacteria3. Killing bacteria by multiple mechanisms limits toxic shock seen in sepsis and limits emerging resistance.

Recently, companies have successfully developed Hu-mAb to treat bacterial infections. The FDA approved two Hu-mAb products: Bezlotoxumab for Clostridium difficile infection and Raxibacumab for Bacillus anthracis infection4. There are six additional Hu-mAb antibacterial solutions in the development pipeline.

Preferred Features of monoclonal antibody deliverable:

- human or humanized antibodies will be given highest priority
- if non-human antibodies will be made, a plan for humanization must be included in Phase III

PHASE I: Selected performer determines the feasibility of the concept by identifying at least 100 unique mAbs that bind to at least 5 unique targets on the native, bacterial surface or secreted factors of a clinically-relevant strain of K. pneumoniae by ELISA, fluorescent microscopy, or other like methods. 50% of mAbs must bind to biofilm-grown bacteria or supernatants of biofilm-grown bacteria and 50% must bind planktonically grown bacteria or secreted factors. Half of each group of mAbs must bind in the presence of capsule. Further, these 100 mAbs may not bind either the capsule or lipopolysaccharide (LPS). Selected performer will coordinate with WRAIR/NMRC for required bacterial strains to help facilitate assay results, and any work by WRAIR/NMRC with respect to this deliverable will be done at no cost. Deliverable 1: The selected performer will provide the COR with 100 unique mAb sequences (to a minimum of 5 unique bacterial proteins) and mAbs.

PHASE II: Selected performer will epitope map mAbs and establish broad reactivity (80% or greater reactivity) of mAbs against a diverse set of at least 100 clinically-relevant K. pneumoniae strains. Performer will determine mAb function by using secondary screens to include, at minimum: anti-growth, anti-biofilm, anti-virulence, complement, and opsonizing activity against the bacteria of interest. Performer will determine identity of bacterial targets of mAbs with activity in any assay listed above. The results of the secondary screen must yield at least 10 antibodies (to at least five unique bacterial targets) that bind to the surface of the bacterium or to secreted bacterial factors and have some antibacterial or enhanced immunologic function, such as increased bacterial killing via complement or opsonophagocytosis. Ultimately, candidates need to be narrowed to at least 10 mAb that reduce bacterial numbers or show in a tissue culture assay that bacteria can no longer kill or intoxicate host cells. Finally, this set of antibodies will be tested in an in vivo efficacy model to identify the best single or combination of antibodies for Phase III. WRAIR/NMRC could assist with this work, and this work would be at no cost. Deliverable 2: Performer will deliver results of in vitro assays to COR.

PHASE III: Positive Phase II results infers that the product will move forward with a series of preclinical experiments to support Deliverable 4: an IND and clinical trial for a Hu-mAb product against K. pneumoniae. This phase will encompass both small and large animal models such as mouse,rabbit, mini-pig and/or pig, for survival, sepsis and SSTI/wound infections. These should be in addition to the animal model done in Phase II to address both safety and efficacy. The models should consider endpoints such as: survival, bacterial burden, and time to wound closure, which reflects the requirements for the U.S. Food and Drug Administration (FDA) with regard to a product for ABSSSI. Promising antibodies will be combined into a defined mix or cocktail and in vivo efficacy experiments repeated. Performer will investigate efficacy of the mixture alone and in combination with antibiotics to evaluate synergy in an appropriate animal model. This phase will also include a formal clinical indication for the cocktail, which would be SSTI, ABSSSI and/or other relevant clinical indication. Additionally, the selected performer will establish an escalating toxicity model to establish a therapeutic window for the FDA. Finally, the performer will address the serum longevity of the final product(s) in a representative animal model of infection. All experiments should be completed GLP-like/GMP-like as best as possible. Funding for this effort could come from the Joint Warfighter Medical Research Program (JWMRP) or from awards in Congressionally Directed Medical Research Program (CDMRP), Additionally, CARB-X a spin off programs of the Biomedical Advanced Research and Development Authority (BARDA) is an additional potential funding source.

The Government customer would use this product a number of ways to include prophylactic therapy or treatment along with the standard of care for wound infections. The market value of a product would be estimated around $100M-$150M as there are about 50,000 of these infections worldwide and current pricing for novel antibiotics is at least $3000 a dose4. Once developed and demonstrated, the technology can be used both commercially in civilian or military settings. The selected performer shall make this product available to potential military and non-military users throughout the world.

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2. Casadevall A. (1996) Antibody-based therapies for emerging infectious diseases. Emerg Infect Dis. 1996 Jul-Sep;2(3):200-8.
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KEYWORDS: Wound Infections, ESKAPE, AMR, monoclonal antibodies, prolonged field care, bacteria, pathogens, antibacterial treatments

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DHA202-004 TITLE: On-Site Creation of Dialysate Fluid

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio medical

OBJECTIVE: The objective of this Small Business Innovation Research topic is to develop a technology that can create dialysate fluid on-site using potable water, non-potable water, and salt water without a source of electrical power that weighs less than 1lb. and is FDA approved for its intended purpose.

DESCRIPTION: It is anticipated that future battlefield environments will have prolonged care scenarios in which critically injured patients will not be evacuated out of theater for extended periods of time, up to and beyond 72 hours. Based on these evacuation times, it is anticipated that patients will arrive at Field Hospitals in critical condition, leading to increased rates of acute kidney injury (AKI) ~19-40% of patients arriving to the Field Hospital, similar to those seen in civilian hospital emergency rooms1-2.

Current technologies that provide support for AKI require large amounts of dialysate fluid to function, ~75L of fluid per patient per day. Shipping this amount of fluid into the battlefield environment is not logistically feasible in future battlefields that will be conducted using Multi-Domain Operations (MDO).

Therefore, the DoD is seeking new and innovative technologies that are able to create dialysate fluid on the battlefield that don't require power, are lightweight, and are rugged enough to withstand military environments. The technology should be able to create the dialysate fluid from any source of available water including, but not limited to potable, non-potable, and salt water.

PHASE I: The contractor should provide basic proof of concept that their selected technology has the ability to create dialysate fluid for use in extracorporeal life support of the kidneys. The basic principle that is demonstrated should be expandable for use with different water types with no or minimal modifications to the process. The technology should function without electrical power. Design drawings for the fully functional prototype device should be completed by the end of this phase.

PHASE II: The contractor should develop and demonstrate their technology showing that it can create dialysate fluid for use in extracorporeal life support of the kidneys. The technology should function without electrical power and be able to use any source of available water to create the dialysate fluid, including, but not limited to potable water, non-potable water, and salt water. The contractor should then validate that the created dialysate fluid meets US standards for dialysate3. Finally, the contractor should conduct a Pre-Submission meeting with the FDA to validate their regulatory strategy and testing of the technology aligns with FDA requirements. Deliverables include 5 prototypes, validation test reports, the contractor's proposed regulatory strategy, FDA pre-submission meeting minutes providing feedback on the contractor's proposed regulatory strategy, and a technology commercialization strategy.

PHASE III: The contractor should refine and implement their regulatory strategy for obtaining FDA approval of their technology for use as dialysate fluid based off of their initial FDA feedback. This phase should culminate in submission to the FDA of the developed technology for approval. In conjunction with FDA submission, the contractor should develop scaled up manufacturing of the technology that follows FDA quality regulations. Work may result in technology transition to an Acquisition Program managed by the Warfighter Expeditionary Medicine and Treatment (WEMT) Project Management Office (PMO) and/or commercialization of this technology capability. Contractor shall seek additional funding from other government sources and/or private sector investors to develop or transition the prototype into a viable product for sale to the military and private sector markets. The ability to create dialysate fluid on the battlefield will remove the logistical constraint for providing kidney support to critically injured soldiers on the battlefield, allowing kidney support to be provided in theater. This type of technology may also be of interest to large-scale dialysate manufacturing companies for further partnership and commercialization.

REFERENCES:

1. Haines et al. (2018). Acute Kidney Injury in Trauma Patients Admitted to Critical Care: Development and Validation of a Diagnostic Prediction Model. Nature Scientific Reports (8:3665) 1-9.;
2. De Abreu et al. (2010). Acute Kidney Injury After Trauma: Prevalence, Clinical Characteristics, and RIFLE Classification. IJCCM, 14(3). 121-128.;
3. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPCD/classification.cfm?ID=KPO

KEYWORDS: Dialysate, Kidney, Extracorporeal, Life Support, Renal Replacement Therapy, Fluid

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# SBIR 20.2 DEFENSE LOGISTICS AGENCY (DLA) SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

**Proposal Submission Instructions**

## GENERAL

The Defense Logistics Agency (DLA) implements, administers, and manages the SBIR/STTR Program as part of the Small Business Innovation Programs through DLA J68 Information Operations / Research, and Development (R&D) Division. Consult the program website at the following location: http://www.dla.mil/SmallBusiness/SmallBusinessInnovationPrograms for general information about the DLA SBIP Program and its mission. If you have any questions regarding the administration of the Program, please contact the DLA SBIR Program Manager (PM):

Denise Price email: DLASBIR2@dla.mil

## TECHNICAL QUESTIONS

For questions regarding the SBIR/STTR topics during the pre-release period, contact the Topic Technical Point of Contact (TPOC) listed for each topic on the SBIR/STTR website at https://www.dodsbirsttr.mil/submissions/login prior to the close of the pre-release. To obtain answers to technical questions during the open period; submit your questions through the online SBIR/STTR Q&A System https://www.dodsbirsttr.mil/submissions/login.

For general inquiries or problems with electronic submission, contact Department of Defense (DoD) SBIR Help Desk at DoDSBIRSupport@reisystems.com or 703.214.1333 between 9:00 am and 6:00 pm ET.

## PHASE I KEY DATES

| | |
|---|---|
| 20.2 BAA (Pre-release) | 6 May 2020 |
| 20.2 BAA (Open period) | 3 June 2020 |
| 20.2 BAA Closes | 2 July 2020 (@ 8PM ET) |

## PROGRAM BROAD AGENCY ANNOUNCEMENT (BAA) 20.2

### PHASE I GUIDELINES

DLA is committed to improving the time to award new projects. As such, all DLA Phase I topics are subject to pilot efforts intended to meet legislative goals.

A list of the topics currently eligible for proposal submission is included in the Topic Index, followed by full topic descriptions. Additional guidance is as follows:

- Proposal period of performance should not to exceed 9 months. However each topic has a specified Period of performance
- Proposal Cost Estimates are topic dependent, and each topic has a specified ceiling. However, the DLA Program Manager has the discretion to waive this limit up to $250,000. This must be pre-approved during the pre-release period. (Approval Attached in Volume V)
- Phase I proposals not to exceed the 20-page limit.
- Proposal attachments, appendices, or references are included in Volume 5.
- Notification of selection and non-selection occurs electronically via e-mail.

For detailed proposal submission guidance, refer to U.S. Department of Defense (DoD) Instructions 20.2 SBIR at: https://www.dodsbirsttr.mil/submissions/login

### PHASE II GUIDELINES

Phase II eligibility is based on the following guidance:

- Phase I awardees may submit a Phase II proposal without invitation.
- Proposal period of performance not to exceed 24 months.
- Proposal Cost Estimate should not to exceed $1,000,000, however, the DLA Program Manager has the discretion to waive this limit up to $1,600,000. The Program Manager will make this determination during the course of the Phase I Project.
- Phase II proposals not to exceed the 40-page limit.
- Proposal attachments, appendices, or references are included in Volume 5.
- Cost Estimate and the Company Commercialization Report are not included in the 40-page limit.
- Commercialization Strategy Requirements:
  - Business Case highlighting benefits to the DoD/DLA.
  - Transition Strategy and Key Tasks
  - Time-Phased Transition Plan
  - Projected Transition Cost Analysis

DLA Phase II proposals must follow the detailed proposal submission guidance in the original Phase I BAA. Refer to DoD Instructions at https://sbir.defensebusiness.org/.

### EVALUATION CRITERIA

Phase I see Section 6 in the OSD BAA Phase II see Section 8 in the OSD BAA

### 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.

**DELIVERABLES / REPORTS**

All DLA SBIR and STTR awardees are required to submit reports in accordance with the deliverable schedule. The recipient must provide all reports to the individuals identified in Exhibit A of the contract. Milestones: Each phase of the project will be milestone driven. The Principal Investigator will propose milestones prior to starting any phase of the project.

**Phase I Proposals** should anticipate a combination of any or all of 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 - DLA SBIP Team will provide a format at the Post Award Conference (PAC).
- The TPOC and PM will determine a meeting schedule at the PAC. Phase I awardees can expect:
  - Mid Term Project Review (format provided at the PAC); and possibly
  - Monthly (or more frequent) Project Reviews (format provided at the PAC)
- 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, non-proprietary high resolution photos or graphics intended for public viewing)
- Phase II Proposal is optional at the Phase I Awardee's discretion (as Applicable)
- Applicable Patent documentation
- Other Deliverables as defined in the Phase I Proposal

**Phase II Proposals** should anticipate a combination of any or all of 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 can expect:
  - Triannual Project Review (format provided at the PAC)
  - Monthly (or more frequent) 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 and 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.

# DEFENSE LOGISTICS AGENCY

## DEFENSE LOGISTICS AGENCY SBIR 20.2 Topic Index

DLA202-001 TITLE: Engaging the Manufacturing Industrial Base in Support of DLA's Critical Supply Chains

RT&L FOCUS AREA(S): Nuclear, General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Air Platform, Materials, Nuclear Technology, Weapons

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 section 3.5 of 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: Build Small Business Manufacturer (SBM) base qualified and ready to improve DLA product availability, provide competition for reduced lead time and cost, and address lifecycle performance issues. Through participation in DLA SBIR, SBMs will have an opportunity to collaborate with DLA Weapons System Program Managers (WSPMs) and our customer Engineering Support Activities (ESAs) to develop innovative solutions to DLA's most critical supply chain requirements. The intent of the topic is to develop SBMs who will economically produce NSNs with historically low demand utilizing innovative technologies resulting in reduced lead time and cost with enhanced life cycle performance. In the end, the SBM benefits from the experience by qualifying as a source of supply as well as from the business relationships and experience to further expand their product lines and readiness to fulfill DLA procurement requirements.

DESCRIPTION: Competitive applicants will have reviewed the parts list provided on DLA Small Business Innovation Program (SBIP) site, (Reference 4) as well as the technical data in the cFolders of DLA DiBBs, (Reference 3). Proposals can evolve in one of four ways depending on the availability of technical data and NSNs for reverse engineering as follows. Information on competitive status, RPPOB, and tech data availability will be provided on the website, Reference 4:

a. Fully Competitive (1G) NSNs where a full technical data package is available in cFolders. The SBM proposal should reflect timeline, statement of work and costs associated with the manufacturing and qualification of a representative article.
b. Other than 1G NSNs where a full Technical Data Package (TDP) is available in cFolders. The SBM proposal should reflect timeline, statement of work, and costs associated with producing a Source Approval Request (SAR). The scope and procedures associated with development of a SAR package are provided in Reference 1.
c. Repair Parts Purchase or Borrow (RPPOB) is for other than 1G NSNs where partial or no technical data is available in cFolders. NSNs can be procured or borrowed through this program for the purposes of reverse engineering. The instructions for RPPOB can be found on the websites, Reference 5. The SBM proposal should reflect timeline, statement of work and costs associated with the procuring the part and reverse engineering of the NSN. Depending on complexity, producing both the TDP and SAR package may be included in Phase I.
d. Reverse Engineering (RE) without RPPOB is when the NSN will be provided as Government Furnished Material (GFM) if available from the ESA or one of our Service customers. In this case, contact the TPOC to discuss the availability of the NSN prior to starting the proposal. The SBM proposal should reflect timeline, statement of work and costs associated with the reverse engineering of the NSN and depending on complexity producing a TDP and SAR package in Phase I.

Specific parts may require minor deviations in the process dependent on the Engineering Support Activity (ESA) preferences and requirements. Those deviations will be addressed post award.

Participating small businesses must have an organic manufacturing capability and a Commercial and Government Entity (CAGE) code and be Joint Certification Program (JCP) certified in order to access technical data if available.

Refer to “link 2” below for further information on JCP certification. Additionally, small businesses will need to create a DLA’s Internet Bid Board System (DIBBS) account to view all data and requirements in C Folders.

Refer to “links 3 and 4” below for further information on DIBBS and C Folders. All available documents and drawings are located in the C Folder location “SBIR202A”. If the data is incomplete, or not available, the effort will require reverse engineering.

PHASE I: The goal of phase I is for the SBM to qualify as a source of supply for DLA NSNs to improve DLA product availability, provide competition for reduced lead time and cost, and address lifecycle performance issues. In this phase, manufacturers will request TDP/SAR approval from the applicable Engineering Support Activity (ESA), if required, for the NSNs. At the Post Award Conference, the awardee will have the opportunity to collaborate with program, weapon system, and/or engineering experts on the technical execution and statement of work provided in their proposal. There are exceptions for more complex parts and the proposal should provide the rationale.

ITAR: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the Announcement.
JOINT CERTIFICATION PROGRAM (JCP): Applicants will be required to obtain JCP Certification in order to view technical data. The lead time to complete JCP certification may be significant. Do this first if you do not already have a JCP certificate.

MULTIPLE NATIONAL STOCK NUMBERS (NSNs) PER PROPOSAL: Applicant may submit multiple NSNs on an individual proposal. However, do not combine multiple parts on the same proposal from multiple weapon systems. The information on NSNs and corresponding weapons system can be found DLA Small Business Innovation Program (SBIP) site link, Reference 4.

PERIOD OF PERFORMANCE: The phase one period of performance is not to exceed 9 months. However, the project schedule should plan to complete the TDP and SAR in the first six months. The last three months needs to be reserved for lead time for TDP and SAR approval and or representative article manufacturing and qualification.

PRE-RELEASE COMMUNICATION: During the pre-release period (6 May 2020 – 3 June 2020) it is highly recommended that applicants communicate with the Technical Points of Contacts (TPOCs) provided in this topic. Best method of scheduling the dialogue is via e-mail.

PROJECT COST: Not to eceed $100k without TPOC Approval. Discuss during Pre-Release period
TABA: TABA in not authorized for this topic.

PHASE II: Phase II – 24 Months $1.6M
The Phase II proposal is optional for the Phase I awardee. Phase II selections are based on Phase I performance, SBM innovation and engineering capability and the availability of appropriate

requirements. Typically t goal of Phase II is to expand the number of NSNs and/or to build capability to expand capacity to better fulfill DLA requirements.

PHASE III DUAL USE APPLICATIONS: No specific funding is associated with Phase III. Progress made in PHASE I and PHASE II should result in the manufacturer's qualification as an approved source of supply enabling participation in future DLA procurement actions. Phase III for this project is defined by relevant procurement awards.

COMMERCIALIZATION: The SBM will pursue commercialization of the various technologies and processes developed in prior phases through participation in future DLA procurement actions on items identified but not limited to this BAA.

REFERENCES:
1. DLA Aviation SAR Package instructions. DLA Small Business Resources: http://www.dla.mil/Aviation/Business/IndustryResources/SBO.aspx
2. JCP Certification: https://public.logisticsinformationservice.dla.mil/PublicHome/jcp
3. Access the web address for DIBBS at https://www.dibbs.bsm.dla.mil , then select the "Tech Data" Tab and Log into c-Folders. This requires an additional password. Filter for solicitation "SBIR202A"
4. DLA Small Business Innovation Programs web site: http://www.dla.mil/SmallBusiness/SmallBusinessInnovationPrograms
5. DLA Aviation Repair Parts Purchase or Borrow (RPPOB) Program: https://www.dla.mil/Aviation/Offers/Services/AviationEngineering/Engineering/ValueEng.aspx

KEYWORDS: Nuclear Enterprise Support (NESO), Source Approval, Reverse Engineering

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DLA202-002 TITLE: Secure Computing Autonomous Network (SCAN)

RT&L FOCUS AREA(S): Cybersecurity
TECHNOLOGY AREA(S): Information 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 section 3.5 of 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, demonstrate, and field a private distributed platform that can continuously identify, assess, report, and mitigate threats, vulnerabilities, and disruptions to DLA's network-connected devices. The platform should be scalable with low bandwidth and compute resource requirements. It should also be capable of running asynchronously within isolated environments outside of network connectivity.

DESCRIPTION: DLA requires a cyber-detection platform that comprehensively addresses supply chain security challenges, evolves as new threats emerge, and endures the test of time to provide uninterrupted support to the warfighter.

The platform should provide distributed command-and-control of cyber threats, including the ability to rapidly stop effects and restore normal operations. The platform must not harm the underlying network infrastructure or host systems. The platform architecture should be system-agnostic and provide distributed aggregation and storage of all relevant cybersecurity data, allowing for real-time analysis of any network.

The platform should passively monitor system data for problem trends and behaviors, and then issue warnings to the operators of more significant systemic faults. The platform should automatically update its risk index to address emerging threats. The platform should classify device-related errors, and have behavior-based or anomaly-based detection of threats that may otherwise go undetected.

In all cases, the platform may be required to function under a variety of scenarios within isolated environments that do not support robust learning models. This lack of connectivity to models makes the common approach to cyber detection less effective. An alternative approach is to focus on coupling machine learning (ML) with distributed ledger technologies (DLT) to provide indexed integrity of system interactions.

The ability to interface with simulation environments is also of interest.

PHASE I: Phase I – 6 Months $100K
The below actions would be required in order to successfully accomplish Phase I:

- At a minimum, a workable concept for a Secure Computing Autonomous Network (SCAN) prototype that addresses the basic requirements of the stated objective above.
- Develop a distributed platform that can conduct automated scans of various data streams to learn, predict, and mitigate future disturbances, abnormal trends, and problems.
- Develop and prove feasibility of a Concept of Operation (CONOP) for the use of the platform. Develop a preliminary design to implement the CONOP.

- Address all viable overall platform design options with respective specifications on software modularity, hardware requirements for computational power and capacity, system/sensor agnosticism, and dissemination of information products requested by the user community.

PHASE II: Phase II – 24 Months $1.6M
Update the CONOP and develop the detailed design and prototype for the cyber-threat mitigation platform. Detail how the platform enables tactical analysts to detect and mitigate threats and restore operations. Demonstrate all major prototype features in a representative environment. The environment should also include hybrid cloud scenarios where the platform must maintain a shared repository across system enclaves for tactical users to pull and share products, as required.

Develop a transition plan that identifies the scope, effort, and resources required to extend the prototype platform to additional analysis methods or data streams; and development of an out-of-network capability for offline threat detection.

Deliver a Data Disclosure Package (DDP) that includes at a minimum: form, fit, function, operation, maintenance, installation and training data, procedures and information plus the data necessary or related to overall physical, functional, interface, and performance characteristics; corrections or changes to Government-furnished data or software; and data or software that the Government has previously received unlimited rights to or that is otherwise lawfully available to the Government.

PHASE III DUAL USE APPLICATIONS: Work with the DLA to implement the platform as described in the Phase II transition plan at a designated DLA lab. Participate in a Preliminary Design Review (PDR) event. Install on a DLA-designated staging environment for system performance testing.

Ensure sufficient cybersecurity and software assurance requirements are met in accordance with DFARS Clause 252.204–7012, NIST Special Publication 800–171, NIST Special Publication 800–53, and NIST Special Publication 800–37. All RMF requirements must be met to enable platform deployment on DLA systems.

Provide an updated DDP that must include at a minimum: any updates to the Phase II DDP, installation, and maintenance procedures; demonstrated compliance with RMF requirements and qualification testing results; and authority to operate certifications for DLA system use.

Prior to fielding, provide onsite training of the platform design, operation, maintenance, and interfaces. Provide documentation and support materials to transfer the platform to DLA SMEs.

PHASE III DUAL USE APPLICATIONS: This platform has dual-use commercial or military applications in any complex system that either uses sensors to detect abnormalities or synthesizes multiple unrelated data streams for failure analysis or fault localization of its underlying sub-systems.

REFERENCES:
1. DoD Enterprise DevSecOps Reference Design, August 2019.
https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0_Public%20Release.pdf?ver=2019–09–26–115824–583
2. It Takes an Average 38 Days to Patch a Vulnerability, Kelly Sheridan, Dark Reading, August 2018.
https://www.darkreading.com/cloud/it-takes-an-average–38-days-to-patch-a-vulnerability/d/d-id/1332638
3. Cyber-security Framework for Multi-Cloud Environment, Taslet Security, September 2018.
https://medium.com/taslet-security/cyber-security-framework-for-multi-cloud-environment-e7d35fd32bd6

4. Zero Trust: Beyond Access Controls, Rob MacDonald, HelpNetSecurity, January 2020. https://www.helpnetsecurity.com/2020/01/23/zero-trust-approach-cybersecurity/

KEYWORDS: Anomaly Detection, Behavior-Based Detection, Block chain, Classification, Computer Network Traffic Analysis, Cryptography, Cybersecurity, Data Analysis, Data Provenance, Decentralized Logging, Logistics Platforms, Machine Learning, Networking, Network Intrusion Detection, Pattern Matching, Supply Chain Risk Management, SCRM, System Of Systems

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DLA202-003 TITLE: Pharmaceutical Supply Chain Vulnerability

RT&L FOCUS AREA(S): Biotechnology, & General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio Medical

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a reliable tool to determine the country of origin of active ingredients, raw materials, excipients, and final products of pharmaceutical used in the United States. This tool will be used to analyze and mitigate vulnerabilities that may pose a security risk to the United States.

DESCRIPTION: Defense Logistics Agency (DLA) Troop Support (TS) Customer Pharmacy Operations Center (CPOC) topic of interest is research focused on the supply chain of medications for the Department of Defense. The security of the pharmaceutical supply chain directly influences war and peacetime healthcare of approximately 2.2 million warfighters, their families, and retirees. A verifiable reference to identify the country of origin for active pharmaceutical ingredients (API) is not readily available to the Customer Pharmacy Operations Center (CPOC). The production of quality API from a sustainable and secure source is a factor in the availability of medications. Another factor, the consolidation of generic manufacturers and a move to a global supply chain have decreased the number of facilities capable of manufacturing quality pharmaceuticals; thus, reducing capacity and quantities of pharmaceutical produced from diversified sources. These vulnerabilities are a concern for the safety and security of the United States. There are reports that a few nations may control the production of 80% to 90% of the raw materials used in pharmaceuticals. These countries have complex political and contentious trade relationships with the United States, which could threaten the pharmaceutical supply chain in the future. Adding to the complexity of the situation, pharmaceutical manufacturers consider the source of their API/final product manufacture to be trade secrets and not adequately tracked by the Food and Drug Administration (FDA) for the purposes of DoD pharmaceutical acquisition.

PHASE I: Phase I – 6 Months $100K
The research and development goals of Phase I should provide a comprehensive analysis of the pharmaceutical supply chain, from creation to completion, in real time. This analysis should identify and track the product from sourcing of the API until the final product is assigned a National Drug Code (NDC). The expectation of Phase I is to develop a concise set of data points that can identify the country of origin for key raw materials, excipients used to synthesize the medicines, and the site of final formulation. This data will be the foundation for the prototype tool developed in Phase II.

PHASE II: Phase II – 24 Months $1.6M
Based on the research and development results, this information will be incorporated into daily operations and strategic planning to adequately analyze and formulate mitigation strategies for potential security risks. The intent is to have a tool that easily and quickly maps the supply chain of raw materials to identify vulnerabilities throughout the pharmaceutical supply chain. In addition, sourcing and flow of materials should allow educated predictions to determine the risk to the supply chain during a time of high demand or in response to a contingency, such as a military conflict, outbreak, earthquake, hurricane, or any other natural disaster. Note, this data highly correlates with Trade Agreements Act (TAA)

compliance, but its applications would extend beyond simply tracking the Country of Origin (COO) for the purposes of the TAA compliance.

The expectation of the Phase II effort is to have a Prototype tool that easily and quickly maps the supply chain of raw materials to identify vulnerabilities throughout the pharmaceutical supply chain.

PHASE III DUAL USE APPLICATIONS: The successful offeror should expect to maintain this tool in sustainment for 5 years. This will occur in the form of a follow-on Phase III contract initiated by the Customer Pharmacy Ops Center (CPOC).

COMMERCIALIZATION: The progression of information would stream throughout the whole of government based on memorandum of understandings and relationships with the DLA Troop Support. Examples, but not limited to, are Force Health Protection, Readiness, and the Defense Health Agency.

REFERENCES:

1. Federal Acquisition Regulation (FAR) 52.225-5, Trade Agreements. https://www.acquisition.gov/content/52225-5-trade-agreements#i1053648
2. Defense Health Agency Procedural Instruction Number 6025.31. December 20, 2019.
3. Defense Logistics Agency: DLA Troop Support Medical. https://www.dla.mil/TroopSupport/Medical.aspx

KEYWORDS: Pharmaceuticals, API, active pharmaceutical ingredients, Country of Origin, Trade Agreements Act, TAA, Security

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DLA202-004 TITLE: Deployable Assembly / Kitting Platform for Unitized Group Rations

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: Develop and/or promote solutions for an assembly/kitting system that is self-contained and can be quickly deployed and operational with a short period of time.

DESCRIPTION: Defense Logistics Agency (DLA) Troop Support (TS) Subsistence topic of interest is research focused on identifying and/or developing a mobile assembly platform to assemble Unitized Group Rations (UGRs) or other kits to supplement or temporarily replace current production at other fixed locations. This research project shall involve:

- Establishing an equipment list to execute the complete assembly function; i.e., carton sealers, roller conveyors, etc.
- Developing the most efficient assembly line configuration to maximize production output
- Researching the container size necessary to store and ship the equipment
- A power system that can either run on its own or use an outside generator
- A loading and unloading system to assist with moving the equipment into and out of the storage/shipping container
- Establishing a maintenance cycle for the equipment
- Ensuring that equipment can be off-loaded and the kitting process started within six hours.

PHASE I: Phase I – 6 Months $100K
The research and development goals of Phase I are to provide eligible Small Business firms the opportunity to successfully demonstrate the viability of a deployable assembly/kitting platform for UGRs. A Concept of Operations (CONOPs) will be created by the vendor for the storage, deployment, and assembly of UGRs. A sample list of UGR components can be found at the following link: https://www.dla.mil/TroopSupport/Subsistence/Operational-rations/ugrhs

The vendor will not be responsible for procuring component items. The CONOPs for this project should include, but not be limited to the lifecycle of the deployable platform; from establishing the equipment list and researching and identifying storage/shipping containers to the off-loading of equipment and the set-up of the assembly line within six hours. The deliverables for this project will include a final report to include a cost breakdown for this initiative.

PHASE II: Phase II – 24 Months $1.6M
Based on the research and development results and the CONOPs developed during PHASE I, the research and development goals of PHASE II will emphasize the form, function, and assembly of the UGRs. The CONOPs will take place within CONUS as mutually agreed upon between TS Subsistence and the vendor. As of now, the vendor will not be required to purchase component items for Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the research and development results and the CONOPs developed during PHASE I, the research and development goals of PHASE II will emphasize the form, function, and assembly of the UGRs. The CONOPs will take place within CONUS as mutually agreed upon between TS Subsistence and the vendor. As of now, the vendor will not be required to purchase component items for Phase II.

COMMERCIALIZATION: The vendor will pursue commercialization of the various processes and technologies associated with the mobile platform assembly of UGRs in prior phases as well as potential commercial sales of any parts or other items.

REFERENCES:

1. DoD Manual1338.10, DoD Food Service Manual;
http://www.dtic.mil/whs/directives/corres/pdf/133810m.pdf
2. TB MED 530/NAVMED P-5010-1/AFMAN 48-147_IP, "Tri-Service Food Code," October 7, 2013;
http://www.med.navy.mil/directives/Pub/5010-1.pdf
3. Defense Logistics Agency: DLA Troop Support Subsistence.
https://www.dla.mil/TroopSupport/Subsistence.aspx

KEYWORDS: Assembly, Kitting, Unitized Group Rations

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DLA202-005 TITLE: Automation-Robotics in Dining Facilities

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: Develop and/or promote solutions for automation within military dining facilities. Conduct research on equipment capable of assisting with the preparation, processing, and/or cooking of food. This research seeks to identify and test solutions to improve efficiency and will permit the Services to better allocate labor resources within military dining facilities.

DESCRIPTION: Defense Logistics Agency (DLA) Troop Support (TS) Subsistence topic of interest is research focused on the use of automation-robotics in dining facilities. This research shall cover the areas involving the preparation, processing, and cooking of food. Specific areas of interest include:

- Identify equipment which can be utilized to perform back-of-the-house tasks that prepare food for service
- Once identified, provide the characteristics/capabilities of the equipment and any locations where the equipment is being used.
- If your firm is currently developing this type of equipment, provide the function the equipment will be executing and any timeframe for commercial testing and production.

PHASE I: Phase I – 6 Months $100K
The research and development goals of Phase I are to provide Small Business eligible Research and Development firms the opportunity to successfully demonstrate how automation can be utilized in military dining facilities to reduce costs and increase efficiency. A concept of operations (CONOPs) or a process will be created by the vendor to show how the equipment can be utilized within the dining facilities. The deliverables for this project will include a final report to include a cost breakdown of the equipment to include, but not necessarily limited to, product cost, shipping, installation, training, parts kits, etc.

PHASE II: Phase II – 24 Months $1.6M
Based on the research and development results and the CONOPs developed during PHASE I, the research and development goals of PHASE II will emphasize the actual use of the equipment within a military dining facility at a location mutually agreed upon between DLA Troop Support Subsistence and the vendor.

PHASE III DUAL USE APPLICATIONS: Dual Use Applications: At this time, no specific funding is associated with PHASE III. Progress documented from PHASE I and PHASE II should result in a vendor's qualification as an approved source for food re-utilization enabling participation in future procurements.

COMMERCIALIZATION: The vendor will pursue commercialization of the various processes and technologies associated with the re-utilization of expired food products as well as petroleum-based packaging developed in prior phases as well as potential commercial sales of any parts or other items.

REFERENCES:
1. DoD Manual1338.10, DoD Food Service Manual;
http://www.dtic.mil/whs/directives/corres/pdf/133810m.pdf
2. TB MED 530/NAVMED P-5010-1/AFMAN 48-147_IP, "Tri-Service Food Code," October 7, 2013;
http://www.med.navy.mil/directives/Pub/5010-1.pdf
3. 3. Defense Logistics Agency: DLA Troop Support Subsistence.
https://www.dla.mil/TroopSupport/Subsistence.aspx

KEYWORDS: Automation, Robotics, Military Dining Facilities

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DLA202-006 TITLE: Re-Purposing of Expired Food Items and Petroleum-Based Packaging for Disposal

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: Develop and/or promote solutions to the disposal or destruction of expired food products and packaging. This research seeks to identify and test environmentally safe solutions to re-purpose these items into usable products thereby eliminating/saving disposal costs.

DESCRIPTION: Defense Logistics Agency (DLA) Troop Support (TS) Subsistence topic of interest is research focused on the re-purposing of expired food products in the Continental United States (CONUS) as well as Outside the Continental United States (OCONUS) where waste reduction and disposal costs in certain countries are becoming a major problem. This research project shall involve commercial industry practices that:

- Support environmentally safe disposal of expired food items
- Increases the re-purposing of food items for other uses
- Reduces the US environmental footprint in OCONUS by decreasing greenhouse gases that arise from food waste buried in landfills
- Examines the petroleum-based packaging accompanying food that is being disposed of in landfills or other methods for re-purposing into other usable products. Additionally, identify equipment that removes and processes the packaging from these products.
- Identifies additional options of dealing with food waste and packaging
- Identifies equipment that not only can re-purpose food products for environmentally safe use but also can remove packaging to potentially save labor costs.

PHASE I: Phase I – 6 Months $100K
The research and development goals of Phase I are to provide Small Business eligible Research and Development firms the opportunity to successfully demonstrate how expired food can be processed in a way that is safe for the environment and reduces costs to DLA. A Concept of Operations (CONOPs) or process will be created by the vendor for the re-utilization of expired food products. The CONOPs or process should include how the product will be either disposed of environmentally or re-purposed for another use that is also sensitive to the environment. In addition to the food products, CONOPs should include removing and recycling packaging so that disposal in landfills is avoided. The deliverables for this project will include a final report to include a cost breakdown of courses of action

PHASE II: Phase II – 24 Months $1.6M
Based on the research and development results and the CONOPs developed during PHASE I, the research and development goals of PHASE II will emphasize the execution of the disposal and/or re-utilization in accordance with the CONOPs. The CONOPs will be in place within CONUS with an emphasis on OCONUS locations as mutually agreed upon between TS Subsistence and the vendor.

PHASE III DUAL USE APPLICATIONS: Dual Use Applications: At this time, no specific funding is associated with PHASE III. Progress documented from PHASE I and PHASE II should result in a vendor's qualification as an approved source for food re-utilization enabling participation in future procurements.

COMMERCIALIZATION: The vendor will pursue commercialization of the various processes and technologies associated with the re-utilization of expired food products as well as petroleum-based packaging developed in prior phases as well as potential commercial sales of any parts or other items.

REFERENCES:

1. DoD Manual1338.10, DoD Food Service Manual;
http://www.dtic.mil/whs/directives/corres/pdf/133810m.pdf
2. TB MED 530/NAVMED P-5010-1/AFMAN 48-147_IP, "Tri-Service Food Code," October 7, 2013;
http://www.med.navy.mil/directives/Pub/5010-1.pdf
3. Defense Logistics Agency: DLA Troop Support Subsistence.
https://www.dla.mil/TroopSupport/Subsistence.aspx

KEYWORDS: Re-engineering, Food re-use, Food Packaging

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DLA202-007 TITLE: Enhancing the E-Waste Recycling technology to recover Rare Earths and Precious Metals from Industrial and Defense Waste Streams

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies consistently to our customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts or materials manufacturing or processing technology at any level resulting in a unit cost reduction.

Research and Development 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 Readiness Level (TRL) 6 or less, but greater than TRL 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 a domestic capability that demonstrates a new novel Rare Earths and Precious Metal recovery and recycling technology from defense or industrial waste feedstock. Various rare earths and precious metals are used in Defense weapon systems, and there is limited domestic production of these materials and therefore a risk of foreign reliance. Developing an economically viable, environmentally friendly process for enhancing the recycling of electronic waste scrap from the existing waste feedstock could facilitate the establishment of a viable, competitive domestic supply chain.

R&D tasks include identifying feedstock sources in the existing domestic supply chain and developing processes for recycling the electronic waste that demonstrates a significant cost advantage versus standard processing. The process should be amenable to the scale of operation required in electronic waste recycling, and will improve the economics of recovering the rare earths and precious metals for electronic reuse, rather than recovery as downgraded materials for lower value uses.

PHASE I: Phase I – 6 Months $100K
Determine, insofar as possible, the scientific, technical, and commercial feasibility of the concept. Include a plan to demonstrate the innovative discrete-parts manufacturing process and address implementation approaches for near term insertion into the manufacture of Department of Defense (DoD) systems, subsystems, components, or parts.

PHASE II: Phase II – 24 Months $1.6M
Develop applicable and feasible process demonstration for the approach described, and demonstrate a degree of commercial viability. Validate the feasibility of the innovative process by demonstrating its use in the production, testing, and integration of items for DLA. Validation would include, but 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 DLA, OEM, 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 DLA and its supply chains.

PHASE III DUAL USE APPLICATIONS: Technology transition via successful demonstration of a new process technology. This demonstration should show near-term application to one or more Department of Defense systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and/or reduction of unit cost or total ownership cost of the proposed subject. Private Sector Commercial Potential: Material manufacturing improvements, including development of domestic manufacturing capabilities, have a direct applicability to all defense system technologies. Material manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, and weapons technologies. Competitive material manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Many of the technologies under this topic would be directly applicable to other DoD agencies, NASA, and any commercial manufacturing venue. Advanced technologies for material manufacturing would directly improve production in the commercial sector resulting in reduced cost and improved productivity.

REFERENCES:
1. https://seas.yale.edu/news-events/news/recycling-rare-earth-metals-e-waste
2. https://www.thebalancesmb.com/electronic-devices-source-of-metals-for-recyclers-2877986

KEYWORDS:

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DLA202-008 TITLE: Cerium-Aluminum (Ce-Al) alloys for military casting

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies consistently to our customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts or materials manufacturing or processing technology at any level resulting in a unit cost reduction.

Research and Development 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 Readiness Level (TRL) 6 or less, but greater than TRL 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: The Department of Defense (DoD) is interested in implementing advanced Cerium-Aluminum alloy castings in defense applications. Cerium-Aluminum (Ce-Al) alloys are lightweight, corrosion-resistant, and exceptionally stable at high temperatures. Additionally, Ce-Al show potential for casting near net shapes without the need for costly heat treatment. For Phase I, DoD is seeking a small metallurgical or foundry company to work with an existing DoD contractor of their choosing to redesign and demonstrate a Cr-Al casting as a substitute for traditional aluminum or magnesium alloy castings. The potential phase II effort would be to qualify the demonstrated Ce-Al component into a defense system. DoD requires that the source of cerium for this project be mined from a National Technology and Industrial Base (NTIB) source. The NTIB is defined by U.S. law under 10 U.S.C. 2500 as the persons and organizations that are engaged in research, development, production, integration, services, or information technology activities conducted within the United States, the United Kingdom of Great Britain and Northern Ireland, Australia, and Canada.

PHASE I: Phase I – 6 Months $100K
Determine, insofar as possible, the scientific, technical, and commercial feasibility of the concept. Include a plan to demonstrate the innovative discrete-parts manufacturing process and address implementation approaches for near term insertion into the manufacture of Department of Defense (DoD) systems, subsystems, components, or parts.

PHASE II: Phase II – 24 Months $1.6M
Develop applicable and feasible process demonstration for the approach described, and demonstrate a degree of commercial viability. Validate the feasibility of the innovative process by demonstrating its use in the production, testing, and integration of items for DLA. Validation would include, but 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 DLA, OEM, 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 DLA and its supply chains.

PHASE III DUAL USE APPLICATIONS: Technology transition via successful demonstration of a new process technology. This demonstration should show near-term application to one or more Department of Defense systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and/or reduction of unit cost or total ownership cost of the proposed subject. Private Sector Commercial Potential: Material manufacturing improvements, including development of domestic manufacturing capabilities, have a direct applicability to all defense system technologies. Material manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, and weapons technologies. Competitive material manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Many of the technologies under this topic would be directly applicable to other DoD agencies, NASA, and any commercial manufacturing venue. Advanced technologies for material manufacturing would directly improve production in the commercial sector resulting in reduced cost and improved productivity.

REFERENCES:
1. https://www.intechopen.com/books/aluminium-alloys-and-composites/composites-and-alloys-based-on-the-al-ce-system
2. https://pubs.rsc.org/en/content/articlelanding/2017/MH/C7MH00391A#!divAbstract

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DLA202-009 TITLE: Commercial Applications for Recycled Thermal Barrier Coatings

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies consistently to our customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts or materials manufacturing or processing technology at any level resulting in a unit cost reduction.

Research and Development 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 Readiness Level (TRL) 6 or less, but greater than TRL 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: The Department of Defense (DoD) is looking for a domestic capability that demonstrates the ability to recycle waste from thermal barrier coatings and find commercial applications of the recycled material. Thermal barrier coating (TBC) and environmental barrier coating (EBC) materials are among the most critical advanced materials utilized in aviation applications. Modern commercial and military aircraft rely on these materials to provide thermal protection for aircraft engine components, allowing the engines to operate at higher temperatures and increased efficiencies while also protecting against the damaging effects of various environmental factors present during operation. Many of the most prevalent TBCs and EBCs presently employed in military aircraft engine coatings contain rare earth zirconate and silicate materials. However, many of the rare earth and zirconium raw materials necessary for the production of these TBC and EBC materials are not readily available from domestic sources. The need to maintain secure supply chains for these raw materials creates an imperative for alternate raw materials sources to be developed. Developing an economically viable process for enhancing the production of existing recycling processes could facilitate the establishment of a viable, competitive domestic supply chain of TBC and EBC coatings for the aerospace industry. Economical reclamation and reuse of thermal barrier coating waste could result in improved supply security and lower costs of these crucial raw material.

PHASE I: Phase I – 6 Months $100K
Determine, insofar as possible, the scientific, technical, and commercial feasibility of the concept. Include a plan to demonstrate the innovative discrete-parts manufacturing process and address implementation approaches for near term insertion into the manufacture of Department of Defense (DoD) systems, subsystems, components, or parts.

PHASE II: Phase II – 24 Months $1.6M
Develop applicable and feasible process demonstration for the approach described, and demonstrate a degree of commercial viability. Validate the feasibility of the innovative process by demonstrating its use in the production, testing, and integration of items for DLA. Validation would include, but 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 DLA, OEM, 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 DLA and its supply chains.

PHASE III DUAL USE APPLICATIONS: Technology transition via successful demonstration of a new process technology. This demonstration should show near-term application to one or more Department of Defense systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and/or reduction of unit cost or total ownership cost of the proposed subject. Private Sector Commercial Potential: Material manufacturing improvements, including development of domestic manufacturing capabilities, have a direct applicability to all defense system technologies. Material manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, and weapons technologies. Competitive material manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Many of the technologies under this topic would be directly applicable to other DoD agencies, NASA, and any commercial manufacturing venue. Advanced technologies for material manufacturing would directly improve production in the commercial sector resulting in reduced cost and improved productivity.

REFERENCES:

1. https://www.dodmantech.com/
2. 2015 Strategic and Critical Materials Report on Stockpile Requirements
3. National Defense Authorization Act For Fiscal Year 2014


KEYWORDS:


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DLA202-010 TITLE: Optimizing Lithium-Ion (Li-Ion) Battery Recycling Technology to Recover Cobalt and Nickel from Industrial and Defense Waste Streams

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials

OBJECTIVE: The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies consistently to our customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts or materials manufacturing or processing technology at any level resulting in a unit cost reduction.

Research and Development 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 Readiness Level (TRL) 6 or less, but greater than TRL 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 a domestic capability that demonstrates a new innovative lithium-ion battery recycling technology, for recovering nickel and cobalt from recovered batteries, which stem from defense or industrial waste streams. Li-Ion batteries are used in Defense weapon systems, these batteries contain cobalt and nickel; there is limited domestic production of these materials and therefore a risk of foreign reliance. Developing an economically viable, environmentally friendly process for enhancing the recycling of Li-Ion batteries from the existing waste feedstock could facilitate the establishment of a viable, competitive domestic supply chain.

R&D tasks include identifying feedstock sources in the existing domestic supply chain and developing processes for recycling the Li-Ion batteries, that demonstrates a significant cost advantage versus standard processing. The process should be amenable to the scale of operation required in Li-Ion battery recycling, and will improve the economics of recovering the Nickel and Cobalt for DoD reuse, rather than recovery as downgraded materials for lower value uses.

PHASE I: Phase I – 6 Months $100K
Determine, insofar as possible, the scientific, technical, and commercial feasibility of the concept. Include a plan to demonstrate the innovative discrete-parts manufacturing process and address implementation approaches for near term insertion into the manufacture of Department of Defense (DoD) systems, subsystems, components, or parts.

PHASE II: Phase II – 24 Months $1.6M
Develop applicable and feasible process demonstration for the approach described, and demonstrate a degree of commercial viability. Validate the feasibility of the innovative process by demonstrating its use in the production, testing, and integration of items for DLA. Validation would include, but 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 DLA, OEM, 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 DLA and its supply chains.

PHASE III DUAL USE APPLICATIONS: Technology transition via successful demonstration of a new process technology. This demonstration should show near-term application to one or more Department of Defense systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and/or reduction of unit cost or total ownership cost of the proposed subject. Private Sector Commercial Potential: Material manufacturing improvements, including development of domestic manufacturing capabilities, have a direct applicability to all defense system technologies. Material manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, and weapons technologies. Competitive material manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Many of the technologies under this topic would be directly applicable to other DoD agencies, NASA, and any commercial manufacturing venue. Advanced technologies for material manufacturing would directly improve production in the commercial sector resulting in reduced cost and improved productivity.

REFERENCES:
1. https://www.nickelinstitute.org/about-nickel/nickel-in-batteries/
2. https://vtechworks.lib.vt.edu/handle/10919/92800

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DLA202-011 TITLE: Novel Approaches for Detection of and Protection from Emerging Viral Pandemics

RT&L FOCUS AREA(S): Biotechnology, & General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio Medical

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and promote novel approaches for the detection, identification, and differentiation of viral pathogens, contamination prevention, and protection from viral infections, such as COVID-19.

DESCRIPTION: Defense Logistics Agency (DLA) Research and Development topics of interest are research focused on complex catastrophic pandemic events, such as COVID-19. This requirement consists of providing materials that block transmission of viral pathogens on various surfaces such as clothing, Meals-Ready-To-Eat (MREs), bottled water, parts, and other mediums of transmission of viral pathogens. Solutions need to be easy to use, rapidly deployable, with low logistics burden for military logisticians, clinics, medical treatment facilities, and forward deployed military and civilian personnel.

PHASE I: Phase I – 6 Months $100K
The research and development goals of Phase I are to provide Small Business eligible Research and Development firms the opportunity to demonstrate a scalable, adaptable, rapid response platform capable of producing methods for the detection, identification, differentiation of viral pathogens, and protection from infections from viral pandemics. Phase I requires a written diagnostic/therapeutic model with preliminary results on the viability of the proposed solution.

PHASE II: Phase II – 24 Months $1.6M
Based on the preliminary findings from Phase I, and in coordination with DLA and industry manufacturers, the Phase II expectation is to develop a prototype solution. This solution must be easy to use with minimal burden on logistics and must demonstrate the effective prevention of transmission of viral pathogens through contact, particularly from contaminated surfaces. The envisioned platform would cut response time significantly in order to stay within the window of relevance for containing contamination, preventing infection, and mitigating an outbreak.

PHASE III DUAL USE APPLICATIONS: PHASE III: Dual Use Applications: At this point, no specific funding is associated with Phase III. Progress made in Phase I and Phase II should result in the use of domestic and international health care markets for in vitro diagnostics and prophylactic uses.
COMMERCIALIZATION: The manufacturer will pursue commercialization of various identification of, protection, and mitigation from viral pathogens, such as COVID-19 and develop potential commercial sales of manufactured chemical materials.

KEYWORDS: Covid-19, infections disease, in vitro diagnostic, point of care, biological warfare agent, biomarkers, anti-viral, MERS, SARS, coronavirus

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DLA202-012 TITLE: Learning From the Coronavirus: An Economic Assessment on the Effects of Pandemics on the Supply and Demand for Strategic & Critical Materials in the Defense Industrial Base.

RT&L FOCUS AREA(S): Biotechnology, & General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio Medical

OBJECTIVE: The Defense Logistics Agency (DLA) seeks to provide responsive, best value supplies consistently to our customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts or materials manufacturing or processing technology at any level resulting in a unit cost reduction.

Research and Development 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 Readiness Level (TRL) 6 or less, but greater than TRL 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: The Department of Defense (DoD) is interested in funding a retrospective economic assessment on the effects of pandemics with special emphasis on the coronavirus outbreak on raw material markets and active pharmaceutical ingredients (API) for the Defense Industrial base Department of Defense respectively. The epidemic's uncertainty is expected to abruptly disrupt supply and demand across the defense industrial base. U.S. business activity in February fell to its lowest level in more than six years due to the epidemic. Further, Economists have struggled to project the full ramifications of this epidemic due to the uncertainty of consumer and firm behavior. For Phase I, the Department is seeking a US based company to design an economic study that will provide a full literature review on pandemics and their corresponding economic effects in the Defense Industrial Base where appropriate, characterize challenges and gaps of existing assessments, design a methodological approach to the aforementioned objective, make a set of recommendations within the current legal framework to mitigate these effects, and report findings.

PHASE I: Phase I – 6 Months $100K
Determine, insofar as possible, the economic ramifications of pandemics on the Defense Industrial base and the Department of Defense, Undertake a literature review, summarize relevant information, identify a methodology and area of potential contribution, identify data sources and quantitative approach.

PHASE II: Phase II – 24 Months $1.6M
Develop and identify data sources for the applicable quantitative approach identified in Phase I. Compare conclusions to identified literature in phase I. Provide assessment on the effectiveness of economic policy initiatives on maintaining the DIB and DoD and make a set of recommendations to the Department on mitigation strategies within current legal framework as codified in the code of federal regulations (CFR). Present research to peers and other economic associations.

PHASE III DUAL USE APPLICATIONS: Develop a repeatable quantitative approach for the Department of Defense to identify the effects that pandemics have on the Defense Industrial base and the Department of Defense. Demonstrate near-term application to one or more Department of Defense systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, and performance.

REFERENCES:


1. https://www.wsj.com/articles/coronavirus-is-different-almost-no-company-is-safe-11583064000
2. https://www.forbes.com/sites/rhockett/2020/03/16/managing-coronaviruss-economic-fallout-demand-and-supply-side-measures/#53c1cec3c219
3. https://www.cnbc.com/2020/02/27/coronavirus-caused-major-decrease-in-china-demand-cfo-survey.html
4. https://hbr.org/2020/02/how-coronavirus-could-impact-the-global-supply-chain-by-mid-march


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**DEFENSE LOGISTICS AGENCY**
**20.2 Small Business Innovation Research (SBIR) Program**
**Direct to Phase II Proposal Submission Instructions**

The Defense Logistics Agency (DLA) Small Business Innovation Program (SBIP) seeks small businesses with strong research and development capabilities to pursue and commercialize specific technologies to meet DLA objectives.

The intent of the 20.2 DLA SBIR Direct to Phase II proposal submission instructions is to clarify the Department of Defense (DoD) instructions as they apply to DLA requirements. This Announcement is for Direct to Phase II proposals only. All Phase II proposals must be prepared and submitted through the DoD SBIR/STTR electronic submission site:https://www.dodsbirsttr.mil/submissions/login. The offeror is responsible for ensuring that their proposal complies with the requirements in the most current version of instructions. Prior to submitting your proposal, please review the latest version of these instructions as they are subject to change before the submission deadline.

Submit specific questions pertaining to the DLA SBIP Program to the DLA SBIP Program Management Office (PMO) at E-mail – DLASBIR2@dla.mil

## 1. DIRECT TO PHASE II

15 U.S.C. §638 (cc), as amended by NDAA FY2012, Sec. 5106, and further amended by NDAA FY2019, Sec. 854, PILOT TO ALLOW PHASE FLEXIBILITY.

This allows the Department of Defense to make an award to a small business concern under Phase II of the SBIR Program with respect to a project, without regard to whether the small business concern received an award under Phase I of an SBIR Program with respect to such project.

DLA is conducting a "Direct to Phase II" implementation of this authority for this SBIR Announcement. This pilot does not guarantee DLA will offer any future Direct to Phase II opportunities.

DLA Direct to Phase II Proposals are different from traditional DLA SBIR Phase I proposals. The chart below explains some of these differences.

| | **STANDARD DLA SBIR PROCESS** | **DLA D2P2 PROCESS** |
|---|---|---|
| **PHASE I TYPICAL FUNDING LEVEL** | $100,000*** | None |
| **PHASE I TECHNICAL POP* DURATION** | 6 months | None |
| **PHASE II TYPICAL FUNDING LEVEL** | $1,000,000** | $1,000,000** |
| **PHASE II TECHNICAL POP DURATION** | 24 months | 24 months |

*POP= Period of Performance
** May Exceed $1,000,000 (up to $1,600,000) with Program Manager Approval
*** May Exceed $100,000 (up to $252,000) with Program Manager Approval

## 2. INTRODUCTION

Direct to Phase II proposals must follow the steps outlined in the following statements.

1. Offerors must create a Cover Sheet using the DoD Proposal submission system.
2. Offerors must provide documentation that satisfies the Phase I feasibility requirement*. that will be included in the Technical Volume of the Phase II proposal
3. Offerors must demonstrate that they have completed research and development through means other than the SBIR/STTR Program to establish the feasibility of the proposed Phase II effort.
4. Offerors must submit a complete Phase II proposal using the DLA Phase II proposal instructions below.

* NOTE: Offerors are required to provide information demonstrating that the scientific and technical merit and feasibility. DLA will not evaluate any Phase II proposal if it determines that the offeror has failed to demonstrate the establishment of technical merit and feasibility.

## 3. PROPOSAL SUBMISSION

Submit the complete proposal, i.e., DoD Proposal Cover Sheet, technical volume, cost volume, and Company Commercialization Report electronically at https://www.dodsbirsttr.mil/submissions/login Ensure your complete technical volume and additional cost volume information is included in this sole submission.

**Complete proposals must include all of the following**:
a. DoD Proposal Cover Sheet (Volume 1)
b. Technical Volume (Volume 2):
    Part 1: Phase I Justification (20 Pages Maximum)
    Part 2: Phase II Technical Proposal (40 Pages Maximum)
c. Cost Volume (Volume 3)
d. Company Commercialization Report (Volume 4)

**The DLA SBIR Program is accepting Volume 5 (Supporting Documents).**

Phase II proposals require a comprehensive, detailed submission of the proposed effort. DLA SBIR Direct to Phase II periods of performance are 24 months. DLA will accept SBIR Direct to Phase II proposals up to a maximum value of $1,000,000 ($1,600,000 with prior authorization from the SBIP PM. Commercial and military potential of the technology under development is extremely important. Successful proposals will emphasize applicability to specific DoD programs of record as well as dual-use applications and commercial exploitation of resulting technologies,

## 4. Direct to Phase II PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

**PROPOSAL FORMAT** (60 pages maximum)

A. **Cover Sheet**. As instructed on the DoD SBIR proposal submission website, prepare a Proposal Cover Sheet (often two pages), include a brief description of the problem or opportunity, objectives, effort, and anticipated results. Summarize the expected benefits, as well as any government or private sector applications of the proposed research. OSD and SBA will post the Project Summary of selected proposals with unlimited distribution. Therefore, the summary should not contain classified or proprietary information.

B. **Technical Volume**

- Phase I Justification (20 Pages Maximum). Offerors are required to provide information demonstrating the establishment of the scientific and technical merit and feasibility.

- Phase II Technical Objectives and Approach (40 Pages Maximum). List the specific technical objectives of the Phase II research and describe the planned technical approaches used to meet these objectives.

- Phase II Work Plan**.** Provide an explicit, detailed description of the Phase II approach. The plan should indicate how and where the firm will conduct the work, a schedule of major events, and the final product to be developed. The Phase II effort should attempt to accomplish the technical feasibility demonstrated in the justification, including potential commercialization results. Phase II is the principal research and development effort and is expected to produce a well-defined deliverable product or process.

- Related Work. Describe significant activities directly related to the proposed effort, including those conducted by the Principal Investigator, the proposing firm, consultants, or others. Report how the activities interface with the proposed project and discuss any planned coordination with outside sources. The proposers must demonstrate an awareness of the state-of-the-art in the technology and associated science.

- Relationship with Future Research or Research and Development. State the anticipated results of the proposed approach if the project is successful. Discuss the significance of the Phase II effort in providing a foundation for a Phase III research or research and development effort.

- Technology Transition and Commercialization Strategy**.** Describe your company's strategy for converting the proposed SBIR research, resulting from your proposed Phase II contract, into a product or non-R&D service with widespread commercial use -- including private sector and/or military markets. Note that the commercialization strategy is separate from the Commercialization Report described in Section 4.L below. The strategy addresses how you propose to commercialize this research, while the Company Commercialization Report covers what you have done to commercialize the results of past Phase II awards. Historically, a well-conceived commercialization strategy is an excellent indicator of ultimate Phase III success. The commercialization strategy must address the following questions:

    - What DoD Program and/or private sector requirement does the technology propose to support?
    - What customer base will the technology support, and what is the estimated market size?
    - What is the estimated cost and timeline to bring the technology to market to include projected funding amount and associated sources?
    - What marketing strategy, activities, timeline, and resources will be used to enhance commercialization efforts??
    - Who are your competitors, and describe the value proposition and competitive advantage over the competition?

- Key Personnel. Identify key personnel, including the Principal Investigator, who will be involved in the Phase II effort. List directly related education and experience and relevant publications (if any) of key personnel. Include a concise resume of the Principal Investigator(s).

- Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase II effort. Justify the purchase of any items or equipment (as detailed in the cost proposal) including Government Furnished Equipment (GFE). All requirements for government furnished equipment or other assets, as well as associated costs, must be determined and agreed to during Phase II contract negotiations. State whether or not the proposed work facilities will be performed meet environmental laws and regulations of federal, state (name) and local governments. This includes, but is not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal, and handling and storage of toxic and hazardous materials.

- Consultants**.** Involvement of university, academic institution, or other consultants in the project may be appropriate. If the firm intends to involve these type of consultants, describe these costs in detail in the Cost Volume.

C. **Cost Volume** (**$1,600,000 Maximum**). A detailed, Phase II Cost Volume must be submitted online and in the proper format shown in the Cost Breakdown Guidance in Section 5.4 d of the DoD SBIR Broad Agency Announcement (BAA). Some items in the cost volume template may not apply to the proposed project. Provide enough information to allow the DLA evaluators to assess the proposer's plans to use the requested funds if DLA were to award the contract.

- List all key personnel by name as well as number of hours dedicated to the project as direct labor.
- Special Tooling, Test Equipment, and Materials Costs:
- Special tooling, test equipment, and materials costs may be included under Phase II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed; and
- The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and relate it directly to the specific effort.
- Cost for travel funds must be justified and related to the needs of the project.

D. **Commercialization Report.** All Phase II proposals must include a Company Commercialization Report (CCR). This required proposal information does not count against the 60-page limit. The submission system will generate CCR is generated by the submission website based on information provided by the firm through the CCR tool. This report will list the name of the awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each SBIR Phase II project performed by the company. The CCR, separate from the commercialization strategy described in Section 4.G, covers what you have done with past Phase II awards. Complete and accurate reporting of Phase III performance data by all participating companies is critical to the future success of the SBIR Program.

## 5. METHOD OF SELECTION AND EVALUATION CRITERIA

A. **Evaluation Criteria**. DLA will review all proposals for overall merit based on the evaluation criteria published in the DoD SBIR Program BAA:

## 6. CONTRACTUAL CONSIDERATIONS

A. Awards. The number of Direct to Phase II awards will depend upon the quality the Phase II proposals and the availability of funds. Each Phase II proposal selected for award under a negotiated contract requires a signature by both parties before work begins. DLA awards Phase II contracts to Small Businesses based on results of the agency priorities, scientific, technical, and commercial merit of the Phase II proposal.

B. Reports**.** For incrementally funded Phase II projects an interim, midterm written report may be required (at the discretion of the awarding agency).

C. Payment Schedule. DLA Phase II Awards are Firm Fixed Price / Level of Effort contracts. Base monthly invoices on the labor hours recorded and the monthly costs associated with the project.

D. Markings of Proprietary Information In accordance with DoD SBIR Program BAA, section 5.3. DLA does not accept classified proposals. All Final Reports are marked with Distribution Statement B.

E. Copyrights, Patents and Technical Data Rights. DLA handles all Copyrights, Patents, and Technical Data Rights in accordance with the guidelines in the DoD SBIR Program BAA.

## 7. 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.

## 8. REPORTING OF PHASE III OR ANY OTHER COMMERCIALIZATION EFFORTS

A. Each small business receiving a Phase II award is required to report all Phase III activities on their Company Commercialization Report https://www.dodsbirsttr.mil/submissions/login. In addition please send any corresponding Phase III documents in PDF format to: DLASBIR2@dla.mil

Reportable activities include:

- Sales revenue from new products and non-R&D services resulting from the Phase II project
- Additional investment from sources other than the Federal SBIR program in activities that further the development and/or the commercialization of the Phase II technology;
- The portion of additional investment representing clear and verifiable investment in the future commercialization of the technology (i.e. "hard investment");
- Whether the Phase II technology has been used in a fielded DoD system or acquisition program and, if so, which system or program;
- The number of patents resulting from the contractor's participation in the SBIR/STTR program;
- Growth in number of firm employees, and; Whether the firm completed an initial public offering (IPO) of stock resulting in part from the Phase II project

## DEFENSE LOGISTICS AGENCY

## DEFENSE LOGISTICS AGENCY SBIR 20.2 Topic Index

DLA202-D013 TITLE: Novel Approaches for Detection of and Protection from Emerging Viral Pandemics

RT&L FOCUS AREA(S): Biotechnology, & General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Bio Medical

OBJECTIVE: Develop and promote novel approaches for the detection, identification, and differentiation of viral pathogens, contamination prevention, and protection from viral infections, such as COVID-19.

DESCRIPTION: Defense Logistics Agency (DLA) Research and Development topics of interest are research focused on complex catastrophic pandemic events, such as COVID-19. This requirement consists of providing materials that block transmission of viral pathogens on various surfaces such as clothing, Meals-Ready-To-Eat (MREs), bottled water, parts, and other mediums of transmission of viral pathogens. Solutions need to be easy to use, rapidly deployable, with low logistics burden for military logisticians, clinics, medical treatment facilities, and forward deployed military and civilian personnel.

PHASE I: Not Required. The vendor must demonstrate Proof of Concept via a technical volume not to exceed 20 pages. This volume is included as part of the Phase II Technical volume (Volume 2)
FEASIBILITY DOCUMENTATION: Offerors interested in participating in Direct to Phase II must include in their response to this topic Phase I feasibility documentation that substantiates the scientific and technical merit and Phase I feasibility described in Phase I above has been met (i.e. the small business must have performed Phase I-type research and development related to the topic, but from non-SBIR funding sources) and describe the potential commercialization applications. The documentation provided must validate that the proposer has completed development of technology as stated in Phase I above. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE II: Based on the results of the vendors Proof of Concept, and in coordination with DLA and industry manufacturers the Phase II expectation is to develop a prototype solution. This solution must be easy to use with a minimal burden on logistics, which effectively prevents escalation of the transmission of viral pathogens through contact, particularly from contaminated surfaces. The envisioned platform would cut response time significantly in order to stay within the window of relevance for containing contamination, preventing infection, and mitigating an outbreak.

PHASE III DUAL USE APPLICATIONS: Dual Use Applications: At this point, no specific funding is associated with Phase III. Progress made in Phase I and Phase II should result in the use of U.S. and European Union domestic health care markets for in vitro diagnostics and prophylactic uses.
COMMERCIALIZATION: The manufacturer will pursue commercialization of various identification of, protection, and mitigation from viral pathogens, such as COVID-19 and develop potential commercial sales of manufactured chemical materials.

KEYWORDS: Covid-19, infections disease, in vitro diagnostic, point of care, biological warfare agent, biomarkers, anti-viral, MERS, SARS, coronavirus

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DLA202-D014 TITLE: Hydrodynamic, Structural, Vibration, and Production Analysis to Build a Torpedo Propeller

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Ground Sea, Weapons

OBJECTIVE: Confirm or refine the existing propeller geometric design. Find alternative methods to produce these propellers at high quality and low cost, while meeting structural, hydrodynamic powering and quiet performance.

COST AND DURATION CLARIFICATION: This topic is a Direct to Phase II proposal requirement. Maximum value for contract effort is $500,000, in a Base contract at up to $250,000 and with Option at $250,000 to be executed at pleasure of the government. Pending execution of this contract's Option, the government may request a follow on proposal for a Sequential Phase II effort.

DESCRIPTION: The Navy has need for a new production stream to deliver high-speed propellers for a long-standing existing weapon. Although functional, the current design has limitations in producible quality and, to an uncertain degree, in the design margins (optimality) of final performance.

This task would include an initial analysis of two existing propellers, which are manufactured in both aluminum and in GRP composite structure, with slight variances in geometry between the fabrication materials. A successful proposal should include descriptions of prior propeller or other equivalent propulsive composite design achievements and capabilities and methods intended to complete analysis, fabricate, and test concept models to achieve equivalent performance of current parts. Drawings are not required for a responsive proposal. Upon award, drawings and part samples will be provided as needed.

| FSC | NIIN | Part Number | Nomenclature | End Item Application |
|---|---|---|---|---|
| 2010 | 01-137-2013 | 5268342 | Composite Forward Propeller | Torpedo |
| 2010 | 01-137-4681 | 5268343 | Composite Aft Propeller | Torpedo |
| 1355 | 00-977-2776 | 2526749 | Aluminum Forward Propeller | Torpedo |
| 1355 | 00-977-2773 | 2526749 | Aluminum Aft Propeller | Torpedo |

Direct to Phase II Base Contract NTE $250,000

Base contract scope of work will leverage the as-built design as provided in Government Furnished Information (drawings) and Government Furnished Equipment (propeller components) to:

1. Completely define, by analytical methods, the quantitative engineering performance requirements in geometric design and volume, weight, and in thrust, vibration, and structural strength to meet RPM and velocity of platform being propelled.
2. Identify their conceptual alternate design(s) for a forward and after propeller and provide analytical results that technically defend said concept will meet or exceed all requirements as developed in 1.
3. Estimate production cost for the concept propellers.

Direct to Phase II OPTION NTE $250,000

Scope of work:

1. Produce and deliver "TBD" propeller Engineering Development Model forward and after prototypes. (Vendor to estimate quantity to be delivered). The government will install and complete operational trials on the target platform and provide system speed, rpm, and other performance results back to the vendor.

2. "Vendor may offer" to conduct static and/or hydrodynamic flow in-water tests in a "vendor funded facility" to capture prototype propeller performance in in-water vibration, structural strength, thrust and/or operating blade deformation... or "vendor may defer some or all of this work to a Sequential Phase II effort".
3. "Vendor may offer" to refine FEA/CFD analysis and provide analytical results to "2." above or defer to Sequential Phase II effort.
4. Vendor shall receive in-water performance tests from "1." above and overlay on analytical results and technically defend variances and methods to resolve insufficient performance in Sequential Phase II.
5. Develop and submit a Sequential Phase II proposal

Sequential Phase II proposal: NTE $1,500,000

1. Effort is not to exceed $1.5 million in value
2. Produce and deliver substantial quantity of functional prototype test propellers (20 or more sets)
3. Complete tests deferred from initial Phase II effort.
4. Complete final adjustments in design thru a series of test, adjust, test adjust… wherein the tests will either be:
5. Government operated "systems performance" trials – providing RPM, speed and other dynamic data
6. Vendor operated static or dynamic in-water trials to capture other attributes of structure, vibration, thrust, deformation … etc.
7. Provide a Phase 3 Production proposal

Based on the results of the vendors Direct to Phase II, and in coordination with DLA and industry manufacturers, the Sequential Phase II expectation is to develop a prototype solution. The proposed work should include engineering, and fabricating development of Prototype propellers and completing water tunnel, in-water, and other testing to prove the performance capability meets the developed specification and/or identify variations where they occur. Expectations include:

- capture as-built designs via 3D imaging and compare 'as-built' component geometry to design drawings to validate 'as-built' accuracy and/or quantify 'design' vs 'as-built' variances;
- affirm the geometry or estimate adjustments, based on fabrication material for one or more propeller variants,
- complete CFD analysis performance estimates in structural strength, structural vibration, powering, and radiated noise of the propeller(s),
- use this analysis to validate design and/or recommend design adjustments

Sequential Phase II would culminate in trial open water runs to prove performance on a navy platform. Complete initial analysis will be manifest in a solid model propeller geometry, which defines the potentially viable replacement propeller(s), along with a comprehensive report of performance estimates, as developed in the above analysis.

Phase 3 Production Proposal – to be funded by Program Office if purchased

1. Deliver up to 400 propellers per year for five years in 100 lot stand-alone shipment quantities.
2. With each lot provide material pedigree through a body of destructive tests of 1 or more propeller sets to prove the product material pedigree meets the performance specifications developed during prior work.

COMMERCIALIZATION: The manufacturer will pursue commercialization of the various UAS technologies and processes developed in prior phases as well as potential commercial sales of manufactured mechanical parts or other items.

REFERENCES:
1. Ductility and plasticity of nanostructured metals: differences and issues, Y.T. Zhu, X.L. Wu, dhttps://www.sciencedirect.com/science/article/pii/S258884201830124X
2. Size effects on material yield strength/deformation/fracturing properties, Ronald W. Armstrong, Journal of Materials Research,Volume 34, Issue 13: 15 July 2019 , pp. 2161-2176: DOI: https://doi.org/10.1557/jmr.2018.406, Published online by Cambridge University Press: 30 January 2019
3. http://www.aerodynamics4students.com/propulsion/blade-element-propeller-theory.php
4. Marine Propeller Design Method based on Lifting Line Theory and Lifting Surface Correction Factors, Ataur Rahmana,∗, Md Refayet Ullahb, Md. Mashud Karimb, 10th International Conference on Marine Technology, MARTEC 2016
5. http://www.omagdigital.com/article/COMPOSITES_VS._METALS/1986792/254792/article.html
6. https://www.materialsforengineering.co.uk/engineering-materials-explore/composite-materials/features/carbon-fibre-replacing-metals-and-polymers-as-material-of-choice-in-medical-applications/160312/

KEYWORDS: Thermoplastic composites, carbon fiber propellers, injection-molded parts, thrust vs propeller blade structural strength, low cost manufacturing structurally equivalent parts

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DLA202-D015 TITLE: Secure Computing Autonomous Network (SCAN)

RT&L FOCUS AREA(S): Cybersecurity
TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop, demonstrate, and field a private distributed platform that can continuously identify, assess, report, and mitigate threats, vulnerabilities, and disruptions to DLA's network-connected devices. The platform should be scalable with low bandwidth and compute resource requirements. It should also be capable of running asynchronously within isolated environments outside of network connectivity.

DESCRIPTION: DLA requires a cyber-detection platform that comprehensively addresses supply chain security challenges, evolves as new threats emerge, and endures the test of time to provide uninterrupted support to the warfighter.

The platform should provide distributed command-and-control of cyber threats, including the ability to rapidly stop effects and restore normal operations. The platform must not harm the underlying network infrastructure or host systems. The platform architecture should be system-agnostic and provide distributed aggregation and storage of all relevant cybersecurity data, allowing for real-time analysis of any network.

The platform should passively monitor system data for problem trends and behaviors, and then issue warnings to the operators of more significant systemic faults. The platform should automatically update its risk index to address emerging threats. The platform should classify device-related errors, and have behavior-based or anomaly-based detection of threats that may otherwise go undetected.
In all cases, the platform may be required to function under a variety of scenarios within isolated environments that do not support robust learning models. This lack of connectivity to models makes the common approach to cyber detection less effective. An alternative approach is to focus on coupling machine learning (ML) with distributed ledger technologies (DLT) to provide indexed integrity of system interactions.

The ability to interface with simulation environments is also of interest.

PHASE I: Not Required. The vendor must demonstrate Proof of Concept via a technical volume not to exceed 20 pages. This volume is included as part of the Phase II Technical volume (Volume 2)
FEASIBILITY DOCUMENTATION: Offerors interested in participating in Direct to Phase II must include in their response to this topic Phase I feasibility documentation that substantiates the scientific and technical merit and Phase I feasibility described in Phase I above has been met (i.e. the small business must have performed Phase I-type research and development related to the topic, but from non-SBIR funding sources) and describe the potential commercialization applications. The documentation provided must validate that the proposer has completed development of technology as stated in Phase I above. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

Read and follow all of the DLA SBIR 20.2 Direct to Phase II solicitation Instructions.
For a Direct to Phase II topic, the Government expects that the small business would identify the following actions in their Feasibility Documentation:

- At a minimum, a workable concept for a Secure Computing Autonomous Network (SCAN) prototype that addresses the basic requirements of the stated objective above.

- Develop a distributed platform that can conduct automated scans of various data streams to learn, predict, and mitigate future disturbances, abnormal trends, and problems.
- Develop and prove feasibility of a Concept of Operation (CONOP) for the use of the platform. Develop a preliminary design to implement the CONOP.
- Address all viable overall platform design options with respective specifications on software modularity, hardware requirements for computational power and capacity, system/sensor agnosticism, and dissemination of information products requested by the user community.

PHASE II: Update the CONOP and develop the detailed design and prototype for the cyber-threat mitigation platform. Detail how the platform enables tactical analysts to detect and mitigate threats and restore operations. Demonstrate all major prototype features in a representative environment. The environment should also include hybrid cloud scenarios where the platform must maintain a shared repository across system enclaves for tactical users to pull and share products, as required.

Develop a transition plan that identifies the scope, effort, and resources required to extend the prototype platform to additional analysis methods or data streams; and development of an out-of-network capability for offline threat detection.

Deliver a Data Disclosure Package (DDP) that includes at a minimum: form, fit, function, operation, maintenance, installation and training data, procedures and information plus the data necessary or related to overall physical, functional, interface, and performance characteristics; corrections or changes to Government-furnished data or software; and data or software that the Government has previously received unlimited rights to or that is otherwise lawfully available to the Government.

PHASE III DUAL USE APPLICATIONS: Work with the DLA to implement the platform as described in the Phase II transition plan at a designated DLA lab. Participate in a Preliminary Design Review (PDR) event. Install on a DLA-designated staging environment for system performance testing.

Ensure sufficient cybersecurity and software assurance requirements are met in accordance with DFARS Clause 252.204–7012, NIST Special Publication 800–171, NIST Special Publication 800–53, and NIST Special Publication 800–37. All RMF requirements must be met to enable platform deployment on DLA systems.

Provide an updated DDP that must include at a minimum: any updates to the Phase II DDP, installation, and maintenance procedures; demonstrated compliance with RMF requirements and qualification testing results; and authority to operate certifications for DLA system use.

Prior to fielding, provide onsite training of the platform design, operation, maintenance, and interfaces. Provide documentation and support materials to transfer the platform to DLA SMEs.

PHASE III DUAL USE APPLICATIONS: This platform has dual-use commercial or military applications in any complex system that either uses sensors to detect abnormalities or synthesizes multiple unrelated data streams for failure analysis or fault localization of its underlying sub-systems.

REFERENCES:
1. DoD Enterprise DevSecOps Reference Design, August 2019. https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0_Public%20Release.pdf?ver=2019–09–26–115824–583
2. It Takes an Average 38 Days to Patch a Vulnerability, Kelly Sheridan, Dark Reading, August 2018. https://www.darkreading.com/cloud/it-takes-an-average–38-days-to-patch-a-vulnerability/d/d-id/1332638

3. Cyber-security Framework for Multi-Cloud Environment, Taslet Security, September 2018. https://medium.com/taslet-security/cyber-security-framework-for-multi-cloud-environment-e7d35fd32bd6
4. Zero Trust: Beyond Access Controls, Rob MacDonald, HelpNetSecurity, January 2020. https://www.helpnetsecurity.com/2020/01/23/zero-trust-approach-cybersecurity/

KEYWORDS: Anomaly Detection, Behavior-Based Detection, Blockchain, Classification, Computer Network Traffic Analysis, Cryptography, Cybersecurity, Data Analysis, Data Provenance, Decentralized Logging, Logistics Platforms, Machine Learning, Networking, Network Intrusion Detection, Pattern Matching, Supply Chain Risk Management, SCRM, System Of Systems, Zero Trust

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**DEFENSE THREAT REDUCTION AGENCY (DTRA)**
**Small Business Innovation Research (SBIR) Program**
**SBIR 20.2 Proposal Instructions**

## I. INTRODUCTION

The Defense Threat Reduction Agency (DTRA) mission is to enable the DoD, the U.S. Government, and International Partners to counter and deter Weapons of Mass Destruction (WMD – Chemical Biological, Radiological and Nuclear) and Improvised Threat Networks. The DTRA SBIR program is consistent with the purpose of the SBIR Program – i.e., to strengthen the role of innovative small business concerns (SBCs) in Federally-funded research or research and development (R/R&D).

The approved FY20.2 list of topics solicited for in the Defense Threat Reduction Agency (DTRA) Small Business Innovation Research (SBIR) Program are included in these instructions followed by full topic descriptions. Offerors responding to this Broad Agency Announcement must follow all general instructions provided in the Department of Defense Program BAA. Specific DTRA requirements that add to or deviate from the DoD Program BAA instructions are provided below with references to the appropriate section of the DoD document.

The DTRA Small Business Innovation Research (SBIR) Program is implemented, administered, and managed by the DTRA SBIR/STTR Program Office. Specific questions pertaining to the administration of the DTRA SBIR Program should be submitted to:

Mr. Mark Flohr
DTRA SBIR/STTR Program Manager
Mark.D.Flohr.civ@mail.mil
Tel: (571) 616-6066

Defense Threat Reduction Agency
8725 John J. Kingman Road
Stop 6201
Ft. Belvoir, VA 22060-6201

For technical questions about specific topics during the pre-release (6 May 2020 to 3 June 2020) contact the DTRA Technical Point of Contact (TPOC) for that specific topic. To obtain answers to technical questions during the formal BAA open period, visit https://www.dodsbirsttr.mil.

For general inquiries or problems with the electronic submission, contact the DoD SBIR/STTR Help Desk 1-703-214-1333 or email: dodsbirsupport@reisystems.com (Monday through Friday, 9:00 a.m. to 7:00 p.m. )

Proposals not conforming to the terms of this announcement will not be considered. DTRA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality as determined by DTRA will be funded. DTRA reserves the right to withdraw from negotiations at any time prior to contract award. The Government may withdraw from negotiations 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 DTRA instructions carefully prior to submitting your proposal.

The SBIR Policy Directive is available at:
https://www.sbir.gov/sites/default/files/SBIRSTTR_Policy_Directive_2019.pdf.

## II. OFFEROR SMALL BUSINESS ELIGIBILITY REQUIREMENTS

Each offeror must qualify as a small business at time of award per the Small Business Administration's (SBA) regulations at 13 CFR 121.701-121.705 and certify to this in the Cover Sheet section of the proposal. Those small businesses selected for award will also be required to submit a Funding Agreement Certification document prior to award.

**SBA Company Registry**

Per the SBIR Policy Directive, all SBIR applicants are required to register their firm at SBA's Company Registry prior to submitting a proposal. Upon registering, each firm will receive a unique control ID to be used for submissions at any of the eleven (11) participating agencies in the SBIR program. For more information, please visit the SBA's Firm Registration Page: https://www.sbir.gov/user/login/

## III. USE OF FOREIGN NATIONALS, GREEN CARD HOLDERS AND DUAL CITIZENS

See the "Foreign Nationals" section of the DoD SBIR Program Announcement for the definition of a Foreign National (also known as Foreign Persons).

**ALL offerors proposing to use foreign nationals, green-card holders, or dual citizens, MUST disclose this information regardless of whether the topic is subject to export control restrictions. Offers must identify any foreign nationals or individuals holding dual citizenship expected to be involved on this project as a direct employee, subcontractor, or consultant.** For those 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. You may be asked to provide additional information during negotiations in order to verify the foreign citizen's eligibility to participate on a SBIR 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). DTRA 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 is found ineligible by the government to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale. In the event a firm is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

## IV. EXPORT CONTROL RESTRICTIONS

The technology within some DTRA 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.

## V. FRAUD, WASTE, and ABUSE

**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.

**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.

**Abuse** includes any intentional or improper use of Government resources, such as misuse of rank, position, or authority or resources.

Offerors shall complete the SBIR Program training related Waste and Abuse. Training is available at: https://www.sbir.gov/tutorials/fraud-waste-abuse/tutorial-1. Please follow guidance provided on the site to complete the required training.

## VI. CYBER SECURITY

Cyber Security. Any Small Business Concern receiving a SBIR award is required to provide adequate security on all covered contractor information systems. Specific security requirements are listed in DFARS 252.204.7012, and compliance is mandatory.

## VII. PROPOSAL FUNDAMENTALS

### Proposal Submission

All proposals MUST be submitted online using the DoD SBIR/STTR submission system https://www.dodsbirsttr.mil/submissions/. Any questions pertaining to the DoD SBIR/STTR submission system should be directed to the DoD SBIR/STTR Help Desk: 1-703-214-1333, or email to: dodsbirsupport@reisystems.com.

### Classified Proposals

Classified proposal are NOT accepted under the DTRA SBIR Program and Phase I contracts are not typically awarded for classified work. However, in some instances, work being performed on Phase II contracts will require security clearances. If a Phase II contract will require classified work, the offeror must have a facility clearance and appropriate personnel clearances in order to perform the classified work.

### Proposal Status

The DTRA program office will distribute selection and non-selection email notices to all firms who submit a DTRA SBIR proposal. The email will be distributed to the "Corporate Official" and "Principal Investigator" listed on the proposal coversheet.

### Proposal Feedback

DTRA will provide written feedback to unsuccessful offerors regarding their proposals upon request. Requests for feedback must be submitted in writing to the DTRA SBIR/STTR within 30 calendar days of non-selection notification. Non-selection notifications will provide instructions for requesting proposal feedback.

### Discretionary Technical and Business Assistance (TABA)

In accordance with the Small Business Act (15 U.S.C. 632), DTRA will authorize the recipient of a Phase I or Phase II SBIR/STTR award to purchase Discretionary Technical & Business Assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on-line data bases, for the purpose of assisting such concerns as:

- making better technical decisions concerning such projects;
- solving technical problems which arise during the conduct of such projects;
- minimizing technical risks associated with such projects; and

- developing and commercializing new commercial products and processes resulting from such projects.
- Meeting cyber security requirements.

If you are interested in proposing use of a vendor for Discretionary Technical & Business Assistance (TABA), you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one-page description of the vendor you will use and the Technical & Business Assistance you will receive. For the Phase I project, the amount for TABA may not exceed $6,500 per award. For the Phase II project, the TABA amount may be less than, equal to, but not more than $50,000 per project. The description should be included as the LAST page of the Technical Volume. This description will not count against the page limit and will NOT be included in the technical evaluation.

Approval of technical and business assistance is not guaranteed and is subject to review of the contracting officer.

For Discretionary Business and Technical Assistance, small business concerns may propose one or more vendors. Additionally, business-related services aimed at improving the commercialization success of a small business concern may be obtained from an entity, such as a public or private organization or an agency of or other entity established or funded by a State that facilitates or accelerates the commercialization of technologies or assists in the creation and growth of private enterprises that are commercializing technology

**VIII. PHASE I PROPOSAL GENERAL INFORMATION**
**Proposal Evaluation**

DTRA will evaluate Phase I proposals using the criteria specified in Section 6.0 of the DoD SBIR Program BAA during the review and evaluation process. The criteria will be in descending order of importance with technical merit, soundness, and innovation of the proposed approach being the most important, followed by qualifications, and followed by the commercialization potential. With other factors being equal, cost of the proposal may be included in the evaluation. DTRA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Government may withdraw from negotiations 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). Phase I contracts are limited to a maximum of $167,500 over a period not to exceed seven months. For clarity, the stated maximum dollar amount is exclusive of the Discretionary Technical and Business Assistance (TABA) that firms may request.

DTRA participates in one DoD SBIR BAA each year and anticipates funding one or possibly two Phase I contracts to small business concerns for each topic.

**DTRA Support Contractors**

Select DTRA-employed support contractors may have access to contractor information, technical data or computer software that may be marked as proprietary or otherwise marked with restrictive legends. Each DTRA support contractor performs under a contract that contains organizational conflict of interest provisions and/or includes contractual requirements for nondisclosure of proprietary contractor information or data/software marked with restrictive legends. These contractors require access while providing DTRA such support as advisory and assistance services, contract specialist support, and support of the Defense Threat Reduction Information Analysis Center (DTRIAC). The contractor, by submitting a proposal or entering into this contract, is deemed to have consented to the disclosure of its information to DTRA's support contractors.

The following are, at present, the prime contractors anticipated to access such documentation: Cherokee Nation Strategic Programs, LLC (contract specialist support), Kent, Campa, and Kate, Inc. (contract closeout support), Engility Corporation (a company under SAIC, Inc), (advisory and assistance services), Quanterion Solutions, Inc. (DTRIAC), Kforce Government Solutions, Inc. (financial/accounting support), and CACI (contract writing system administration). This list is not all inclusive (e.g., subcontractors) and is subject to change.

## IX. PHASE I PROPOSAL GUIDELINES

The DoD SBIR/STTR Proposal Submission system (available at https:/www.dodsbirsttr.mil/submissions/ will lead you through the preparation and submission of your proposal. Read Section 5.0 of the DoD Announcement for detailed instructions on proposal format and program requirements. You must include a Company Commercialization Report (CCR) as part of each proposal you submit. Proposals not conforming to the terms of this Announcement will not be considered. To be considered for evaluation the proposal package must be formally submitted on the DoD SBIR/STTR submission system by clicking the green "SUBMIT PROPOSAL" button.

Proposals addressing the topics will be accepted for consideration if received no later than the specified closing hour and date in the DoD Announcement – **12:00 p.m. Eastern Time, Thursday, 2 July 2020.** The Agency requires your entire proposal to be submitted electronically through the DoD Submission Web site https://www.dodsbirsttr.mil/submissions/. A hardcopy is NOT required and will not be accepted. Hand or electronic signature on the proposal is also NOT required.

**MAXIMUM PHASE I PAGE LIMIT FOR DTRA IS 20 PAGES FOR VOLUME 2, TECHNICAL VOLUME**

Any pages submitted beyond the 20-page limit within the Technical Volume (Volume 2) will not be evaluated**.** Letters of support and TABA requests should be included as part of Volume 5 and will not count towards the 20-page Technical Volume (Volume 2) limit. Any technical data/information that should be in the Technical Volume (Volume 2) but is contained in other Volumes will not be considered. DTRA's objective for the Phase I effort is to determine the merit and technical feasibility of the concept. The contract period of performance for Phase I shall be seven (7) months and the award shall not exceed $167,500. A list of topics currently eligible for proposal submission is included in these instructions, followed by full topic descriptions.

**Phase I Proposal**

**A complete Phase I proposal consists of five volumes (six if letters of support and/or TABA is included):**

- Volume 1. Proposal Cover Sheet (required) does not count towards the 20-page limit.
- Volume 2. Technical Volume is required. DTRA has established a **20-page limitation** for Technical Volumes submitted in response to its topics. The Technical Volume includes, but is not limited to: table of contents, pages left blank, references and letters of support, appendices, key personnel biographical information, and all attachments.
- Volume 3. Cost Volume (required) does not count towards the 20-page limit. DTRA requires that small business concerns complete the Cost Volume form on the DoD Submission site versus submitting it within the body of the uploaded volume.
- Volume 4. Company Commercialization Report (required) does not count towards the 20-page limit).
- Volume 5. Supporting Documentation Volume (optional) does not count towards the 20-page limit. The Supporting Documentation Volume will be considered part of the evaluation documentation. It

allows for additional specific documents limited to: (a) any additional letters of support, (b) additional cost information. (c) Funding Agreement Certification, (d) Technical Data Rights (Assertions), (e) Lifecycle Certification, and (f) Allocations of Rights.

- Volume 6. Fraud, Waste, and Abuse Training Certification (required) does not count towards the 20-page limit.

**Proposal Submittal**

Proposals are required to be submitted in Portable Document Format (PDF), and it is the responsibility of submitters to ensure any PDF conversion is accurate and does not cause the Technical Volume portion of the proposal to exceed the 20-page limit. **Any pages submitted beyond the 20-page limit, will not be read or evaluated.** If you experience problems uploading a proposal, call the DoD SBIR/STTR Help Desk from 9:00 a.m. to 5:00 p.m. Eastern Time Monday through Friday at: 1-703-214-1333 or E-mail: dodsbirsupport@reisystems.com

**Animal and Human Research**

Companies should plan carefully for research involving animal or human subjects, biological agents, etc. (see Sections 4.7 - 4.9 in the DoD Program Announcement). The few months available for a Phase I effort may preclude plans including these elements unless coordinated before a contract is awarded.

## X. DECISION and NOTIFICATION

DTRA has a single Evaluation Authority (EA) for all proposals received under this solicitation. The EA either selects or rejects Phase I and Phase II proposals based upon the results of the review and evaluation process plus other considerations including limitation of funds, and investment balance across all the DTRA topics in the solicitation. To provide this balance, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Following the EA decision, the DTRA SBIR/STTR office will release notification e-mails for each accepted or rejected offer. E-mails will be sent to the addresses provided for the Principal Investigator and Corporate Official. Offerors may request a debriefing of the evaluation of their not selected proposal and should submit this request via email to dtra.belvoir.RD.mbx.sbir@mail.mil and include "SBIR 20.2/ Topic XX Debriefing Request" in the subject line. Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the EA decision.

For selected offers, DTRA will initiate contracting actions which, if successfully completed, will result in contract award. DTRA Phase I awards are issued as fixed-price purchase orders with a maximum period of performance of seven-months. DTRA may complete Phase I awards without additional negotiations by the contracting officer or without opportunity for revision for proposals that are reasonable and complete.

## XI. PHASE II PROPOSAL GUIDELINES

Small business concerns awarded a Phase I contract are permitted to submit a Phase II proposal for evaluation and potential award selection. The Phase II proposals should be submitted no later than (NLT) 30 days AFTER the end of the 7 month Phase I period of performance.

All SBIR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations.

DTRA is not responsible for any money expended by the proposer prior to contract award.

DTRA has established a **40-page limitation** for Technical Volumes submitted in response to its topics. This does not include the Proposal Cover Sheets (pages 1 and 2, added electronically by the DoD submission site), the Cost Volume, or the Company Commercialization Report. The Technical Volume includes, but is not limited to: table of contents, pages left blank, references and letters of support, appendices, key personnel biographical information, and all attachments.

Further details on the due date, content, and submission requirements of the Phase II proposal will be provided either in the Phase I award or by subsequent notification.

**Phase II Proposal Instructions**

Each Phase II proposal must be submitted through the DoD SBIR/STTR Submission Web site by the deadline as specified in the Phase II Proposal Guidelines, or in the Phase I award or subsequent notification. Each proposal submission must contain a Proposal Cover Sheet, Technical Volume, Cost Volume, and a Company Commercialization Report (see Sections 5.4.c.and 5.5 of the BAA Announcement).
As instructed in Section 5.4.e of the DoD SBIR Program BAA, the CCR is generated by the submission website based on information provided by you through the "Company Commercialization Report" tool.

**Commercialization Strategy**

See Section 7.4 of the DoD SBIR 20.2 BAA.

**Phase II Evaluation Criteria**

Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of this Program Announcement and will be similar to the Phase I process.

## XII. PUBLIC RELEASE OF AWARD INFORMATION

If your proposal is selected for award, the technical abstract and discussion of anticipated classified information in these sections. For examples of past publicly released DoD SBIR/STTR Phase I and II awards, visit https://www.dodsbirsttr.mil.

## XIII. PROTESTS

Service of Protest (Sept 2006)

(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the Government Accountability Office (GAO), shall be served on the Contracting Officer (addressed to Ms. Megan Faherty, Contracting Officer, as follows) by obtaining written and dated acknowledgment of receipt from (if mailed letter) Defense Threat Reduction Agency, ATTN: AL-AC (Ms. Megan Faherty), 8725 John J. Kingman Road, M.S. 6201, Fort Belvoir VA 22060. If Federal Express is used for the transmittal, the appropriate address is: Defense Threat Reduction Agency, ATTN: AL-AC (Ms. Megan Faherty), 6200 Meade Road, Fort Belvoir, VA 22060.

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

(End of provision)

## DTRA SBIR 20.2 Topic Index

**NOTE:** The technology within some of the topics may be restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense related material and services. Offerors must disclose any proposed use of Foreign nationals, their country of origin, and what tasks each would accomplish in this statement of work in accordance with section 3.5.b(7) of the solicitation.

| | |
|---|---|
| DTRA202-001 | Ship Board Water Intake Radiation Sensor |
| DTRA202-002 | Radiation Dose Advisor Application |
| DTRA202-003 | Pedigree Reconstruction for Identifying Terrorist Networks |
| DTRA202-004 | Transient Electric Field Measurements As Test Diagnostics |
| DTRA202-005 | Nuclear Scintillation Mitigation by Matched Channel Filtering |
| DTRA202-006 | Radiation-Resistant and Temperature-Insensitive Solid State Photomultipliers |

DTRA202-001 TITLE: Ship Board Water Intake Radiation Sensor'

RT&L FOCUS AREA(S): Nuclear
TECHNOLOGY AREA(S): Ground/Sea Vehicles, Nuclear, Sensors

OBJECTIVE: DTRA seeks to investigate and develop a radiation detector that can be placed on a naval vessel's water intake pipe in order to frequently measure for radiation in the water through which the vessel is sailing.

DESCRIPTION: In the aftermath of the Fukushima event it was learned that radioactive isotopes were in the water off the coast of the reactor site. Ships struggled to determine if the water they were sailing through had radioactive isotopes. This is important since large ships use water from the body of water they are sailing through on the ship for numerous uses. Having a detector on the water intake pipe taking regular measurements would inform the ship's crew of rising radiation levels in the water and thus make informed decisions on the next course of action to take. This is valuable to all large naval vessels that are concerned.

The detector system should be readily repairable, will make measurements on the exterior surface of the pipe with no penetrations into the pipe, should be able to measure through varying thicknesses of pipe 1/4" up to 1", should use a less expensive crystal material for the detector, able to measure gamma rays in the range of 60 KeV to 3 MeV, able to run continuously for 1 year with minimal maintenance, and able to communicate data to a software application that records and reports the data via a cable or wireless communication.

PHASE I: Identify the materials, methods, and processes to meet the design objectives. By the end of phase one, materials and techniques should have been demonstrated to have the potential for fulfilling a fully integrated prototype.

PHASE II: Develop a prototype and demonstrate its ability to meet the requirements provided in the description. This phase will utilize the materials and techniques developed in Phase I of this research. Develop manufacturing and commercialization plans for implementing the research into production and then into the marketplace.

PHASE III DUAL USE APPLICATIONS: This technology could be used on any water intake pipe or effluent pipe where detection of radiation is a concern, such as on ships in both fresh or salt water, water treatment facilities, nuclear power plant effluent systems, and other industrial facilities that process water with radioactive isotopes.

REFERENCES:
[1] G. Knoll, Radiation Detection and Measurement. John Wiley & Sons (2010)

KEYWORDS: Ship, water, radiation, sea vessel, radiation detector, radiation detection, radioactive

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DTRA202-002 TITLE: Radiation Dose Advisor Application

RT&L FOCUS AREA(S): Nuclear
TECHNOLOGY AREA(S): Bio Medical, Nuclear

OBJECTIVE: DTRA is interested in developing a simple electronic application or toolkit that is able to run on a hand held electronic device in conjunction with a radiation detector to provide stay time and health hazard decision making support to individuals in unknown or varying radiation fields.

DESCRIPTION: Often radiation fields can vary or are unknown in emergent situations where first responders and other individuals must still be able to perform critical operations. This application is intended to take real time radiation sensor data (to include the dose rate and accumulated dose), any optional user input such as any dose restrictions for the responders, and then rapidly run calculations to compare against a set of safety guidelines to then display a stay time in the current area and display any applicable health warnings based on the dose accumulated.

This application should be able to:

1) Run on a tablet, computer, smart device, or smartphone with windows or android operating system or a given operating system and be networkable
2) Collect and process radiation sensor data sufficiently to extract dose and dose rate data
3) Given a set of safety guidelines, incorporate the threshold values as references
4) Use the reference values, accumulated dose from the detector, user defined restrictions on allowed dose, and dose rate from the detector to calculate a stay time in the current location.
5) Taking the accumulated dose calculations from 4) and then compare against other overall reference values to determine any health hazard warnings
6) Display percent of allowed dose accumulated
7) Display stay time
8) Display any health hazard warnings that can be acknowledged and minimized.
9) Share the calculated data on the network to other users
10) Update calculations on flexible frequency, faster at high dose rates, slower at low dose rates
11) Have reference values updated as needed

PHASE I: Identify and demonstrate pathways for meeting the performance goals at the end of Phase I. Incorporate the provided safety guidelines and ability to accept user defined restrictions into the application and demonstrate the calculations can be done with simulated detector data.

PHASE II: Using progress from phase one, use actual detector data and user defined limitations to demonstrate stay time, percent of allowed dose, and any warnings will display on user smart device.

PHASE III DUAL USE APPLICATIONS: This has numerous applications for any individuals needing to work in unknown or rapidly changing radiation fields, such as local, state, and federal first responders and emergency response personnel at power plants and other nuclear facilities.

REFERENCES:
[1] G. Knoll, Radiation Detection and Measurement. John Wiley & Sons (2010)
[2] Joint Publication 3.11

KEYWORDS: Toolkit, application, radiation dose, radiation support, radiation decision making, dose rate, radioactive, radiation decision support

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DTRA202-003 TITLE: Pedigree Reconstruction for Identifying Terrorist Networks

RT&L FOCUS AREA(S):
TECHNOLOGY AREA(S): Human Systems, Information Systems

OBJECTIVE: To develop a software platform for pedigree reconstruction that can use naïve DNA profiles to establish familial relationships between individuals and within groups of interest.

DESCRIPTION: DESCRIPTION: A presently under-utilized tool for military applications is pedigree analysis that combines DNA data with computational approaches to derive information regarding the nature of familial relationships. The advent of DNA sequencing and its adaptation as the gold-standard method for biological characterization led to the development of expansive genetic databases, which are now available for a use in a wide variety of studies [1,2]. Genetic typing provides a compelling means to establish identity in cases where biological evidence is available. Pedigree reconstruction further extends its utility by allowing inferences of relatedness [3]. DNA markers like single nucleotide polymorphisms (SNP) are shown to be informative for evaluating ancestry as well as for forensic reconstruction of lineages, and sustained efforts like the 1000 Genomes Project, GEDmatch, Family Tree DNA and others provide a wealth of accessible information that is essential to and underpins the fidelity of a given reconstruction [4]. Researchers have used various approaches, including the application of alternative statistical approaches and different combinations of markers, to improve heritability estimates and thus veracity of results. Groups report different levels of success dependent upon specific project goals [4,5,6], but some boast detection of relatedness out to 9th degree relationships and deduction of the precise degree of relatedness between 6th degree relatives (e.g., second cousins, once removed). However, because the primary aim of such projects is maintaining high levels of accuracy, supporting analysis requires long periods of time and substantial computational resources. Although direct-to-consumer genetic testing companies make similar assurances and enjoy the advantages associated with access to massive amounts of data, their processes tend to lack scientific rigor, and the companies fall short of making quality assurance guarantees with respect to their analyses [7].

Reconstruction of family lineages has multiple military and civilian applications where identifying the probable contributors of samples of human origin is desirable. For example, one notable application is identification of missing service members. The Armed Forces presently require provision of DNA samples from service members upon processing through enlisted basic training or officer training school, so that the samples can be used for identification of remains if needed [8]. However, prior to the establishment of the Armed Forces Repository of Specimen Samples (AFRSSIR) in 1992, such samples were not required, thus establishing the identity of war casualties from fifty-plus years ago can present a considerable technical challenge. The Armed Forces Medical Examiner System's-Armed Forces DNA Identification Laboratory (AFMES-AFDIL) is presently charged with "providing human remains DNA testing in support of current day operations (AFMES), past accounting operations (Defense POW/MIA Accounting Agency) and other U.S. Department of Defense Agency missions." [9] AFMES-AFDIL uses the most modern tools available for genomic sequencing, but pedigree reconstruction for the purpose of identification remains a lengthy process because a high level of stringency is desirable. Tradeoffs between surety and timeliness similarly plague those tasked with establishing likely identity of sample origin for the purpose of criminal investigations.

Another application of importance is identification of familial lineages that are significantly represented in terrorist network nodes. Family ties can serve as the mobilizing infrastructures for establishment of terrorist groups. Many social scientists argue that other "preconditions" are irrelevant without an organizational structure that brings together friends and family members using the strength of their relationships as the precipitant event rather than other factors like the nature of their grievances or religious affiliations [10]. The history of groups like the Irish Republican Army underscores the foundational role of kinship in the incipient formation of terrorist cells. Several similar examples exist in other regions of the world, including those of specific interest to the U.S. Department of Defense, and recent high-profile acts of terrorism executed by relative and friend groups have refocused attention on the importance of family ties for establishing terrorist networks and garnering commitment to a common cause [11]. Analysing the relationships among the perpetrators of terrorist acts will, in the short term, allow identification of likely sources of recruitment and radicalization. In the longer term, analysis of the causal and contributing factors will allow development of more effective de-radicalization strategies so that such acts can be subverted.

The specific goal of the present topic is to conflate the useful elements of small-scale and large-scale approaches in order to develop a process that handles new data with high efficiency while maintaining quality in terms of analytical stringency. The overarching aims are to validate the concept that DNA is a theater-relevant biometric and to develop a software platform that supports its operational use.

PHASE I: Leverage or create a computational architecture for pedigree analysis that can be scaled to incorporate successively larger DNA datasets while maintaining operational efficiency and veracity of analyses normally conducted at smaller scales, with the end-state goal of developing a software platform that can accept new information and generate pedigrees as the data arrives. Identify criteria for final selection of ancestry-estimation methods and markers. Explicitly identify genetic databases used for the project and indicate means by which [potentially] sensitive data were protected. Develop metrics to evaluate performance of the new architecture as compared to presently available approaches and standards to represent statistical confidence in resultant pedigrees. Initiate development of a quality assurance protocol. Phase I deliverables will include (1) a final report and (2) demonstration of the preliminary architecture to the cognizant project officer. The report should also provide results on architecture performance using unambiguous statistical methods, describe development including parameterization, and identify limitations / weaknesses. The report should include plans for development of a user interface which will address Phase II expectations. Operating system, other software requirements, and data compatibility should be specifically addressed, as should proposed location of the final interface.

PHASE II: Phase II efforts will focus on iterative improvement to the proof-of-concept approach developed during Phase I. The performer will mature the architecture by improving performance as compared to the preliminary architecture evaluated as part of the Phase I effort and will modify the software, as needed, to provide for ease-of-use and –interpretation of results. The performer will identify weaknesses in performance that could be improved through additional data, modified statistical approaches, and / or additional pre-processing steps and will codify / relay observations to the project officer. The phase II deliverables will be a proof of concept demonstration of the software platform with the introduction of novel genetic profiles whose pedigrees have been established by other means and a report detailing (1) description of the approach, including optimization techniques and performance outcomes, (2) testing and validation methods, and (3) advantages and disadvantages / limitations of the method; and a user interface with any associated executables.

PHASE III DUAL USE APPLICATIONS: In addition to implementing further improvements that would enhance use of the developed product by the sponsoring office, identify and exploit features that would be attractive for commercial or other private sector pedigree analysis applications.

REFERENCES:
[1] Goudet J, Kay T, Weir BS. 2018. How to Estimate Kinship. Molecular Ecology 27:4121-4135.
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[3] Budowle B, van Daal A. 2008. Forensically Relevant SNP Classes. BioTechniques 44:603-610.

[4] Huisman J. 2017. Pedigree Reconstruction from SNP Data: Parentage Assignment, Sibling Clustering and Beyond. Molecular Ecology Resources 17:1009-1024.
[5] Morimoto C et al. 2016. Pairwise Kinship Analysis by the Index of Chromosome Sharing Using High-Density Single Nucleotide Polymorphisms. PLOS ONE DOI:10.1371/journal.pone.0160287.
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[9] https://www.dpaa.mil/Resources/Fact-Sheets/Article-View/Article/590581/armed-forces-medical-examiner-system-dna-identification-laboratory/
[10] Noricks D et al. 2009. Social Science for Counterterrorism: Putting the Pieces Together. Rand Corporation Technical Report (ISBN 978-0-8330-4706-9).
[11] Copeland S. 2017. The Importance of Terrorists' Family and Friends. https://crestresearch.ac.uk/comment/copeland-terrorist-families-and-friends/

KEYWORDS: Pedigree reconstruction, kinship, familial relatedness, genotyping., terrorism, terrorist, radicalization

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DTRA202-004 TITLE: Transient Electric Field Measurements As Test Diagnostics

RT&L FOCUS AREA(S):
TECHNOLOGY AREA(S): Sensors, Weapons

OBJECTIVE: To advance the state of the art of using transient electric field measurements as a test diagnostics tool, specifically for conventional explosive tests.

DESCRIPTION: Signals of various types are of interest to DTRA and DOD for conventional explosives testing. Historically, seismic and acoustic signals have been the primary diagnostic signals of interest in explosives testing, mainly due to the relatively mature understanding of their generation and propagation, their direct applicability to damage potential and forensics, and the variety of sensors available to collect these signals. However, other signals are generated from conventional explosives detonations that are not as well understood. It has long been known that the detonation of conventional explosives produces various types of electric and electromagnetic phenomena [1-3]. This innovation challenge involves exploration of these electric and electromagnetic phenomena to determine how they are generated, what the measured signal content represents, and the best method(s) to conduct measurements of electric and electromagnetic phenomena during explosives testing.

Past work has identified various general mechanisms by which the detonation of conventional explosives produces electric and electromagnetic phenomena. These mechanisms include early time ionization [4], case breakup, piezoelectric effects [5], lightning in the debris cloud [6], seismoelectric effects, and movement of charge within porous earth materials. These phenomena are related to seismoelectric exploration [7-8] as well as the field of magnetotellurics. Using transient electric field measurements as a test diagnostics tool is attractive because 1) a major advantage of electric methods compared to mechanical methods is that they eliminate the ambiguity that often exists for mechanical signals regarding the travel path and/or propagation velocity (since electric signals propagate at the speed of light, the travel time is insignificant), and 2) valuable data can be collected and analyzed in future tests if it can be determined how the electric field measurements can be related to phenomena of interest [9]. An example of a DoD area of interest would be using the electric field measurements to provide information regarding weapon fuse function and other performance forensics. Methods exist today to collect these electric field measurements, ranging from the expensive such as magnetometers and electric field meters with high frequency recording systems to cheaper options such as ground rods connected to a recording system [6], but interpretation of these measurements is an area that requires further investigation.

The desired outcome of this innovation challenge is to better understand the electric field measurements recorded during explosive tests and how they can be correlated to phenomena of interest, i.e., bridging the current gap between known/hypothesized mechanisms of electric field generation and the characteristics (magnitude, frequency content, duration, etc.) of the signals generated by these mechanisms. Additionally, a major issue existing today is how to separate out effects from different phenomena and therefore extract useful diagnostic information from an electric field measurement during an explosive test. These electric field measurements currently represent a relatively untapped source of diagnostics which could provide valuable information for future tests if research efforts prove fruitful.

PHASE I: Identify the most important mechanisms that generate transient electric fields during explosive tests, and the signal types and characteristics expected from such mechanisms. Arguments should be testable and supported using methods such as (list is not exhaustive): theoretical derivations, modeling, previous studies, and simple experiments (if cost feasible). The best method or methods to collect transient electric field measurements during explosive tests should also be proposed. The Phase I deliverable is a technical report.

PHASE II: Execute an experimental test program to verify mechanisms identified in Phase I, incorporating the measurement method(s) proposed in Phase I. The experimental test program shall incorporate pre-test predictions.

PHASE III DUAL USE APPLICATIONS: Since phenomena generated during conventional explosive detonations are also generated in natural events such as earthquakes and volcanic eruptions, there could be significant crossover between this work and other fields once enhanced understanding is obtained. Methods and devices used to measure the electric field generated from conventional explosive detonations could also find applicability in the fields of seiesmoelectric exploration and magnetotellurics.

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[1] H. Kolsky, 1954, “Electromagnetic Waves Emitted on Detonation of Explosives”, Nature, Vol. 173, page 77.
[2] Fine, J.E., and S.J. Vinci, 1998, “Causes of Electromagnetic Radiation from Detonation of Conventional Explosives: A Literature Survey”, Army Research Laboratory Technical Report ARL-TR-1690.
[3] Lauten, W.T., Reinke, R.E., and R.J. Martin, 2006, “The Measurement and Modeling of Earth Electric Signals Produced by Impacts and Detonations” in Proceedings of the 19th Symposium on the Military Aspects of Blast and Shock (MABS 19), Calgary, October.
[4] Kuhl, A.L., White, D.A., and B.A. Kirkendall, 2014, “Electromagnetic Waves from TNT Explosions”, Journal of Electromagnetic Analysis and Applications, Vol. 6, pages 280-295.
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[6] Reinke, R.E., and J.A. Leverette, 1999, “Earth Potential Signals as Diagnostic Tools for High Explosive Structures Testing” in Proceedings of the 9th ISIEMS, Berlin, May.
[7] Theriault, R., St-Laurent, F., Freund, F.T., and J.S. Derr, 2014, “Prevalence of Earthquake Lights Associated with Rift Environments”, Seismological Research Letters, Vol. 85, pages 159-178.
[8] Russell, R.D., Butler, K.E., Kepic, A.W., and M. Maxwell, 1997, “Seismoelectric Exploration”, The Leading Edge, Vol. 16, Issue 11, page 1611.
[9] Soloviev, S.P., Surkov, V.V., and J.J. Sweeney, 2002, “Quadrupolar electromagnetic field from detonation of high explosive charges on the ground surface”, Journal of Geophysical Research, Vol. 107.

KEYWORDS: High explosives, electrical field, electrical signals, detonation, diagnostics, signal processing

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DTRA202-005 TITLE: Nuclear Scintillation Mitigation by Matched Channel Filtering

RT&L FOCUS AREA(S): Nuclear, Space
TECHNOLOGY AREA(S): Battlespace, Nuclear

OBJECTIVE: The objective of this SBIR topic is to conduct research, development, and demonstration for a new method to mitigate digital communications message errors resulting from communication over nuclear-disturbed RF propagation channels. Such errors can occur on SATCOM links which must pass through magneto-ionic media generated by nuclear weapons detonationin the high atmosphere. Accordingly, the objective of this research is to define a "Matched Channel Filter" (MCF)—matched to the then current scintillated communication channel filter function, and to demonstrate the mitigation offered by the new MCF filter via experiments with GFE HWIL scintillation simulators.

DESCRIPTION: Previous DTRA scintillation research has successfully formulated models of propagating channels disturbed by high-altitude nuclear weapons detonations. Detailed computer simulations to analyze and predict the disturbed channel performance have also been developed. DTRA has also developed Hardware-in-the-Loop (HWIL) fading channel simulators (like the WCS, CoLTS, RNECS, and others). These simulators have been used for developmental and acceptance testing of strategic RF communication systems and components which must operate with transmitters propagating in a scintillation medium. Two important DoD capabilities have been derived from these previous efforts: 1) the ability to harden the design of strategic RF systems against scintillation, and 2) the ability to test the performance of fielded RF systems under simulated wartime (nuclear-disturbed atmosphere conditions).

**Antenna Channel Impulse Response Function (ACIRF)**
The principal DTRA modeling tool which is used for analysis and testing of scintillated communication links is the Antenna Channel Impulse Response Function (ACRIF--Ref 2). DTRA's ACIRF code provides the DoD strategic communication and radar communities with a formal method of representing disturbed trans-ionospheric propagation channels for SATCOM, HF communications, or even two way radar propagation channels. ACIRF also models the filtering effects of the receive antenna. ACIRF output files, called "realizations" when associated with a particular link, are usually pre-computed in accordance with link specifications (frequency, modulation bandwidth, geometry, and either measured or derived channel parameters). ACIRF generates pseudo-random baseband equivalent realizations of RF fading channels, and are considered to be the channels impulse response function. These realizations are stored to hard drive for use in analysis codes or in HWIL test systems.

**Channel Realization Generator (CReG)**
Although the ACIRF code has proven to be a valuable tool, it has limitations. It runs off-line to generate one fixed-length realization that must be stored and repeatedly played back to represent a fading channel effects over a long duration communication link testing scenarios. Secondly, any test or analysis application using ACIRF realizations must have a large storage and retrieval capability to accept and playback ACIRF realizations needed during HWIL testing, rather than just accepting a stream of channel realization updated in real test time. Thirdly, ACIRF only generates complex baseband realizations with Rayleigh or Rician amplitude statistics. This is appropriate for the highly-disturbed propagation paths associated with extreme wartime conditions, but not for propagation paths disturbed by distant high altitude explosions, or by natural phenomena such as tropospheric scatter or auroral effects. Consequently, DTRA has recently developed a real-time channel realization generation code (called CReG), and is in process of implementing it in the newest HWIL simulator (now under development—called CoLTS-AD (Configurable Link Test System--All Digital). A full description of the CReG code and its capabilities can be available to bidders on this topic within SBIR contractor rights restrictions (Ref

3), as well as a description of the CoLTS-AD HWIL system (Ref 4) within the same SBIR rights restrictions.

**Matched Propagation Channel Filter Function**

The concept of matched channel filter synthesis for compensating the effects of a disturbed magneto-ionic propagation channel has been investigated in the past. Then, Halpin and Urkowitz of GE Aerospace (Ref 5) considered implementing an intentionally pre-distorted wideband chirp radar waveform before transmission through a scintillated propagation channel. The pre-distortion essentially implemented a matched propagation channel filter at the Cobra Dane radar transmitter. Halpin chose to implement transmit waveform pre-distortion so that the propagation channel itself would filter the pre-distorted waveform, allowing linear de-chirp radar return signal processing to proceed at the radar receiver as if the propagation path had been through free space. In this SBIR effort, we wish to find the channel filter of the scintillated channel itself in real time, and then implement the matched channel filter on receive as the method to mitigate errors imposed by the transmit channel scintillation.

The primary intent of this research is to define a Matched Channel Filter (MCF) —matched to the then current scintillated communication channel filter function, where $Hs(\omega)$ is the MCF function and $hs(t, \tau)$ is the scintillated communication channel impulse response (the channel response at time t to an impulse applied at $t-\tau$). It is believed that $hs(t, \tau)$, may be found by measuring the then current channel parameters of the nuclear-disturbed channel directly, and therefrom computing the scintillated channel filter function. Then, it is desired to synthesize a "matched filter" function for the newly found fading channel filter. The matched channel filter function may be found by conjugating the determined current channel filter function, but other syntheses may also be pursued. For this application, it remains to be shown that the MCF is the conjugate of the channel filter function.

PHASE I: Phase I investigation will be a modeling study using the DTRA code ACIRF, CReG or other to define a scintillated Channel Impulse Response Function (CIRF), as well as the scintillation channel parameters themselves which are necessary to define that CIRF. Then, the modeling study will continue with the mathematical synthesis to find the Matched Channel Filter (MCF)--matched to the fading channel transfer function, H(w,t). The critical channel parameters needed to synthesize the MCR will also be subject to a sensitivity study in order to bound the needed accuracy of their measurement for satisfactory synthesis of the MCF. A necessary part of the phase I investigation is to suggest how these channel parameters may be estimated or measured in real time (probably by some channel sounding technique).

The Phase I modeling activity will conclude with the (almost) error free recovery of the communication waveform after having been passed through both a scintillated propagation channel (CIRF) and then recovered in a receiver outfitted with the new matched propagation channel filter for that link (MCF). Phase I modeling will affirm the feasibility of the proposed mitigation concept via matched channel filter processing. As noted, Phase Iwill also investigate and describe possible means of determining the real-time channel parameters for any scintillated communication link. The channel parameters to be found by real time channel sounding techniques (or other) are: frequency selective bandwidth, scintillation delay tau0, scintillation index, own antenna dimensions, and Line-of-sight Total Electron Content (TEC).

PHASE II: Phase II will proceed to incorporate the propagation matched filter defined during Phase I into a stand-alone software emulation for the purpose of demonstrating the mitigating capability of the matched filter function. This demonstration is intended to quantify the mitigation capability of the matched channel filter (probably by measuring Bit Error Rate) for the disturbed digital communication waveform, based on how well the matched channel filter can be defined and implemented. The matched channel filter can be programmed into one of the DTRA HWIL simulator test channels, and exercised when presented with the disturbed channel impulse response communications waveform. Phase II will be completed when a detailed plan for incorporating the new matched channel filter in a scintillation HWIL test set has been prepared and delivered to the sponsor. Candidate HWIL sets include WCS, CoLTs, CoLTs-LC, and the new all-digital Scintillator (CoLTS-AD) now being designed and built for DTRA (Ref 4).

PHASE III DUAL USE APPLICATIONS: The commercial market for the recently developed software and run-time CReG codes and for the matched channel filter mitigation being developed herein, includes two communities: 1) the academic community where a number of communication channel simulators have been developed for general purpose use (as for example at the Naval Post Graduate School where a CoLTs-LC scintillator has been in university research use), and 2) the commercial marketplace where tools such as the MATLAB Communications Toolbox are available. Market spaces such as commercial SATCOM, cellular phone, GPS, and Wi-Fi should all be interested in the natural multipath-induced fading channel impulse response calculation of the CReG code and of the matched Channel Filter mitigation being developed herein. In the academic marketplace the matched channel filter development would be of specific interest at Virginia Polytechnic Institute and State University where scintillation mitigation research is underway for a 28 MHz wide area communications network (Ref 6).

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[1] Bello, P. A., "Characterization of randomly time-variant linear channels", IEEE Trans. On Comm. Systems, CS 11, Dec. 1963, pp. 360-393.
[2] Dana, R. A., ACIRF User's Guide for the General Model (Version 3.5), DNA-TR-91-162, June 1992, code available from DTRA at: dtra.belvoir.rd.mbx.reachback-software-distribution@mail.mil
[3] CReG description document (Sawyer, et.al, Welkin Sciences, (within SBIR-rights restrictions)
[4] CoLTS-AD description document (Sawyer, et.al., Welkin Sciences (within SBIR-rights restrictions)
[5] Halpin, Urkowitz, and Maron, "Propagation Compensation by Waveform Pre-Distortion", GE Aerospace, Government Electronic Systems Division, Moorestown, NJ, Proceedings of the IEEE International Radar Conference, 1990.
[6] "Channel Impulse Response and Its Relationship to Bit Error
Rate at 28 GHz Wide Area Communications Network" by Mary Miniuk, Master Thesis, Department t of Electrical Engineering, Virginia Technical University, 2007.

KEYWORDS: Nuclear technology, Survivable communications, Nuclear Scintillation, Scintillation Mitigation

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DTRA202-006 TITLE: Radiation-Resistant and Temperature-Insensitive Solid State Photomultipliers

RT&L FOCUS AREA(S): Nuclear
TECHNOLOGY AREA(S): Battlespace, Electronics, Materials, Nuclear,Sensors

OBJECTIVE: To improve or develop silicon-based photomultipliers that are radiation resistant and insensitive to variations in environmental temperature, suitable to be used in equipment for warfighting missions under nuclear battlefield environments. The proposed new Silicon-based Photomultiplier (SiPM) shall demonstrate orders of magnitude higher radiation tolerance for both below and above the breakdown voltage over the commercial state-of-the-art SiPMs available today. The new SiPM shall also demonstrate orders of magnitude reduction in gain sensitivity to the environmental temperature, with the objective to achieve gamma-ray isotope identification without external temperature compensation.

While silicon-based photomultipliers remain to be preferred development path due to the high level of technology maturity and industry support, this topic does not rule out the use of other wide band gap semiconductor materials [2], referred to as solid state photomultiplier, or SSPM, as long as the performance requirements described herein can be met.

DESCRIPTION: Silicon photomultipliers have many advantages over the traditional vacuum-based photomultiplier tubes (PMTs), including single photon sensitivity, higher photon detection efficiency, lower bias voltage/power consumption, compactness, matching wavelength with the emerging high-performance scintillators, negligible aging effects, immunity to magnetic fields, and can be mass produced. The main drawbacks of SiPMs, compared to PMTs, include high dark count rate, limited effective detection area, cross-talk between neighboring cells, after pulsing, and they are subject to radiation damages. These drawbacks has severely limited its applications in programs intended for the nuclear battlefield. In recent years, these drawbacks have been dramatically reduced thanks to cooperative developmental effort of the private industry and government. Despite this, progresses in reducing SiPM dark current dependency on radiation and temperature are still lacking to fully qualify the field deployment of SiPMs in radiation detectors operating under nuclear battlefield environments.
The effect of radiation in silicon detectors [3] below the breakdown voltage at which avalanche multiplication becomes significant is very well studied and documented. Radiation damage to silicon photomultipliers primarily include x-ray induced surface radiation damage and high-energetic electrons, photons and hadrons (such as neutrons) induced bulk radiation damage. Factors limiting SiPM [4] operation in high-radiation environment including significantly increased dark current during operation below and above the breakdown voltage due to deep level defects produced by radiation in the silicon bulk, and loss of single photon counting resolution due to the increased noise. As an example, a typical SiPM can increase its dark current by about three orders of magnitude after irradiation with neutrons at 1-MeV-equivalent energy up to fluence of 1014-1015 cm-2 at -30 °C below voltage, whereas above breakdown voltage the increase can be more than six orders of magnitude. A considerable degradation in SiPM performance is already evident even at much lower neutron fluence of 108-1010 cm-2 [5]. Consequently, SiPMs lose single photon counting resolution at relatively low neutron fluence, typically around ~1010 cm-2 at room temperature. Other limitations under high-radiation environments include reduction in SiPM gain and photo detection efficiency due to high generation-recombination rate, damage in dielectric-silicon interface and charge trapping in non-depleted entrance layer; increased power consumption due to p-n junction temperature; and increased breakdown voltage due to induced changes in doping concentration. It is well-known that changing temperature can have a significant impact on SiPM operations, most notably fluctuates the breakdown voltage and the dark current. As a result, all SiPMs presently integrated in radiation sensors require external temperature compensation for gain stabilization, e.g. the bias voltage is adjusted according to the environmental temperature in order to keep the overvoltage fixed.

For these reasons, even though SiPMs have many advantages over PMTs working with modern scintillators, their nuclear survivability is limited and thus are largely excluded from deployment where nuclear survivability is a key requirement.

In order to take the advantage of new families of high-performing scintillators, the defense community has an urgent need to improve the radiation tolerance and temperature insensitivity of the SiPMs. This topic seeks solutions to overcome the operational limitations of the SiPMs in high-radiation environment and to minimize the temperature sensitivity of the SiPM on its gain stability while maintaining many of the competitive edges of the SiPMs over PMTs. Potential directions for such SiPMs development include but are not limited to:

- Reducing the dark noise generation in SiPMs by avoiding surface current reaches the multiplication region, reducing diffusion from the non-depleted bulk, and optimizing the field in the depletion region;
- Reducing the cell occupancy by reducing the cell active volume and cell recovery time;
- Limiting breakdown voltage increases by reducing the thickness of the depletion region;
- Reducing damage in SiPM entrance window.
- Reducing the temperature coefficient of the quenching resistors.

At the end of the Phase I and II development, the goal of this SBIR is to demonstrate pathways and develop near commercial-grade prototype SiPMs capable of operating under nuclear environments, respectively. If the photomultiplier(s) is developed based on other wide band gap semiconductor substrate alternative to silicon, the SSPM shall be capable of achieving the same objective.

PHASE I: Develop detailed realistic simulation model of SiPMs/SSPMs in order to optimize the SiPM/SSPM designs for sensor applications in nuclear battlefields. Conduct experiments to systematically quantify the radiation fluence dependence of the individual parameters, such as mobility and multiplication coefficient as function of doping, field-enhanced generation of traps, microscopic measurements on defects through defect engineering, etc. The outcome of the optimization will depend on the targeted wavelength and the expected operation temperature for the SiPM/SSPM. In addition, model the effect of annealing to recover single photo-electron resolution to better define limits on the operational range. At the end of Phase I, identify proof-of-concept and potential pathways to develop radiation-resistant and temperature-insensitive SiPMs/SSPMs that can meet the Phase II threshold/objective requirements for prototyping in Phase II.

PHASE II: Further optimizations for the candidate pathways to achieve highly radiation-tolerant and temperature-insensitive SiPMs/SSPMs are conducted. Develop at least two copies of SiPMs/SSPMs prototypes for each design variation. Demonstrate the prototype survivability on nuclear battlefield environment by meeting the following threshold {objective} performance requirements [6][7]:

- Graceful degradation that still allows the SiPM to be used for dose rate measurements {retain the original performance} after irradiation under 108 cGy/sec of gamma-rays at 667 keV (equivalent to 2.5x1017 cm-2/s gamma-ray fluence), up to a total gamma-ray dose limit of 1000 cGy.
- Graceful degradation that still allows the SiPM to be used for dose rate measurements {retain the original performance} after irradiation under 4x1010 cGy/sec of neutrons at 1-MeV-equivalent energy (equivalent to 1018 cm-2/sec neutron fluence), up to a total neutron dose limit of 1000 cGy.
- Gain variation is less than 1% for 667 keV gamma-rays over a temperature range of -20 °C to +50 °C with minimal temperature compensation {without temperature compensation}.

Test the prototype SiPMs/SSPMs in a relevant environment at government designated test facility, such as the pulse reactor at White Sands Missile Range (WSMR). Evaluate the results to determine the ability of the proposed solution to satisfy requirements for military use in the nuclear battlefield.

PHASE III DUAL USE APPLICATIONS: Following a successful Phase II development and demonstration, Phase III will further improve SiPM/SSPM design, engineering, ruggedization, scalability, manufacturability, and maturation to fully meet nuclear survivability requirements, including the development of a plan to enable successful technology transition at the end of this phase. Develop dual commercial/military use system(s) to integrate SiPMs/SSPMs into radiation sensors, enhancing the tool set of Warfighters while minimizing the exposure to risks.

REFERENCES:
[1] K. Shah, "New scintillator detectors", 19th International Conference on Crystal Growth and Epitaxy (ICCGE-19), Keystone, CO, Jul 2019.
[2] G. Lutz, "Semiconductor radiation detectors - device physics", Springer Verlag Berlin/Heidelberg.
[3] G. Lindstrom, "Radiation damage in silicon detectors", Nucl. Instr. & Meth. A, 512 (1) (2003) 30 – 43.
[4] E. Garutti, et. al, "Radiation damage of SiPMs", Nucl. Instr. & Meth. A, Vol. 296, 11 May 2019, Page 69-84.
[5] M. Calvi, et. al, "Single photon detection with SiPMs irradiated up to 1011 cm-2 1-MeV-equivalent neutron fluence", arXiv:1805.07154v2 [physics.ins-det] 15 Jan 2019.
[6] ICRP Publication 74, Conversion coefficient for use in radiological protection against external radiation.
[7] Seog-Guen, Kwon, et. al, "Calculation of Neutron and Gamma-Ray Flux-to-Dose-Rate Conversion Factors".

KEYWORDS: radiation detection, neutron/gamma radiation detection, photo detector, single photon detection, radiation damage

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**MISSILE DEFENSE AGENCY (MDA)**
**20.2 Small Business Innovation Research (SBIR)**
**Proposal Submission Instructions**

## I. INTRODUCTION

The Missile Defense Agency's (MDA) mission is to develop and deploy a layered Missile Defense System to defend the United States, its deployed forces, allies, and friends from missile attacks in all phases of flight.

The MDA Small Business Innovation Research (SBIR) Program is implemented, administered, and managed by the MDA SBIR/STTR Program Management Office (PMO), located within the Advanced Technology (DV) directorate. Specific questions pertaining to the administration of the MDA SBIR Program should be submitted to:

**Missile Defense Agency**
**SBIR/STTR Program Office**
**MDA/DVR**
**Bldg. 5224, Martin Road**
**Redstone Arsenal, AL 35898**

**Email: sbirsttr@mda.mil**
**Phone: 256-955-2020**

Proposals not conforming to the terms of this Announcement will not be considered. MDA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality as determined by MDA will be funded. MDA reserves the right to withdraw from negotiations at any time prior to contract award. The Government may withdraw from negotiations 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 MDA 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.

### Federally Funded Research and Development Centers (FFRDCs) and Support Contractors

Only Government personnel with active non-disclosure agreements will 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 MDA SBIR awards in the SBIR 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 that are labeled by the offerors as "Government Only." Pursuant to FAR 9.505-4, the MDA 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, MDA 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 MDA SBIR/STTR 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 aforementioned organizations may require access to proprietary information contained in the offerors' proposals.

## II. OFFEROR SMALL BUSINESS ELIGIBILITY REQUIREMENTS

Each offeror must qualify as a small business at time of award per the Small Business Administration's (SBA) regulations at 13 CFR 121.701-121.705 and certify to this in the Cover Sheet section of the proposal. Small businesses that are selected for award will also be required to submit a Funding Agreement Certification document prior to award.

### SBA Company Registry

Per the SBIR/STTR Policy Directive, all SBIR applicants are required to register their firm at SBA's Company Registry prior to submitting a proposal. Upon registering, each firm will receive a unique control ID to be used for submissions at any of the eleven (11) participating agencies in the SBIR program. For more information, please visit the SBA's Firm Registration Page: http://www.sbir.gov/registration.

### Performance Benchmark Requirements for Phase I Eligibility

MDA does not accept proposals from firms that are currently ineligible for Phase I awards as a result of failing to meet the benchmark rates at the last assessment. Additional information on Benchmark Requirements can be found in the DoD Instructions of this Announcement.

## III. ORGANIZATIONAL CONFLICTS OF INTEREST (OCI)

The basic OCI rules for Contractors which support development and oversight of SBIR 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 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.

## IV. USE OF FOREIGN NATIONALS, GREEN CARD HOLDERS AND DUAL CITIZENS

See the "Foreign Nationals" section of the DoD SBIR Program Announcement for the definition of a Foreign National (also known as Foreign Persons).

**ALL offerors proposing to use foreign nationals, green-card holders, or dual citizens, MUST disclose this information regardless of whether the topic is subject to export control restrictions. Identify any foreign nationals 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. You may be asked to provide additional information during negotiations in order to verify the foreign citizen's eligibility to participate on a SBIR 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). MDA 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 is found ineligible by the government to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale. In the event a firm is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

## V. EXPORT CONTROL RESTRICTIONS

The technology within most MDA 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 MDA SBIR 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.

## VI. CLAUSE H-08 PUBLIC RELEASE OF INFORMATION (Publication Approval)

Clause H-08 pertaining to the public release of information is incorporated into all MDA SBIR contracts and subcontracts without exception. Any information relative to the work performed by the contractor under MDA SBIR contracts must be submitted to MDA 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 MDA's review for approval.

## VII. 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: MDA clause H-08 (Public Release of Information) , DFARS 252.204-7000 (Disclosure of Information), and DFARS clause 252.204-7012 (Safeguarding Covered Defense Information and Cyber Incident Reporting). Your proposal submission confirms that any proposed subcontract is in accordance to the clauses cited above and any other clauses identified by MDA in any resulting contract.

## VIII. OWNERSHIP ELIGIBILITY

Prior to award, MDA may request business/corporate documentation to assess ownership eligibility as related to the requirements of the Guide to SBIR 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 MDA, the contractor shall provide all necessary documentation for evaluation prior to SBIR award. Failure to submit the requested documentation in a timely manner as indicated by MDA may result in the offeror's ineligibility for further consideration for award.

## X. FRAUD, WASTE, AND ABUSE

All offerors must complete the fraud, waste, and abuse training (Volume 6) that is located on the Defense SBIR/STTR Innovation Portal (DSIP). Please follow guidance provided on DSIP to complete the required training.

To Report Fraud, Waste, or Abuse, Please Contact:

MDA Fraud, Waste & Abuse
Hotline: (256) 313-9699
MDAHotline@mda.mil

DoD Inspector General (IG) Fraud, Waste & Abuse
Hotline: (800) 424-9098
hotline@dodig.mil

Additional information on Fraud, Waste and Abuse may be found in the DoD Instructions of this Announcement; sections 3.6 and 4.18.

## XI. PROPOSAL FUNDAMENTALS

### Proposal Submission

All proposals MUST be submitted online using DSIP (https://www.dodsbirsttr.mil). Any questions pertaining to the DoD SBIR/STTR submission system should be directed to the DoD SBIR/STTR Help Desk: 703-214-1333 or DoDSBIRSupport@reisystems.com.

It is recommended that potential offerors email topic authors to schedule a time for topic discussion during the pre-release period from 06 May 2020 – 02 June 2020.

**Classified Proposals**

Classified proposals **ARE NOT** accepted under the MDA SBIR Program. The inclusion of classified data in an unclassified proposal MAY BE grounds for the Agency to determine the proposal as non-responsive and the proposal not to be evaluated. Contractors currently working under a classified MDA SBIR contract must use the security classification guidance provided under that contract to verify new SBIR proposals are unclassified prior to submission. Phase I contracts are not typically awarded for classified work. However, in some instances, work being performed on Phase II contracts will require security clearances. If a Phase II contract will require classified work, the offeror must have a facility clearance and appropriate personnel clearances in order to perform the classified work. For more information on facility and personnel clearance procedures and requirements, please visit the Defense Security Service Web site at: http://www.dss.mil/index.html.

**Communication**

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

**Proposal Status**

The MDA Contracting Office will distribute selection and non-selection email notices to all firms who submit an MDA SBIR proposal. The email will be distributed to the personnel listed on the proposal coversheet. MDA cannot be responsible for notification to a company that provides incorrect information or changes such information after proposal submission. MDA anticipates that selection and non-selection notifications will be distributed to all offerors in the September 2020 timeframe.

**Proposal Feedback**

MDA will provide written feedback to unsuccessful offerors regarding their proposals upon request. Requests for feedback must be submitted in writing to the MDA SBIR/STTR PMO within 30 calendar days of non-selection notification. Non-selection notifications will provide instructions for requesting proposal feedback. Only firms that receive a non-selection notification are eligible for written feedback.

**Technical and Business Assistance (TABA)**

Section 9(b) of the SBIR Policy Directives allows agencies to enter into agreements with suppliers to provide technical assistance to SBIR awardees, which may include access to a network of scientists and engineers engaged in a wide range of technologies or access to technical and business literature available through on-line data bases.

MDA permits award recipients to obtain technical assistance in accordance with the SBIR/STTR Policy Directive. All requests for TABA must be included on the MDA SBIR/STTR Phase I TABA Form (https://www.mda.mil/global/documents/pdf/SBIR_STTR_PHI_TABA_Form.pdf) and included as a part of Volume 5 of the proposal package.

An SBIR firm may acquire the technical assistance services described above on its own. Firms must request this authority from MDA and demonstrate in its SBIR proposal that the individual or entity selected can provide the specific technical services needed. In addition, costs must be included in the cost volume of the offeror's proposal. The TABA provider may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g. research partner or research institution).

If the awardee supports the need for this requirement sufficiently as determined by the Government, MDA will permit the awardee to acquire such technical assistance, in an amount up to $5,000 per year. This will be an allowable cost on the SBIR award. The per year amount will be in addition to the award and is not subject to any burden, profit or fee by the offeror. The per-year amount is based on the original contract period of performance and does not apply to period of performance extensions. Requests for TABA funding outside of the base period of performance (6 months) for Phase I proposal submission will not be considered.

The purpose of this technical assistance is to assist SBIR awardees in:
1. Making better technical decisions on SBIR projects;
2. Solving technical problems that arise during SBIR projects;
3. Minimizing technical risks associated with SBIR projects; and
4. Developing and commercializing new commercial products and processes resulting from such projects including intellectual property protections.

The MDA Phase I TABA form can be accessed here: (https://www.mda.mil/global/documents/pdf/SBIR_STTR_PHI_TABA_Form.pdf) and should be included as part of Volume 5 using the "Other" category.

## XII. PHASE I PROPOSAL GUIDELINES

The Defense SBIR/STTR Innovation Portal (available at https://www.dodsbirsttr.mil) will lead you through the preparation and submission of your proposal. Read the front section of the DoD Announcement for detailed instructions on proposal format and program requirements. Proposals not conforming to the terms of this Announcement will not be considered. To be considered for evaluation the proposal package must be formally submitted on DSIP.

**MAXIMUM PHASE I PAGE LIMIT FOR MDA IS 15 PAGES FOR VOLUME 2, TECHNICAL VOLUME**

Any pages submitted beyond the 15-page limit within the Technical Volume (Volume 2) will not be evaluated. Letters of support and TABA requests should be included as part of Volume 5 and will not count towards the 15-page Technical Volume (Volume 2) limit. Any technical data/information that should be in the Technical Volume (Volume 2) but is contained in other Volumes will not be considered.

MDA's objective for the Phase I effort is to determine the merit and technical feasibility of the concept. The contract period of performance for Phase I shall be six (6) months and the award shall not exceed $150,000. 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.

### Phase I Proposal

**A complete Phase I proposal consists of five volumes (six if letters of support and/or TABA is included):**

- Volume 1 (required): Proposal Cover Sheet *(does not count towards 15-page limit)*
- Volume 2 (required): Technical Volume (maximum of 15 pages)

- Volume 3 (required): Cost Volume *(does not count towards 15-page limit)*
- Volume 4 (required): Company Commercialization Report *(does not count towards 15-page limit)*
- Volume 5 (optional): Supporting Documents: Letters of Support and/or TABA *(does not count towards 15-page limit)*
- Volume 6 (required): Fraud, Waste, and Abuse Training Certification

**Volume 5 Information**
MDA will only accept letters of support and/or TABA as part of Volume 5. Any other type of documentation included as part of Volume 5 will not be considered. Letters of support should be loaded within Volume 5 using the "Letters of Support" category on the DoD submission website. TABA should be loaded within Volume 5 using the "Other" drop-down category.

**References to Hardware, Computer Software, or Technical Data**
In accordance with the SBIR Directive, SBIR contracts are to conduct feasibility-related experimental or theoretical R/R&D related to described agency requirements. The purpose for Phase I is to determine the scientific and technical merit and feasibility of the proposed effort.

It is not intended for any formal end-item contract delivery and ownership by the Government of your hardware, computer software, or technical data. As a result, your technical proposal should not contain any reference to the term "Deliverables" when referring to your hardware, computer software, or technical data. Instead use the term: "Products for Government Testing, Evaluation, Demonstration, and/or possible destructive testing."

**FAR 52.203-5 Covenant Against Contingent Fees**

As prescribed in FAR 3.404, the following FAR 52.203-5 clause shall be included in all contracts awarded under this Broad Agency Announcement (BAA):

(a) The Contractor warrants that no person or agency has been employed or retained to solicit or obtain this contract upon an agreement or understanding for a contingent fee, except a bona fide employee or agency. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability or to deduct from the contract price or consideration, or otherwise recover, the full amount of the contingent fee.

(b) Bona fide agency, as used in this clause, means an established commercial or selling agency, maintained by a contractor for the purpose of securing business, that neither exerts nor proposes to exert improper influence to solicit or obtain Government contracts nor holds itself out as being able to obtain any Government contract or contracts through improper influence.

"Bona fide employee," as used in this clause, means a person, employed by a contractor and subject to the contractor's supervision and control as to time, place, and manner of performance, who neither exerts nor proposes to exert improper influence to solicit or obtain Government contracts nor holds out as being able to obtain any Government contract or contracts through improper influence.

"Contingent fee," as used in this clause, means any commission, percentage, brokerage, or other fee that is contingent upon the success that a person or concern has in securing a Government contract.

"Improper influence," as used in this clause, means any influence that induces or tends to induce a Government employee or officer to give consideration or to act regarding a Government contract on any basis other than the merits of the matter.

## XIII. PHASE I PROPOSAL SUBMISSION CHECKLIST

**____1. The following have been submitted electronically through the DoD submission site by 12:00 p.m. (noon) EDT July 2, 2020.**

- ✓ Volume 1: DoD Proposal Cover Sheet

- ✓ Volume 2: Technical Volume (DOES NOT EXCEED 15 PAGES)**: Any pages submitted beyond this will not be evaluated. Your Proposal Cover Sheet, Cost Volume, and Company Commercialization Report DO NOT count toward your maximum page limit.**

  **If proposing to use foreign nationals, green card holders, and/or dual citizens; identify the personnel you 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.**

- ✓ Volume 3: Cost Volume. **(Online Cost Volume form is REQUIRED by MDA)**

- ✓ Volume 4: Company Commercialization Report. (required even if your firm has no prior SBIR/STTR awards).

- ✓ Volume 5 (optional): Letters of Support and/or TABA.

- ✓ Volume 6 (required): Fraud, Waste, and Abuse Training Certification.

**____2. Phase I proposal is not to exceed $150,000. (or not to exceed $155,000 if TABA is included)**

**____3. The proposal must be formally submitted on DSIP. Proposals that are not submitted will not be evaluated.**

## XIV. MDA SECURITY REVIEW OF ABSTRACTS, BENEFITS, AND KEYWORDS

Proposal titles, abstracts, anticipated benefits, and keywords of proposals that are selected for contract award will undergo an MDA Policy and Security Review. Proposal titles, abstracts, anticipated benefits, and keywords are subject to revision and/or redaction by MDA. Final approved versions of proposal titles, abstracts, anticipated benefits, and keywords may appear on DSIP and/or the SBA's SBIR/STTR award site (https://www.sbir.gov/sbirsearch/award/all).

## XV. MDA PHASE I PROPOSAL EVALUATIONS

MDA will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this Announcement document. MDA reserves the right to award none, one, or more than one contract under any topic. MDA is not responsible for any money expended by the offeror before award of any contract. Due to limited funding, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality as determined by MDA will be funded.

Phase I proposals will be evaluated based on the criteria outlined below, including potential benefit to the Ballistic Missile Defense System (BMDS). 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.

Firms with a Commercialization Achievement Index (CAI) at or below the 20th percentile will be penalized in accordance with the DoD program Announcement.

Please note that potential benefit to the BMDS 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.

Qualified letters of support should be included as part of Volume 5 within the “Letters of Support” category on the DoD submission site and will **not** count towards the 15-page Volume 2 page limit. Letters of support will be evaluated towards criterion C if included as part of Volume 5, but are not required for Phase I or Phase II. Letters of support shall not be contingent upon award of a subcontract.

A qualified letter of support is from a relevant commercial or Government Agency procuring organization(s) working with MDA, articulating their pull for the technology [i.e..., what BMDS requirements does the technology support 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. This letter should be included as Volume 5. Letters of support which are faxed, e-mailed separately, or otherwise not included as part of Volume 5 will NOT be considered.

**Phase II Proposal Submission**

Per DoD SBIR Phase II Proposal guidance, all Phase I awardees from the 20.2 Phase I Announcement will be permitted to submit a Phase II proposal for evaluation and potential negotiation. Details on the due date, content, and submission requirements of the Phase II proposal will be provided by the MDA SBIR/STTR PMO after contract award. Only firms who receive a Phase I award resulting from the 20.2 Announcement may submit a Phase II proposal.

MDA will evaluate and select Phase II proposals using the Phase II evaluation criteria listed in the DoD Program Announcement. While funding must be based upon the results of work performed under a Phase I award and the scientific and technical merit, feasibility and commercial potential of the Phase II proposal, Phase I final reports will not 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, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. MDA does not participate in the DoD Fast Track program.

All Phase II awardees must have a Defense Contract Audit Agency (DCAA) approved accounting system. It is strongly urged that an approved accounting system be in place prior to the MDA Phase II award timeframe. If you do not have a DCAA approved accounting system, this will delay/prevent Phase II contract award. Please reference www.dcaa.mil/small_business/Accounting_System.pdf for more information on obtaining a DCAA approved accounting system.

Approved for Public Release
20-MDA-10410 (9 Mar 20)

**MISSILE DEFENSE AGENCY (MDA) SBIR 20.2 Phase I Topic Index**

MDA20-001 TITLE: Automated Factor-Based Sensitivity Analysis

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning; General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Weapons

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.
OBJECTIVE: Develop an automatic software analysis tool to understand the behavior and performance of Missile Defense (MD) mission-critical algorithms.

DESCRIPTION: This topic seeks to gain a deeper understanding of how the Aegis Weapon System (AWS) MD Engage-ability prelaunch Figure of Merit (FOM) algorithm directly contributes to performance in a given MD scenario/vignette. A conceptual factor-based sensitivity analysis tool offers an innovative means to uncover and understand the inherent sensitivities and limitations of mission-critical algorithms. By controlling the data flow into and out of an algorithm under test, the tool can force the system down processing paths that otherwise would not have been exercised with the actual AWS. The outcomes of these off-nominal cases can then be aggregated and analyzed to establish behavioral and performance trends which will aide in understanding the AWS FOM selection logic and should aide in the analysis of impacts to software upgrades and how they impact missile intercept probabilities.

PHASE I: Develop a proof of concept product around the AWS FOM algorithm. Perform an analysis to demonstrate the concept and an initial understanding of the AWS FOM calculations. Phase I should be a feasibility concept study that supports a proposed design solution and down selection of alternatives.

PHASE II: Enhance and refine the proposed tool based on the results and findings of the Phase I and expand its capabilities to generalize the prototype tool to analyze any algorithm in the AWS MD system. The Phase II objective will be to validate a new technology solution that a customer can transition in Phase III. Validate the feasibility of the Phase I concept by development and demonstrations that will be tested to ensure performance objectives are met. The Phase II effort should result in a prototype with substantial commercialization potential.

PHASE III DUAL USE APPLICATIONS: Productize the tool to expand the capabilities to other interested users in the government. Develop and execute a Phase III incremental test & integration plan that will produce a final prototype.

REFERENCES:

1. Statistical Issues in Defense Analysis and Testing, “Sources of Variability”, https://www.nap.edu/read/9686/chapter/4
2. “Sensitivity Analysis”, https://www.sciencedirect.com/topics/computer-science/sensitivity-analysis
3. Donald E. Knuth, Selected Papers on the Analysis of Algorithms (Stanford, California: Center for the Study of Language and Information, 2000) ISBN 1-57586-212-3.
4. “Determining the significance of input parameters using sensitivity analysis”, https://link.springer.com/chapter/10.1007/3-540-59497-3_199

5. "A sensitivity analysis algorithm for hierarchical decision models", https://www.sciencedirect.com/science/article/abs/pii/S0377221707000264
6. Aegis Ballistic Missile Defense Fact Sheet: https://www.mda.mil/global/documents/pdf/aegis.pdf

KEYWORDS: Aegis BMD, Algorithm, Aegis Weapon System, Weapon Control System, Figure of Merit, Robustness and Sensitivity Analysis

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MDA20-002 TITLE: Lightweight Structural Metamaterials for Second and Third Stage Rocket Motors

RT&L FOCUS AREA(S): Hypersonics; General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Weapons; Space Platform; Battlespace

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 section 3.5 of 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 structural metamaterials to improve technology readiness levels of constituent technologies essential to a high capacity future interceptor.

DESCRIPTION: This topic seeks to develop lightweight structural metamaterials for second and third stage rocket motors that are able to withstand the mechanical and thermal stresses of terminal missile defense maneuvers. Modern missile defense forces are expected to confront large raids of ballistic, non-ballistic/high Mach, and strategic cruise missiles in the near to mid timeframe. To gain the advantage over the threat, missile defense assets will require a compact, highly agile, high loadout interceptor for the terminal defense segment that is capable of very high axial and lateral accelerations.
MAX phase materials are metallic ceramics known for combining favorable mechanical properties such as good machinability and high elastic stiffness with good thermal shock resistance, low thermal expansion coefficients, and rigidity at high temperature. MAX phase composite metamaterials may prove effective as low-density, lightweight structures, for rocket motor casings, combustion chambers, nozzles, and control surfaces. Candidate solutions should demonstrate the feasibility of rocket motor components that meet the following technical goals:

- Half the weight (or less) of components made from traditional steel alloys.
- Operates at high temperatures, up to 1400°C.
- Withstands very large axial and lateral accelerations.
- Maintains rigidity and structure during variable thrust or multiple pulse operations.
- Demonstrates self-healing characteristics.

PHASE I: For candidate solutions, conduct a concept definition for advanced rocket motor components, to include a proof-of-principle study, design of notional components, and predicted technical performance of notional components. Technical performance parameters should include maximum thermal and mechanical tolerances.

PHASE II: For candidate solutions, develop and execute an incremental test and evaluation plan that will mature the constituent technologies and produce a prototype for assessment based on the design proposed in Phase I.

PHASE III DUAL USE APPLICATIONS: For candidate solutions, investigate applications of prototype components from Phase II for use in economical, reusable space launch vehicles in addition to missile defense interceptors.

REFERENCES:


1. Barsoum, M. W. (2013) “MAX Phases: Properties of Machinable Ternary Carbides and Nitrides.” Wiley-VCH Verlag GmbH & Co. KGaA.
2. Farle, A et al. 2016. “Demonstrating the self-healing behavior of some selected ceramics under combustion chamber conditions,” Smart Mater. Struct. 25 084019.
3. Gilbert, C.J. et al. 1999. “Fatigue-Crack Growth and Fracture Properties of Coarse and Fine-Grained Ti3SiC2,” Scripta mater. 42 (2000) 761-767.
4. Aegis Ballistic Missile Defense Fact Sheet: https://www.mda.mil/global/documents/pdf/aegis.pdf


KEYWORDS: MAX Phases, Metalized Ceramics, Advanced Rocket Motors, Metamaterial


TPOC-1: LCDR Chester Hewitt
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MDA20-003 TITLE: Solid Rocket Motors for High Performance Interceptors

RT&L FOCUS AREA(S): Hypersonics; General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Weapons; Space Platform; Battlespace

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 section 3.5 of 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 highly loaded grain (HLG) rocket motors to improve technology readiness levels of constituent technologies essential to a future high performance interceptor.

DESCRIPTION: This topic seeks to develop advanced solid rocket motors for compact, high performance, interceptors. Modern missile defense forces are expected to confront large raids of ballistic, non-ballistic/high Mach, and strategic cruise missiles in the near to mid timeframe. To gain the advantage on the threat, missile defense assets require a compact, highly agile, high loadout interceptor for the terminal defense segment that is capable of very high axial and lateral accelerations. To meet this need, the government desires to develop HLG solid rocket motors with high density and specific impulse. HLG rocket motors pack more solid rocket propellant into a given volume and thus achieve a higher propellant-to-inert mass fraction, which leads to more total impulse achieved within the same volume. Candidate solutions should demonstrate the feasibility of rocket motor propellants that meet the following technical goals:

- Increase in total impulse of greater than 20% relative to current rocket motor propellants.
- Achieve vacuum specific impulse of at least 280s.
- Tailorable to very high thrust applications.
- Tailorable to variable thrust or multiple pulse operations.

PHASE I: For candidate solutions, conduct a concept definition for advanced rocket propellant, to include a proof-of-principle study, design of notional propellant grain, and predicted technical performance of the propellant. Technical performance parameters should include maximum thrust, specific impulse, and the ability to conduct multiple pulse operations.

PHASE II: For candidate solutions, develop and execute an incremental test and evaluation plan that matures the constituent technologies and produces a prototype for assessment based on the design proposed in Phase I.

PHASE III DUAL USE APPLICATIONS: For candidate solutions, investigate applications of prototype components developed in Phase II for use in more efficient space launch vehicles in addition to missile defense interceptors.

REFERENCES:
1. Giangreco, L. (2017, May 30) “USAF developing next generation air dominance missile.” Retrieved from https://www.flightglobal.com/news/articles/usaf-developing-next-generation-air-dominance-missil-437728/

2. Naval Air Warfare and Weapons: Counter Air Defense (CAD) Improvements, page 34. https://www.onr.navy.mil/-/media/Files/35/code-35-naval-air-warfare-and-weapons-program-guide.ashx?la=en&hash=66F4B02F6FC4269E790E8813A6B1FA47D3F3DCF0
3. Aegis Ballistic Missile Defense Fact Sheet: https://www.mda.mil/global/documents/pdf/aegis.pdf

KEYWORDS: Rocket propellant, Highly Loaded Grain, Solid Rocket Motor

TPOC-1: LCDR Chester Hewitt
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MDA20-004 TITLE: High Power, Single Mode, Diode Emitter for Directed Energy Applications

RT&L FOCUS AREA(S): Directed Energy
TECHNOLOGY AREA(S): Weapons; Space Platform; Materials; Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design, develop, and demonstrate high power (>1-3 W), single mode, direct diode emitters that meet the emerging government need for high-power, high-brightness laser systems with greatly reduced size, weight, and power (SWaP) consumption.

DESCRIPTION: This topic seeks the development of high power, single-mode, high-brightness, narrow linewidth, near diffraction limited diode emitters that can be spectrally or coherently beam combined for further power scaling. Most current electrically-powered high energy lasers require an additional gain medium to achieve necessary beam quality (high brightness). Since an additional gain medium creates power loss, it is desirable to eliminate the additional gain medium and use high power direct diodes directly.

Semiconductor laser sources offer reduced optical elements, higher efficiency, better SWaP, increased robustness, lifetime, reliability, manufacturability, and lower cost of operation and ownership when compared to other types of laser systems, such as fiber lasers. Diode lasers have proven to be very reliable, very compact, and should continue to prove to be cost effective compared to other laser sources. Maturing highly efficient laser diodes will directly benefit current research and development efforts in the field of next generation multi-kW laser sources, extending the efficiency, reliability, operating temperature, and providing multi-kW power scaling capabilities.

The overall goal of this topic is to develop direct diode emitters that, when combined, produce high power direct diode laser (HPDDL) systems capable of achieving upwards of 10-100 kW (dependent on the beam combining technique) of high output power while maintaining the beam quality to a near diffraction limited spot size (M2< 1.2) in a low SWaP configuration. By combining multiple high-power, single-mode, direct diode emitters into elements, and multiple elements into a HPDDL system, the potential exists to meet these SWaP needs based on the inherently high (potentially>70%) electrical-to-optical power conversion efficiency (PCE) of direct diode systems. Solutions are highly desired to meet challenges such as short coherence length, multiple modes, and high divergence angles (which limits maintaining a tight spot while propagating over a long distance).

PHASE I: Collaborate with government and industry to review and adjust, as needed, the topic objectives in order to increase commercialization prospects. Identify any significant design trades and work with the government to resolve them. Complete a preliminary direct diode emitter design and perform modeling and simulation to estimate its performance with enough fidelity to quantify major specifications. Conduct additional research, analyses, and experimentation as needed to demonstrate feasibility and/or validate models. Determine the feasibility of manufacturing the product in realistic quantities and at commercially competitive costs. Complete preliminary cost and performance estimates and compare with existing products. Complete a preliminary plan for fabricating and testing prototypes in Phase II and begin coordinating with potential service providers, suppliers, and sub-contractors.

PHASE II: Complete a prototype design. Model and simulate its performance with enough fidelity to quantify almost all of its specifications. Fabricate and test HPDDL prototypes in sufficient quantities to make a preliminary assessment of yield and performance variation. Compare test results with predictions. Begin initial qualification of the new design. Finalize the cost and performance estimates based on results and compare with existing products. Begin commercialization of the new approach. Seek commitments from potential customers in order to help fund Phase III.

PHASE III DUAL USE APPLICATIONS: Incorporate lessons-learned from the prototype into a product design. Begin producing and delivering products, at a low rate, to customers. Fully qualify the product for the intended application(s). Assist in integrating this product into a demonstrator system.

REFERENCES:

1. Y. Zhao and L. Zhu, "On-chip coherent combining of angled-grating diode lasers toward bar-scale single-mode lasers", Optical Society of America, Opt. Express 6375, Vol. 20, No. 6, March 2012.
2. Y. Zhao and L. Zhu, "Improved Beam Quality of Coherently Combined Angled-Grating Broad-Area Lasers," IEEE Photonics Journal, Vol. 5, No. 2, April 2013.
3. Leisher et al., "Feedback-Induced Failure of High Power Diode Lasers," IEEE Journal of Quantum Electronics, JQE-134992-2018.R1, Oct 2018.


KEYWORDS: High Power Direct Diode Laser, HPDDL, Direct diode emitters, Single mode, High brightness, Beam quality, Spectral and Coherent beam combining, Laser Power Scaling


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MDA20-005 TITLE: Low-Cost Space-Based Cryocoolers

RT&L FOCUS AREA(S): Space
TECHNOLOGY AREA(S): Sensors; Space Platform; Materials

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 section 3.5 of 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 innovative approaches for producing space-based cryocoolers at low cost and in large numbers.

DESCRIPTION: This topic seeks to develop innovative technologies to reduce the cost per unit for cryocoolers. Some types of infrared detectors must be cooled to cryogenic temperatures in order to perform within specifications, Cryocoolers are the components on a spacecraft that provide this cryogenic cooling. Currently, space-based cryocoolers are custom designed, fabricated, and qualified in low numbers and at great expense (e.g. $3-5M per unit). Production in large quantities, using existing designs and manufacturing technologies, might reduce this cost to less than $1M per unit. Further reductions in cost per unit will require innovative approaches and/or new technologies in both manufacturing processes and cryocooler designs. The objective of this topic is to develop these innovations and/or technologies. Proposed approaches will be considered in the following (decreasing) order of priority:

1. Process improvements in order to substantially reduce the cost of manufacturing existing (or slightly modified) cryocooler or subcomponent designs.
2. New cryocooler or subcomponent designs that are cheaper and/or easier to manufacture without compromising performance or reliability.
3. Innovations related to ancillary equipment such as control electronics or the cryocooler’s mechanical, thermal, and electrical interfaces.
4. Other approaches will be considered if they show a clear potential to meet topic objectives.

Although a pulse-tube cryocooler appears best suited for space based application(s), any cryocooler type will be considered that shows a clear potential to meet the following objectives:

1. Less than $250K per unit (excluding ancillary equipment) at a production rate of 50 units per year.
2. At least 5 Watts of cooling at 77 Kelvin with a 300 Kelvin rejection temperature.
3. At least 5 years of continuous on-orbit operation with high reliability.
4. Approaches, meets, or exceeds the state-of-the-art in terms of performance, efficiency, size, weight, and power, electromagnetic interference, mean-time-to-failure, interfaces, and vibration.

These objectives may be adjusted in Phase I in order to increase potential customer demand and prospects for commercialization.

PHASE I: Study the scientific and technical feasibility of the proposed approach. Collaborate with government agencies and industry to develop a common set of requirements in order to increase demand. Conduct research, analyses, and experimentation as needed to demonstrate feasibility and/or validate models. Develop preliminary designs for any new equipment, if applicable. Complete preliminary cost and performance estimates. Complete a preliminary plan for Phase II and begin coordinating with Phase II partners.

PHASE II: Demonstrate the proposed approach in order to validate predictions. Fabricate and test prototype equipment, if applicable. Begin initial qualification of any new designs, if applicable. Finalize the cost and performance estimates based on results. Begin commercialization of the new approach. Seek commitments from multiple potential customers to help fund Phase III.

PHASE III DUAL USE APPLICATIONS: Commercialize the new approach by supplying subcomponents to cryocooler integrators, by supplying equipment to cryocooler manufacturers, or by manufacturing cryocoolers in-house. Begin producing and delivering products, at a low rate, to customers. Fully qualify the product for the intended application(s). Assist in integrating the product into a demonstrator system.

REFERENCES:


1. R. Radebaugh, “Cryocoolers: the state of the art and recent developments,” J. Phys.: Condens. Matter 21 (2009), 164219.
2. R. Radebaugh, “Pulse Tube Cryocoolers for Cooling Infrared Sensors,” Proceedings of SPIE, The International Society for Optical Engineering, Infrared Technology and Applications XXVI, Vol. 4130, pp. 363-379 (2000).
3. Proceedings of the 20th International Cryocooler Conference.


KEYWORDS: Cryocooler, manufacturing, pulse tube, cryogenic, space


TPOC-1: Aaron Williams
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MDA20-006 TITLE: High-Reliability Rad-Hard Space-Based Low-Voltage Direct Current (DC)-to-DC Converter

RT&L FOCUS AREA(S): Microelectronics; Space
TECHNOLOGY AREA(S): Nuclear; Electronics; Space Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and produce a commercially-competitive, high-reliability, radiation-hardened, low-voltage DC-to-DC converter for future space-based missile defense applications.

DESCRIPTION: This topic seeks innovative low voltage DC-to-DC convertors for future space-based missile defense applications. DC-to-DC converters are used to step-down and condition a spacecraft's bus voltage (e.g. 28 V) to the low voltages (e.g. 5 V or lower) required to power modern space electronics (e.g. field programmable gate arrays). There are a large number of commercially available DC-to-DC converters for a variety of applications. However, very few of these converters have the high-reliability, radiation-hardness (against both natural and manmade environments), and performance needed for space-based missile defense applications. Of those converters that meet these requirements, further improvements in performance, size, weight, and/or cost are desirable. The government anticipates that small business respondents could achieve these improvements with an innovative design that incorporates new technologies. The government further anticipates that SBIR resources would be sufficient to finalize, fabricate, and test a prototype design by the end of Phase II, which would then lead to a low-rate production of a product (or series of products) in Phase III. The product resulting from this topic should meet or exceed the following objectives:

1. Minimum Time Between Failure (MTBF) of 10 Million hours or more.
2. Screened up to a class V assurance level.
3. Accumulate a Total Ionizing Dose (TID) of 1 Mrad(Si) or more while performing within specification
4. Immune to destructive Single Event Effects (SEEs) at Linear Energy Transfers (LETs) of 80 MeV-cm^2/mg or less.
5. Immune to non-destructive SEEs at LETs of 36 MeV-cm^2/mg or less.
6. Immune to prompt doses of 1E10 rad(Si)/s or less.
7. Survives prompt doses of 1E12 rad(Si)/s or less.
8. Contains no components that have increased susceptibilities to displacement damage caused by neutrons or protons.
9. Supports standard interfaces, input & output ranges, operating temperatures, under- & over-voltage protections, fault-tolerances, control functions, packaging, electromagnetic interference (EMI) & ripple suppression, line/load variations, and bandwidths.
10. Has a flexible design that could be easily modified in order to support additional voltages or power outputs.
11. Preferably monolithic, versus hybrid, design.
12. Costs the same as, or less than, comparable existing products.
13. Approaches, meets, or exceeds the current state-of-the-art in terms of efficiency, conditioning, size, and weight with respect to comparable existing products.

The Phase II prototype should (notionally) take a nominal 28 V input and produce a single, isolated output of up to 20 W at 5 V or 3.3 V. This objective, in addition to those listed above, will be reviewed during Phase I.

PHASE I: Collaborate with government and industry to review and adjust, as needed, the topic objectives in order to increase commercialization prospects. Identify any significant design trades and work with the government to resolve them. Complete a preliminary design for the DC-to-DC converter. Model and simulate its performance with enough fidelity to quantify its major specifications. Conduct additional research, analyses, and experimentation as needed to demonstrate feasibility and/or validate models. Determine the feasibility of manufacturing a resulting product in realistic quantities and at commercially competitive costs. Complete preliminary cost and performance estimates and compare with existing products. Complete a preliminary plan for fabricating and testing prototypes in Phase II and begin coordinating with potential service providers, suppliers, and sub-contractors.

PHASE II: Complete a prototype design for the DC-to-DC converter. Model and simulate its performance with enough fidelity to quantify its specifications. Fabricate and test prototypes in sufficient quantities to make a preliminary assessment of yield and performance variation. Compare test results with predictions. Begin initial qualification of the new design. Finalize the cost and performance estimates based on results and compare with existing products. Begin commercialization of the new approach. Seek commitments from multiple potential customers in order to help fund Phase III.

PHASE III DUAL USE APPLICATIONS: Incorporate lessons-learned from the prototype into a product design. Begin producing and delivering products, at a low rate, to customers. Fully qualify the product for the intended application(s). Assist in integrating this product into a demonstrator system.

REFERENCES:


1. P. C. Adell & L. Z. Scheick (2013). Radiation Effects in Power Systems: A Review, IEEE Transactions on Nuclear Science, Vol. 60, No. 3, June 2013.
2. P. C. Adell et. al (2002). Total-Dose and Single-Event Effects in Switching DC/DC Power Converters, IEEE Transactions on Nuclear Science, Vol. 49, No. 6, December 2002.


KEYWORDS: Power, Converter, DC-DC, Space, Radiation, Rad Hard, Reliability


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MDA20-007 TITLE: Flexible Thermal Protection System Materials

RT&L FOCUS AREA(S): Hypersonics; General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Materials; Air Platform

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 section 3.5 of 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 innovative deformable/flexible (elastic) thermal protective materials capable of surviving high temperature, high Mach environments.

DESCRIPTION: This topic seeks the development of thermal protective materials that are flexible, can survive, and maintain elasticity when exposed to the high temperatures, oxidative environments and mechanical loads associated with high Mach flight. These capabilities would enable variable geometries to perform in-flight adaptation of aircraft aerodynamic surfaces in compliance with the most efficient shapes for each flight regime, providing both flow regulation and control to enhance flight performance, control authority, and multi-mission capability.

A flight vehicle's geometry has dramatic influences on its stability, maneuverability, and drag. Static geometry configurations are optimized for one flight regime; therefore suffering performance reductions outside of that regime. Extreme variations in altitude and velocities required for high Mach flight consequently render a static-geometry vehicle inherently non-optimal. Additionally, control surfaces are currently limited to unitary moving parts that impart additional drag and produce possible adverse flow disturbances, e.g., shock-shock interactions.

Proposers should strive to develop candidate materials and demonstrate their elasticity (maximum desired bend radius of a one (1) inch thick sample to be twelve (12) inches), and survivability when exposed to thermal environments above 3,000°F for durations of greater than five (5) minutes. Technologies desired for this topic can be applied to both powered (rocket and air-breathing) and glide vehicles. Variable geometry aerodynamic surfaces (e.g., aerodynamic surfaces, shape-adaptive air inlets) are also desired if they offer an advancement in vehicle performance.

PHASE I: Collaborate with government agencies and industry to identify relevant environments and define initial material requirements, e.g., elasticity properties, thermal properties, etc., for the proposed application(s). Identify significant design trades, and work with the government to resolve them. Identify the intended applications, the methods of testing the materials' elastic and thermal properties, and its survivability at relevant temperatures. Evaluate producibility of candidate material(s) in realistic quantities and perform a top-level assessment of the industry base and raw material availability for production. Conduct additional research, analyses, and experimentation as needed to demonstrate feasibility and/or validate models. Complete preliminary cost and performance estimates and compare with existing products. Complete a preliminary plan for fabrication and testing of candidate materials in Phase II and begin coordinating with potential service providers, suppliers, and sub-contractors.

PHASE II: Develop test articles of the candidate materials. Model and simulate material performance with adequate fidelity to quantify primary material specifications. Plan and perform sufficient testing to determine material feasibility in defined environments. Compare test results with predictions. Fully characterize and demonstrate elastic and thermal properties for top candidate(s). Demonstrate in a representative environment and compare with existing products. Develop cost and performance estimates based on results. Begin commercialization of the new approach and seek commitments from potential customers in order to help fund Phase III.

PHASE III DUAL USE APPLICATIONS: Incorporate lessons-learned from the prototype materials into a product design. Begin producing and delivering products, at a low rate, to customers. Fully qualify the product for the intended application(s). Assist in integrating the product into a demonstrator system.

REFERENCES:

1. Smith, Butt, Spakovsky, A Study of the benefits of Using Morphing Wing Technology in Fighter Aircraft Systems, AIAA Thermophysics Conference, June 2007.
2. Gaetano Arena, Rainer M. J. Groh, Alex Brinkmeyer, Raf Theunissen, Paul M. Weaver and Alberto Pirrera. Adaptive compliant structures for flow regulation. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, Volume 473, Issue 2204, 16 August 2017.


KEYWORDS: Elastic, deformable, flexible, thermal protection system, survivability, high Mach, adaptive, morphing, variable geometry


TPOC-1: Barry Heflin
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MDA20-008 TITLE: Additive Manufacturing for Radio Frequency Antennas, Waveguides, and Connectors on Flexible Substrates

RT&L FOCUS AREA(S): Microelectronics; Space
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Characterize additive manufactured Radio Frequency (RF) antennas and wave guides to determine their signal loss relative to additively printed conductors and to determine the effects of voids within the materials on RF performance.

DESCRIPTION: This topic seeks to characterize the RF performance of additively manufactured antennas and wave guides with additively printed conductors on various flexible substrate types. As part of this characterization effort, RF performance effects of void densities and sizes within the materials will be established. To develop consistently capable RF additive printed electronics, characterization of various material sets are needed.

Flexible electronics usage in RF applications can be very beneficial to both government and commercial applications, since they may be lightweight, lower cost, and provide comparable performance. The antenna and wave guide performance will vary with the frequency range for which it was designed, power handling requirements, the material types, and voids induced in the production process. Currently, the capabilities of various printed material and substrate combinations are not well defined. Also, the voids induced by the different deposition methods will have an effect on RF performance, but these effects are not well understood in relation to void density and size.

To characterize the additive materials used for the antennas and waveguides, the printed conductors, and various flexible substrates, the government desires multiple test coupons to be manufactured for each of the following RF bands: L, S, C, X, and Ku. The proposer should develop a nondestructive process to establish void sizes and densities within the antennas, waveguides, and conductors. Each of the samples should then be characterized for RF signal performance for the bands stated above at 1W, 25W, and 50W. Environmental tests consisting of thermal cycling, vibration, and flexure should be conducted at -40°C, 25°C, and 125°C on the samples and compared to the baseline results.

PHASE I: Down select material types to be used for the antennas and waveguides, conductors, and flexible substrates. Establish material set combinations to be used for the characterization efforts and sample sizes needed for each material set. Design test coupons for antennas and waveguides at L, S, C, X, and Ku RF band center frequencies. Develop a nondestructive process to establish void sizes and densities for each material set. Develop a test plan for baseline characterizations and environmental tests, as well as acceptable changes in performance. Perform verification of the nondestructive void measurement process and the characterization plan for a representative test coupon.

PHASE II: Produce test coupons in quantities established in Phase I. Determine void sizes and densities in the material sets test coupons. Conduct a characterization test plan on all test coupons at -40°C, 25°C, and 125°C with power levels of 1W, 25W, and 50W. Produce a report summarizing test results.

PHASE III DUAL USE APPLICATIONS: Construct/Print additive manufactured Radio Frequency (RF) antenna(s) and wave guides on flexible substrate(s) for missile defense applications based on Phase II characterization and environmental test results to verify optimum material set performance for the program application.

REFERENCES:

1. “Volumetric 3D-printed antennas, manufactured via selective polymer metallization” https://arxiv.org/abs/1812.04080
2. “Printable Materials for the Realization of High Performance RF Components: Challenges and Opportunities”. https://www.hindawi.com/journals/ijap/2018/9359528/

KEYWORDS: Radio Frequency, Additive, Flexible Substrate

TPOC-1: Steven Cox
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MDA20-009 TITLE: High Toughness Thermal Protection Systems (TPS) for non-ballistic/high Mach Vehicles

RT&L FOCUS AREA(S): Hypersonics
TECHNOLOGY AREA(S): Space Platform; Materials; Air Platform

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 section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a new process of forming thermal protective coverings for non-ballistic/high Mach vehicles.

DESCRIPTION: This topic seeks to demonstrate the production of thermal protection materials which conform to complex shapes and are low weight while providing high resistance to erosion and impact damage. Thermal protection materials today require long manufacturing times and have a large scrap rate due to manufacturing issues. These materials are also prone to erosion and interlaminate blistering under high Mach flight conditions.

The government is interested in developing thin shell (1/4 - 3/4 inch thick) Carbon-Carbon (C-C) TPS materials with high toughness and erosion resistance. Potential material solutions may include through shell reinforcements, including stitched laminates, chopped fiber, or carbon nanotube reinforced composites, or other methods for reducing surface failure in TPS panels. The vendor must develop a process with high repeatability and low statistical variation in performance while matching or improving thermal, strength, and weight characteristics of the current TPS state of the art. The material solution must be faster and cheaper to produce than current TPS solutions and have a low scrap rate.

PHASE I: Develop a methodology for providing through thickness reinforcement to shell TPS structures that produces high strength/high density structures with a short manufacturing time. Demonstrate the process on a sample >1/4 inch thick and >1/4 ft^2. Test the material properties of the sample. Document the process and the resulting material properties.

PHASE II: Mature the process for forming larger, production representative, C-C shells with through thickness reinforcement. Demonstrate a reduced production timeline for full scale parts (<6 months for fully densified parts). Produce sample structures for arc testing and mechanical properties testing and test them at appropriate high Mach test facilities. Demonstrate ablation performance and characterize material properties and performance of the reinforced TPS shells. Document the process and materials.

PHASE III DUAL USE APPLICATIONS: Transition the manufacturing process to a program of record to build prototype panels for use in test flights. Collect required performance data to support certification of C-C parts for use in production systems. Demonstrate <10% scrap rate for full scale (>3ft^2) parts.

REFERENCES:
1. Congressional Research Service Report 45811. Background and Issues for Congress. https://crsreports.congress.gov/product/pdf/R/R45811

2. Ultra-high temperature ceramic composite, https://www.tandfonline.com/doi/full/10.1080/17436753.2018.1475140

KEYWORDS: TPS, C-C, Thermal Protection System, carbon-carbon 2D laminate, manufacturing, high Mach

TPOC-1: Steven Cox
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MDA20-010 TITLE: Jitter Reduction in Light Weight Beam Control Devices

RT&L FOCUS AREA(S): Directed Energy
TECHNOLOGY AREA(S): Weapons; Sensors

OBJECTIVE: Develop methods or system designs that reduce angular errors from vibration on low mass, high performance, laser beam control assemblies.

DESCRIPTION: This topic seeks innovative methods to reduce vibration and jitter in laser systems, while leveraging low mass components, to provide better beam control accuracy. Successful utilization of directed energy requires precision in pointing accuracy. However, many laser platforms are at a disadvantage as Size, Weight, and Power (SWAP) requirements work against the ability to dampen vibrations by traditional means. For this topic, innovative methods are sought that might include mechanisms that are either passive or active in nature, utilize beneficial tolerances for the assembly, or other means to improve pointing accuracy. Methods that enable the use of additive manufacturing, for rapid development cycles at reduced cost, or to further light weight beam control systems to meet technical objectives are also desired.

PHASE I: Develop a concept for a low jitter beam control system that utilizes light weight components. Manufacture prototypes of the key mechanisms in a beam control system or the active components, in order to demonstrate the concept to dampen jitter in a beam control system made of lightweight materials. Additive manufacturing can be used to facilitate prototyping. Develop test metrics and plans to mature the design in Phase II.

PHASE II: Develop and integrate the components needed to test the environmental performance in a more mature prototype. Utilize vibration tables or other means of inducing jitter to characterize the jitter of the prototype design. Additive manufacturing can be used to rapidly evolve the concept. Document the key characteristics of the design and the prototype's performance.

PHASE III DUAL USE APPLICATIONS: Transition design concepts to a government program of record for further development use in tests. Collect required data to support qualification of the design for program use.

REFERENCES:
1. High-power Military Lasers: The Pentagon's laser weapon plans expand https://www.laserfocusworld.com/lasers-sources/article/16555228/highpower-military-lasers-the-pentagons-laser-weapon-plans-expand
2. Services Report Progress on Directed Energy Programs https://www.nationaldefensemagazine.org/articles/2019/6/19/services-report-progress-on-directed-energy-programs

KEYWORDS: Beam Control, Low SWaP, Jitter Reduction, Lightweight Materials, Additive Manufacturing

TPOC-1: Jacob Putman
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MDA20-011 TITLE: Non Destructive Evaluation (NDE) of Production Additive Manufactured Parts

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)
TECHNOLOGY AREA(S): Space Platform; Materials; Air Platform

OBJECTIVE: Develop an innovative process for rapidly evaluating the suitability of 3D printed production metal parts through non-destructive means.

DESCRIPTION: This topic seeks to determine the statistical correlation between defects in 3D printed metal parts which result in a reduction in strength, toughness or fatigue life, and non-destructive performance parameters such as deflections from sub-yield forces, acoustic or electrical resonance or other easily testable metrics. Innovative methods are sought to correlate nondestructive tests with tests-to-failure for an assortment of representative part designs to determine if deviations from the predicted response to nondestructive inputs can be used to detect defects which would cause the failure of a part in service.

Additively manufactured prints of metal parts contain voids and intra-granular impurities which are difficult to detect in the finished part. Computerized Tomography (CT) scans are currently used to detect internal voids but require expensive equipment, substantial time, and experienced operators to run. It is also difficult to properly evaluate CT scans of complex parts with irregular overlapping structures. To facilitate certification of 3D printed flight hardware, innovative NDE tests which are fast and work well on irregular complex shapes are sought.

PHASE I: Identify one or more NDE technique(s) which have a high likelihood of detecting internal voids and defects, resulting in lower than expected failure resistance or fatigue life. Print multiple test bars using a common aerospace material, some with known defects and some without, and demonstrate that some combination of NDE techniques are capable of detecting the flawed parts. Test the printed samples to failure. Document results including the NDE methodology, correlation between the NDE results and the ultimate strength, and describe plans for Phase II.

PHASE II: Demonstrate the ability to detect internal flaws in multiple complex parts using cheap, fast NDE techniques. Print a large number of complex parts with assorted internal flaws and demonstrate the correlation between NDE results and the ultimate strength at failure with high statistical confidence. Document the minimum detectable flaw sizes and densities and their impact on ultimate strength and how this is affected by part shape and complexity. Demonstrate the ability of the NDE to validate the quality of a 3D print of prototype flight hardware with the same confidence as CT scans.

PHASE III DUAL USE APPLICATIONS: Develop necessary NDE performance specifications for 3D printed part(s) of a government flight hardware system. Demonstrate the screening of production quantities of the 3D printed parts using the developed methodology with sufficient confidence to permit flight certification of accepted parts. Transition the methodology to applications in aviation, maritime, and ground vehicles.

REFERENCES:

1. Consortium for Additive Manufacturing Materials Roadmap, http://www.cimp-3d.org/documents/camm_roadmap.pdf
2. Nondestructive Testing of Additive Manufactured Metal Parts Used in Aerospace Applications, https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20180001858.pdf;


KEYWORDS: NDE, 3D printing, certification, production, Additive Manufacturing


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20-MDA-10382 (19 Feb 20)

**Joint Service Small Arms Program (JSSAP)**
**Office of the Secretary of Defense (OSD)**
**20.2 Small Business Innovation Research (SBIR)**
**Direct to Phase II**
**Proposal Submission Instructions**

**IMPORTANT**

**Deadline for Receipt:** Proposals must be **completely** submitted no later than **12:00 p.m.** ET, July 2, 2020. Proposals submitted after 12:00 p.m. will not be evaluated.

Proposers must follow all instructions as provided in the DoD SBIR 20.2 BAA Instructions at https://www.dodsbirsttr.mil/submissions, EXCEPT for the specific deviations listed below.

**Help Desk**: If you have questions about the Defense Department's SBIR or STTR Programs, please call the DoD SBIR/STTR Help Desk email DoDSBIRSupport@reisystems.com.

## INTRODUCTION

The Joint Service Small Arms Program (JSSAP) is participating under the OSD SBIR Program on this SBIR 20.2 Broad Agency Announcement (BAA).

Proposers responding to the JSSAP topic listed in this Announcement must follow all instructions provided in the DoD SBIR 20.2 Broad Agency Announcement (BAA) posted on the DoD SBIR/STTR website at: https://www.dodsbirsttr.mil/submissions.

Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section, and with the ability to commercialize the results, are encouraged to participate. The OSD SBIR Program will support high quality 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.

Objectives of the OSD SBIR 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 and development results. The guidelines presented in the announcement incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

CHART 1: Consolidated SBIR Topic Information

| Applicable Topics | Direct to Phase II | | | |
|---|---|---|---|---|
| | Technical Volume (Vol 2) | Additional Info (Vol 5) | Award Amount | Technical Duration |
| OSD202-D001 | Not to exceed 30 pages | N/A | Base Period: $1,000,000<br>Option Period: $500,000<br>**Not to exceed total award amount: $1,500,000** | Base Period: 12 months<br>Option Period: 6 months<br>**Total Duration: 18 months** |

**DIRECT TO PHASE II**

15 U.S.C. §638 (cc), as amended by NDAA FY2012, Sec. 5106, and further amended by NDAA FY2019, Sec. 854, PILOT TO ALLOW PHASE FLEXIBILITY, allows the Department of Defense to make an award to a small business concern under Phase II of the SBIR program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project. OSD is conducting a Direct to Phase II (DP2) implementation of this authority for this 20.2 SBIR Announcement and does not guarantee DP2 opportunities will be offered in future Announcements.

Proposers interested in submitting a DP2 proposal in response to an eligible topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Work submitted within the feasibility documentation must have been substantially performed by the proposer and/or the PI.

OSD will not evaluate the proposer's related Phase II proposal if it determines that the proposer has failed to demonstrate that technical merit and feasibility has been established or the proposer has failed to demonstrate that work submitted in the feasibility documentation was substantially performed by the proposer and/or the PI.

Feasibility documentation cannot be based upon any prior or ongoing federally funded SBIR or STTR work and DP2 proposals MUST NOT logically extend from any prior or ongoing federally funded SBIR or STTR work.

The OSD SBIR Program reserves the right to not make any awards under this DP2 announcement. The Government is not responsible for expenditures by the offeror prior to award of a contract. All awards are subject to availability of funds and successful negotiations.

## PROPOSAL SUBMISSION

Proposers are REQUIRED to submit UNCLASSIFIED proposals via the Defense SBIR/STTR Innovation Portal (DSIP) at https://www.dodsbirsttr.mil/submissions/. Firms submitting through this site for the first time will be asked to register. It is recommended that firms register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Submission deadlines are strictly enforced. Proposals submitted by any other means will be disregarded.

Full proposal packages must be submitted by 12:00 PM EST on July 2, 2020.

## DIRECT TO PHASE II PROPOSAL PREPARATION INSTRUCTIONS AND PROPOSAL REQUIREMENTS

The Technical Volume is limited to 30 pages, which includes 10 pages for the feasibility documentation and 20 pages for the Phase II Technical Proposal. The Cover Sheet, Cost Volume and Commercialization Report do not count toward the 30-page limitation. The Government will not consider pages in excess of the page count limitations.

Phase II proposals require a comprehensive, detailed submission of the proposed effort. OSD Direct to Phase II efforts are awarded up to a maximum value of the dollar amounts and duration listed in Chart 1.

A. Proposal Cover Sheet (Volume 1): Complete as specified in DoD SBIR/STTR BAA section 5.

B. Format of Technical Volume (Volume 2):
   (1) The Technical Volume must include two parts, PART ONE: Feasibility Documentation and PART TWO: Technical Proposal.
   (2) 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.
   (3) Layout: Number all pages of your proposal consecutively. Font size should not be smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by 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)

**PART ONE: Feasibility Documentation**

- Provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.
- Maximum page length for feasibility documentation is 10 pages. If you have references, include a reference list or works cited list as the last page of the feasibility documentation. This will count towards the page limit.
- Work submitted within the feasibility documentation must have been substantially performed

by the proposer and/or the PI.

- If technology in the feasibility documentation is subject to Intellectual Property (IP), the proposer must either own the IP, or must have obtained license rights to such technology prior to proposal submission, to enable it and its subcontractors to legally carry out the proposed work. Documentation of IP ownership or license rights shall be included in the Technical Volume of the proposal
- DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated.

**PART TWO: Technical Proposal**

Maximum page length for the technical proposal is 20 pages. If you have references, include a reference list or works cited list as the last page of the technical proposal. This will count towards the page limit.

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

(2) Phase II Technical Objectives. Enumerate the specific objectives of the Phase II work and describe the technical approach and methods to be used in meeting these objectives.

(3) Phase II Statement of Work. The statement of work should provide an explicit, detailed description of the Phase II approach, indicate what is planned, how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

   a) Phase II Option Statement of Work The statement of work should provide an explicit, detailed description of the activities planned during the Phase II Option, if exercised. Include how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail.

(4) Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the PI, the proposer, consultants or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state of the art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number) and (3) date of completion.

(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 II effort in providing a foundation for Phase III research and development or commercialization effort.

(6) Key Personnel. Identify key personnel who will be involved in the Phase II effort including information on directly related education and experience. A concise resume of the PI, including a list of relevant publications (if any), must be included. All resumes count toward the page limitation. Identify any foreign nationals you expect to be involved on this project.

(7) 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. 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)).

(8) Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase II effort. Items of equipment to be purchased (as detailed in the cost proposal) shall be justified under this section. Also 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.

(9) Subcontractors/Consultants. Involvement of a university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be identified and described according to the Cost Breakdown Guidance. Please refer to section 4 of the DoD BAA for detailed eligibility requirements as it pertains to the use of subcontractors/consultants.

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

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

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

(11) Commercialization Strategy. Discuss key activities to achieve commercialization of the funded research into a product or non-R&D service with widespread commercial use – including private sector and/or military markets. Note that the commercialization strategy is separate from the Commercialization Report required in Volume 4. The strategy addresses how you propose to commercialize this research, while the Company Commercialization Report covers what you have done to commercialize the results of past Phase II awards.

The commercialization strategy must address the following questions:

a) What DoD Program and/or private sector requirement does the technology propose to support?
b) What customer base will the technology support, and what is the estimated market size?
c) What is the estimated cost and timeline to bring the technology to market to include projected funding amount and associated sources?

d) What marketing strategy, activities, timeline, and resources will be used to enhance commercialization efforts?
e) Who are your competitors, and describe the value proposition and competitive advantage over the competition?

D. Content of the Cost Volume (Volume 3)
Complete the Cost Volume by using the on-line cost volume form on the Defense SBIR/STTR Innovation Portal (DSIP). Some items in the Cost Breakdown Guidance may not apply to the proposed project. If that is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow us to understand how you plan to use the requested funds if a contract is awarded.

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

(2) While special tooling and test equipment and material cost may be included, 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.

(5) A Phase II Option should be fully costed separately from the Base approach.

(6) All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal. Enter this information in the Explanatory Material section of the on-line cost proposal form.

If the proposal is selected for a potential 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 http://www.dcaa.mil. Click on "Guidance" and then click on "Audit Process Overview Information for Contractors."

E. Company Commercialization Report (Volume 4) Complete as specified in DoD SBIR/STTR BAA section 5.

**METHOD OF SELECTION AND EVALUATION CRITERIA**
Phase II proposals will be evaluated based on the criteria outlined in section 8 of the DoD 20.2 SBIR BAA Instructions.

## OSD SBIR 20.2 Topic Index

OSD202-D001 TITLE: Microelectromechanical System (MEMS)/Coriolis Vibratory Gyroscope for Small Arms Fire Control Application

RT&L FOCUS AREA(S): Autonomy, Microelectronics (ME)
TECHNOLOGY AREA(S): Sensors, Electronics and Electronic Warfare, Weapons

OBJECTIVE: Develop a precise 2/3-axis MEMS gyroscope with low size/weight/cost for use in small-arms fire control devices designed for navigation/designation in high EMI and denied environments.

DESCRIPTION: Advanced weapon-mounted fire control requires accurate azimuth, cant and attitude information to calculate firing solutions. The combination of a hostile environment encountered by weapon mounted fire control devices making traditional navigation aids susceptible to failure and the emerging need to navigate and designate in denied environments formulates a need for a novel approach to this technical problem. The MEMS gyroscope should be well suited for the weapon-mounted environment: shock, power consumption and size must be appropriate for this intended use. The accuracy/drift should be sufficient that infrequent recalibration is required. Other than for initial and infrequent calibration, the sensor must operate without emission of any RF and in an environment with significant electromagnetic interference and/or metal housings. The sensor when in its operational configuration must be completely passive. The sensor should be ready to integrate into prototype fire control solutions and sized appropriately for this integration. The sensor must be capable of guiding navigation of the Warfighter to and from an objective and providing the azimuth and attitude (optionally cant) of the weapon system for a firing solution.

PHASE I: Given the direct to Phase II nature of this effort, a determination of Phase I equivalency will be made which will require proof the project is sufficiently mature to be funded at a Phase II level. A report detailing the Phase I equivalent efforts should be included. The technical approach should be well developed with preliminary functional prototyping at a minimum. Evidence of past successes in MEMS gyroscope development should be provided, ideally within the DOD development environment. The preliminary results obtained from functional prototyping should include drift, power requirements and size in addition to projected results in these parameters after the Phase II effort.

PHASE II: The primary deliverables for Phase II shall be:

1. A comprehensive report highlighting actual test results in both lab and operational environments. The report should address any barriers to full-rate production, potential manufacturing partners for full-rate production and design deficiencies w/ possible fixes to address any performance shortcomings
2. A test device for evaluation of the capabilities of the gyroscope. This device shall be internally powered with directionally-based outputs to show the gyroscope's capability in real time. Optionally, this device should integrate with a sample map and will be capable of passive navigation across a sample operational area using only the gyroscope w/ other included passive sensors, showing position on the map.
3. Up to ten (10) 2/3-axis gyroscopes capable of being integrated by the USG into prototype fire control devices.
4. A detailed Interface Control Document for the gyroscope that will assist the USG and/or a contractor in integrated the gyroscope into fire control devices.
5. A requirements document for the project initially, and a requirements review at the end of the effort.

PHASE III DUAL USE APPLICATIONS: This gyroscope will have tremendous commercial potential in end user devices, unmanned aerial systems and smart optical devices of all kinds. Additionally, this sensor has application in Augmented Reality/Virtual Reality systems where precision acceleration inputs are required. MEMS gyroscopes have potential to proliferate across consumer electronics to become standard equipment for increasing device orientation and movement accuracy. The DOD and commercial uses for the gyroscope are essentially identical with the only difference being the device integration. As a Phase III effort, there is potential to integrate the successful gyroscope into prototype fire control devices or create standalone navigational aids for integration into legacy systems. These efforts could be funded by either a Program Manager or Combat Capabilities Development Command entity.

REFERENCES:

1. Gyroscope Technology and Applications: A Review in the Industrial Perspective. https://www.mdpi.com/1424-8220/17/10/2284/pdf. 7 Oct 17.

KEYWORDS: Gyroscope, passive navigation, MEMS, Coriolis vibratory gyroscope, denied environment, fire control

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**OSD/STRATEGIC CAPABILITIES OFFICE (SCO)**
**2020.2 Small Business Innovation Research (SBIR) Program**
**Direct to Phase II Proposal Submission Instructions**

The Strategic Capabilities Office (SCO) seeks small businesses with strong research and development capabilities to pursue and commercialize specific technologies to meet SCO objectives.

The 2020.2 SCO SBIR Direct to Phase II proposal submission instructions are intended to clarify the Department of Defense (DoD) instructions as they apply to SCO requirements. This Announcement is for Direct to Phase II proposals only. All Phase II proposals must be prepared and submitted through the DoD SBIR/STTR electronic submission site: https://www.dodsbirsttr.mil/. The offeror is responsible for ensuring that their proposal complies with the requirements in the most current version of instructions. Prior to submitting your proposal, please review the latest version of these instructions as they are subject to change before the submission deadline.

Specific questions pertaining to the SCO SBIR Program should be submitted to the SCO SBIR Program office at:

E-mail – sbir@sco.mil

## 1. DIRECT TO PHASE II

15 U.S.C. §638 (cc), as amended by NDAA FY2012, Sec. 5106, and further amended by NDAA FY2019, Sec. 854, PILOT TO ALLOW PHASE FLEXIBILITY, allows the Department of Defense to make an award to a small business concern under Phase II of the SBIR Program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR Program with respect to such project. SCO is conducting a "Direct to Phase II" implementation of this authority for this 2019.3 SBIR Announcement and does not guarantee Direct to Phase II opportunities will be offered in future Announcements. Each eligible topic requires documentation to determine that Phase I feasibility described in the Phase I section of the topic has been met.

SCO Direct to Phase II Proposals are different from traditional SCO SBIR Phase I proposals. The chart below explains some of these differences.

| | **STANDARD SCO SBIR PROCESS** | **SCO D2P2 PROCESS** |
|---|---|---|
| **PHASE I TYPICAL FUNDING LEVEL** | $250,000 | None |
| **PHASE I TECHNICAL *POP DURATION** | 6 months | None |
| **PHASE II TYPICAL FUNDING LEVEL** | $1,500,000 | $1,500,000 |
| **PHASE II TECHNICAL *POP DURATION** | 24 months | 24 months |

*POP= Period of Performance

## 2. INTRODUCTION

Direct to Phase II proposals must follow the steps outlined below:

1. Offerors must create a Cover Sheet using the DoD Proposal submission system. Offerors must provide documentation that satisfies the Phase I feasibility requirement* that will be included in the Phase II proposal. Offerors must demonstrate that they have completed research and development through means other than the SBIR/STTR Program to establish the feasibility of the proposed Phase II effort based on the criteria outlined in the topic description.
2. Offerors must submit a Phase II proposal using the SCO Phase II proposal instructions below.

* NOTE: Offerors are required to provide information demonstrating that the scientific and technical merit and feasibility has been established. SCO will not evaluate the offeror's related Phase II proposal if it determines that the offeror has failed to demonstrate that technical merit and feasibility has been established or the offeror has failed to demonstrate that work submitted in the feasibility documentation was substantially performed by the offeror and/or the Principal Investigator (PI). Refer to the Phase I description (within the topic) to review the minimum requirements that need to be demonstrated in the feasibility documentation.

## 3. PROPOSAL SUBMISSION

The complete proposal, i.e., DoD Proposal Cover Sheet, technical volume, cost volume, and Company Commercialization Report, must be submitted electronically at https://www.dodsbirsttr.mil/. Ensure your complete technical volume and additional cost volume information is included in this sole submission.

**Complete proposals must include all of the following**:

a. DoD Proposal Cover Sheet (Volume 1)
b. Technical Volume (Volume 2):
   Part 1: Phase I Justification (5 Pages Maximum)
   Part 2: Phase II Technical Proposal (10 Pages Maximum)
c. Cost Volume (Volume 3)
d. Company Commercialization Report (Volume 4)

**The SCO SBIR Program is accepting Volume 5 (Supporting Documents).**

Phase II proposals require a comprehensive, detailed submission of the proposed effort. SCO SBIR Direct to Phase II periods of performance are 24 months. SCO may award SBIR Direct to Phase II efforts up to a maximum value of $1,500,000 per contract award. Commercial and military potential of the technology under development is extremely important. Proposals emphasizing dual-use applications and commercial exploitation of resulting technologies are sought.

## 4. Direct to Phase II PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

### PROPOSAL FORMAT

A. **Cover Sheet.** As instructed on the DoD SBIR proposal submission website, prepare a Proposal Cover Sheet. Proposal Abstract and Expected benefits and Government or private sector applications of the proposed research should also be summarized in the space provided. The abstract/benefits of selected proposals will be submitted for publication with unlimited distribution. Therefore, the summary should not contain classified or proprietary information.

B. **Phase I Justification (5 Pages Maximum)**. Offerors are required to provide information demonstrating the establishment of the scientific and technical merit and feasibility. **Feasibility documentation MUST**

**NOT be solely based on work performed under prior or ongoing Federally funded SBIR or STTR work.**

C. **Phase II Technical Objectives and Approach (10 Pages Maximum).** List the specific technical objectives of the Phase II research and describe the technical approach in detail to be used to meet these objectives.

D. **Phase II Work Plan.** Provide an explicit, detailed description of the Phase II approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be developed. A Phase II effort should attempt to accomplish the technical feasibility demonstrated in Phase I, including potential commercialization of results. Phase II is the principal research and development effort and is expected to produce a well-defined deliverable product or process.

E. **Related Work.** Describe significant activities directly related to the proposed effort, including those conducted by the Principal Investigator, the proposing firm, consultants, or others. Report how the activities interface with the proposed project and discuss any planned coordination with outside sources. The proposers' awareness of the state-of-the-art in the technology and associated science must be demonstrated.

F. **Relationship with Future Research or Research and Development**. State the anticipated results of the proposed approach if the project is successful. Discuss the significance of the Phase II effort in providing a foundation for a Phase III research or research and development effort.

G. **Technology Transition and Commercialization Strategy.** Describe your company's strategy for converting the proposed SBIR research, resulting from your proposed Phase II contract, into a product or non-R&D service with widespread commercial use -- including private sector and/or military markets. Note that the commercialization strategy is separate from the Commercialization Report described in Section 4.L below. The strategy addresses how you propose to commercialize this research, while the Company Commercialization Report covers what you have done to commercialize the results of past Phase II awards. Historically, a well-conceived commercialization strategy is an excellent indicator of ultimate Phase III success. The commercialization strategy must address the following questions:

1. What is the first product that this technology will go into?
2. Who will be your customers, and what is your estimate of the market size?
3. How much funding will you need to bring the technology to market, and how will you raise those funds?
4. Does your company contain marketing expertise and, if not, how do you intend to bring that expertise into the company?
5. Who are your competitors, and what is your price and/or quality advantage over your competitors?

H. **Key Personnel**. Identify key personnel, including the Principal Investigator, who will be involved in the Phase II effort. List directly related education and experience and relevant publications (if any) of key personnel. Include a concise resume of the Principal Investigator(s).

I. **Facilities/Equipment**. Describe available instrumentation and physical facilities necessary to carry out the Phase II effort. Justify items of equipment to be purchased (as detailed in the cost proposal) including Government Furnished Equipment (GFE). All requirements for government furnished equipment or other assets, as well as associated costs, must be determined and agreed to during Phase II contract negotiations. 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. This includes, but is 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.

J. **Consultants.** Involvement of university, academic institution, or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in the Cost Volume.

K. **Cost Volume** (**$1,500,000 Maximum**). A detailed, Phase II Cost Volume must be submitted online and in the proper format shown in the Cost Breakdown Guidance in Section 5.4 d of the DoD SBIR Broad Agency Announcement (BAA). Some items in the cost volume template may not apply to the proposed project. If such is the case, there is no need to provide information for each and every item. Provide enough information to allow the SCO evaluators to assess the proposer's plans to use the requested funds if the contract is awarded.

1. List all key personnel by name as well as number of hours dedicated to the project as direct labor.
2. Special Tooling, Test Equipment, and Materials Costs:

a. Special tooling, test equipment, and materials costs may be included under Phase II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed; and

b. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific effort.

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

L. **Commercialization Report.** All Phase II proposals must include a Company Commercialization Report (CCR). This required proposal information does not count against the 60-page limit. The CCR is generated by the submission website based on information provided by the firm through the CCR tool. This report will list the name of the awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each SBIR Phase II project performed by the company. The CCR, separate from the commercialization strategy described in Section 4.G, covers what you have done with past Phase II awards. Complete and accurate reporting of Phase III performance data by all participating companies is critical to the future success of the SBIR Program.

## 5. METHOD OF SELECTION AND EVALUATION CRITERIA

A. **Evaluation Criteria**. All proposals will be reviewed for overall merit based on the evaluation criteria published in the DoD SBIR Program BAA:

1. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
2. 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.
3. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

## 6. CONTRACTUAL CONSIDERATIONS

A. **Awards**. The number of Direct to Phase II awards will depend upon the quality the Phase II proposals and the availability of funds. Each Phase II proposal selected for award under a negotiated contract requires a signature by both parties before work begins. SCO awards Phase II contracts to Small Businesses based on results of the agency priorities, scientific, technical, and commercial merit of the Phase II proposal.

B. **Reports.** For incrementally funded Phase II projects an interim, midterm written report may be required (at the discretion of the awarding agency).
C. **Payment Schedule**. SCO Phase II Awards Level of Effort Firm Fixed Price contracts. Monthly invoices are based on the labor hours recorded and the monthly costs associated with the project.
D. **Markings of Proprietary Information**. Per DoD SBIR Program BAA, section 5.3.
E. **Copyrights, Patents and Technical Data Rights**. Per DoD SBIR Program BAA.
F. **Security Information**. SCO anticipates work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA). The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

   Contractors wishing to submit classified proposals must send an unclassified email to sbir@sco.mil requesting classified submission instructions, and a DD Form 254 issued by SCO security. Contractors will ensure all industrial, personnel, and information systems processing security requirements are in place and at the appropriate level.

## 7. TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The SCO SBIR Program will participate in the Technical and Business Assistance (formally the Discretionary Technical Assistance Program), not to exceed $5,000 per award.

## 8. REPORTING OF PHASE III OR ANY OTHER COMMERCIALIZATION EFFORTS

B. Each small business receiving a Phase II award is required to report all Phase III activities on their Company Commercialization Report (Volume 4 of proposal submission). In addition please send any corresponding Phase III documents in PDF format to: sbir@sco.mil

Reportable activities include: sales revenue from new products and non-R&D services resulting from the Phase II project; additional investment from sources other than the Federal SBIR program in activities that further the development and/or the commercialization of the Phase II technology; the portion of additional investment representing clear and verifiable investment in the future commercialization of the technology (i.e. "hard investment"); whether the Phase II technology has been used in a fielded DoD system or acquisition program and, if so, which system or program; the number of patents resulting from the contractor's participation in the SBIR/STTR program; growth in number of firm employees, and; whether the firm completed an initial public offering (IPO) of stock resulting in part from the Phase II project.

**SCO SBIR 20.2 Direct to Phase II Topic**
**SCO202-001**

TITLE: Fusion-Aided Sensor Resource Management

RT&L FOCUS AREA(S): Autonomy; Artificial Intelligence/Machine Learning
TECHNOLOGY AREA(S): Sensors

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 section 3.5 of 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:

Navy Air Systems Command (NAVAIR) has a requirement to expand Research and Autonomy Innovation Development Environment and Repository (RAIDER) to support diverse Department of Defense (DoD) relevant missions. This SBIR should enable expansion of RAIDER capabilities by producing Future Airborne Capability Environment (FACE) or Open Mission Systems (OMS) compliant units of portability (UOPs) that provide Unmanned Aerial Systems (UAS) with resilient autonomous Sensor Resource Management (SRM). The SRM should include maneuvers and planning services as well as promote operational resilience. UOPs must be capable of managing unexpected circumstances occurring during a mission including unpredicted threats, unanticipated adversarial/non-combatant maneuvers, and overcoming losses of capability due to UAS and/or data link damage and malfunction.

DESCRIPTION:

RAIDER UAS UOPs must be capable of satisfying operator provided mission objectives and rules of engagement by generating tactical decisions without further operator involvement. UOPs must utilize a principled approach to assure that UAS decisions are appropriate within objectives and time requirements. Operational resilience should be demonstrated by showing that the on-board planning with the UOPs is capable of:

- Providing effective UAS autonomous collaborative communication supporting sensor fusion and tracking. UOPs should be capable of coordinating teams of 2-30 UAS to respond to maneuvers and threats from as many as 50 adversaries; maximizing allocation of sensors/platforms in a manned/unmanned teams (MUM-T) to optimize tracking performance and achieve mission goals.
- Operating in denied environments in which communications and GPS are limited, and full connectivity between UAS and/or operator may not exist for periods throughout an engagement. UAS must overcome limits in communication and navigation.
- Guaranteeing that a priori operator-provided rules of engagement are not violated. Rules of engagement may include geospatial, temporal, and behavioral constraints.
- Supporting coordination between heterogeneous teams in which UAS may include different payloads, communications transceivers, and mobility characteristics.

The DoD's concept of employment of the above described UOP(s) is a fusion-aided SRM capability integrated into a distributed data fusion architecture. This approach will augment RAIDER to determine sensor resource allocations that improve track localization (where necessary) to form kill chains on identified targets of interest (TOIs). The fusion-aided SRM recommendations would be sent to a higher-level autonomy function where the data fusion recommendations could be weighed against and combined with recommendations or constraints from other onboard functions to determine the MUM-T resource reallocations.

Problem Statement: Collaborative autonomous fusion UOPs are desired to generate a nearly-common operational picture (NCOP) amongst a group of UAS. In order for a set of MUM-T to develop high quality fused tracks in composable kill chains, an SRM capability is necessary to task sensors and platforms across a team to optimize track fusion.

Technical goals specific to this proposal include developing a capability that:

- Determines if a track in the fused scene meets required kill chain CEP/localization thresholds
- Prioritizes sensor resource allocation based on target threat rankings obtained from mission priorities, Order of Battle, or a Threat Analysis module
- Selects resources based on sensor type, availability, modes of operation, and proximity/range
- Implements a Sensor Geometry Analysis algorithm that determines candidate sensor positions and number of sensors needed to improve fused track quality to meet minimum localization requirements
- Collectively optimizes tasking and positioning across the all the platforms/sensors in the MUM-T to maintain the highest level of situational awareness and scene cohesion and localize high priority TOIs
- Supports kill chain formation

PHASE I:

Develop a prototype fusion-based capability to provide an SRM module with platform and sensor actions recommended to improve track quality in order to meet required target localization thresholds. Demonstrate UOP resilience in simulation-based experiments. Explain how the systems will be improved and demonstrated using RAIDER in Phase II.

Methodology should be designed to address constraints on communication between UAS, i.e., a reduced subset of information can be shared. Information includes own-ship telemetry and sensor measurements or tracks or a combination of the two. Each UAS must be able to determine constraints on sharing information with other UAS in the distributed autonomous systems to support mission success. Such intelligent information sharing must consider the mission(s) objectives, time constraints, bandwidth constraints, mission constraints, and the information required to support the mission objectives.

This topic is accepting Direct to Phase II proposals only. Proposers must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the request for proposals has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.

- If you have references, include a reference list or works cited list as the last page of the feasibility documentation. This will count towards the page limit.
- Work submitted within the feasibility documentation must have been substantially performed by the proposer and/or the principal investigator (PI).
- If technology in the feasibility documentation is subject to IP, the proposer must have IP rights.
- Include a one page summary on Commercialization Potential addressing the following:
    i. Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
    ii. Describe the potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.
- DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated.

PHASE II:

Integrate autonomy UOPs into RAIDER-enabled UAS and conduct live flight demonstrations showing proof of concept for fusion-aided sensor resource management UOPs in relevant missions.

Metrics shall be gathered from flight demonstration to show the completeness, accuracy, and timeliness of identifying, tracking, and localizing emitters.

Collaborative autonomous fusion UOPs designed to address constraints on communication between UAS should be demonstrated. The intelligent information sharing must show consideration of the mission objectives, time constraints, bandwidth constraints, mission constraints, and the information required to support the mission objectives. Metrics should be gathered from demonstration to show fusion, information sharing effectiveness, communications effectiveness, and ability to thrive and complete desired mission in denied communications and GPS environments. Algorithms shall be demonstrated on operationally realistic simulated scenarios and modified/extended as necessary to address any challenges that arise during development and testing.

PHASE III DUAL USE APPLICATIONS:

NAVAIR anticipates commercial applications for this technology. The commercial sector is expected to have thousands of drones operational within the next five years. Companies will undoubtedly find a wide variety of applications for drones as the industry continues to grow, and there will be a need to perform coordinated UAS functions such as managing deliveries of commercial goods, detecting and combating forest fires, and precision farming.

Consider the commercial application of detecting and combating forest fires. Firefighting teams have limited resources with which to combat large forest fires. Therefore, it is critical that these teams allocate their resources to optimize their effectiveness in fighting these fires to minimize the fire damage. SRM algorithms deployed on a team of coordinated UAS could be used to optimize resource allocation to aid in the identification and localization of forest fire “hot spots” as well as hazardous areas to avoid. An SRM used to fight fires would be constructed similar to the approach described above. A firefighting SRM would 1) identify affected regions that need improved SA, 2) prioritize these search regions, 3) identify available resources, 4) conduct a sensor geometry analysis using all combinations of available resources, and 5) optimize the sensor resource allocation to position the set of UAS to localize and identify prioritized fire “hot spots.” (Similar SRM applications can be applied to managing deliveries of commercial goods and precision farming.)

Private sector commercial potential includes autonomous automobiles aircraft and trucks.

KEYWORDS: Autonomy, Manned-Unmanned Teaming, Data Fusion

REFERENCES:

1. Defense Advanced Research Projects Agency. (2019, December 16). Collaborative Operations in Denied Environment. Retrieved from DARPA: https://www.darpa.mil/program/collaborative-operations-in-denied-environment
2. Open Group. (2019, December 16). Future Airborne Capability Environment. Retrieved from Open Group: https://www.opengroup.org/face
3. United Stats Air Force. (2017, September 27). Open Mission Systems. Retrieved from Virtual Distributed Laboratory: https://www.vdl.afrl.af.mil/programs/uci/oms.php

# UNITED STATES SPECIAL OPERATIONS COMMAND
## 20.2 Small Business Innovation Research (SBIR)
## Phase I Proposal Submission Instructions

**Introduction:**

The United States Special Operations Command (USSOCOM) seeks small businesses with strong research and development capabilities to pursue and commercialize technologies needed by Special Operations Forces through the Department of Defense (DoD) SBIR 20.2 Program Broad Agency Announcement (BAA). A thorough reading of the "Department of Defense Small Business Innovation Research (SBIR) Program, SBIR 20.2 Program Broad Agency Announcement (BAA)" prior to reading these USSOCOM instructions is highly recommended.

These USSOCOM instructions explain USSOCOM specific aspects that differ from the DoD Announcement and its instructions.

**Table 1: Consolidated SBIR Topic Information**

| Topic | Technical Volume (Vol 2) | Additional Info. (Vol 5) | Period of Performance | Award Amount | Contract Type |
|---|---|---|---|---|---|
| *Phase I*<br>SOCOM202-001 | Not to exceed 5 pages | 15 page PowerPoint | Not to exceed 6 months | Typically $150,000 | Firm-Fixed-Price |

**Contract Awards:**

SBIR awards for topic SOCOM202-001 may be made under the authority of National Defense Authorization Act for Fiscal Year 2020, Section 851, **PILOT PROGRAM FOR DEVELOPMENT OF TECHNOLOGY-ENHANCED CAPABILITIES WITH PARTNERSHIP INTERMEDIARIES.** USSOCOM may use a partnership intermediary to award SBIR contracts and agreements to small business concerns. SOCOM202-001 SBIR contract awards may be done through SOFWERX and result in a commercial contract between the firm and DEFENSEWERX. The Government will evaluate and select for award all SOCOM202-001 proposals.

**Proposal Submission:**

Firms must upload their SOCOM202-001 proposal to the Defense SBIR/STTR Innovation Portal Proposal Submissions at https://www.dodsbirsttr.mil/submissions/login . Additional USSOCOM specific submission requirements for each volume are detailed below.

**Technical Inquiries:**

During the Pre-release Period of the DoD SBIR 20.2 Program BAA, all questions must be submitted in writing either by e-mail to sbir@socom.mil or to the online SBIR/STTR Interactive Topic Information System (SITIS). All questions and answers submitted to SITIS will be released to the general public. USSOCOM does not allow inquirers to talk directly or communicate in any other manner to the topic authors (differs from Section 4.14.c. of the DoD SBIR 20.2 Program BAA instructions). **All inquiries must include the topic number in the subject line of the e-mail.**

During the Open Period, follow the instructions in section 4.14.d of the DoD SBIR 20.2 Program BAA Instructions.

***Site visits will not be permitted during the Pre-release and Open Periods of the DoD SBIR 20.2 Program BAA.***

**Proposal Volumes:**

**Volume 1: Cover page required per DoD instructions.**

**Volume 2: Technical Volume**
The Technical Volume page count will include all the required items under section 5.4.c of the DoD SBIR 20.2 instructions and shall not exceed 5 pages. Offerors shall also submit a slide deck not to exceed 15 PowerPoint slides in Volume 5 and there is no set format requirements for the two documents. It is recommended (but not required) that more detailed information is included in the technical volume and higher level information is included in the slide deck. The Cost Volume (Volume 3) for the Topics will cover the total effort.

The identification of foreign national involvement in a USSOCOM SBIR topic is needed to determine if a firm is ineligible for award on a USSOCOM topic that falls within the parameters of the United States Munitions List, Part 121 of the International Traffic in Arms Regulation (ITAR). A firm employing a foreign national(s) (as defined in paragraph 3.5 entitled "Foreign Nationals" of the DoD SBIR 20.2 Announcement) to work on a USSOCOM ITAR topic must possess an export license to receive a SBIR Phase I contract.

**Volume 3: Cost Volume**
Companies submitting a Phase I proposal under this BAA must complete the USSOCOM Phase I Cost excel spreadsheet, with a base cost typically $150,000 not to exceed $225,000 plus Technical and Business Assistance (TABA) cost (if applicable) not to exceed $6,500 over a period of up to six months.

USSOCOM may provide TABA funds in Phase I awards to firms to meet Cybersecurity Maturity Model Certification (CMMC) Level 1 certification requirements. Draft of the CMMC is located at https://www.acq.osd.mil/cmmc/draft.html.

The TABA information must be included in the firm's cost proposal specifically identified as "Discretionary Technical and Business Assistance" and cannot be subject to any profit or fee by the requesting SBIR firm. In addition, the provider of the TABA may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider). Proposed TABA will be evaluated by the USSOCOM SBIR Program office. The proposed amount is in addition to the award amount for Phase I and cannot exceed $6,500. The firm's proposal must (1) clearly identify the need for assistance (purpose and objective of required assistance); (2) provide details on the provider of the assistance (name and point of contact for performer and unique skills/specific experience to carry out the assistance proposed); and (3) the cost of the required assistance (costs and hours proposed or other details on arrangement that would justify the proposed expense).

A minimum of two-thirds of the research and/or analytical work in Phase I must be conducted by the proposing firm. The percentage of work is measured by both direct and indirect costs as a percentage of the total contract cost.

**Volume 4: Company Commercialization Report**
Not Required by DoD for 20.2 BAA and not evaluated by USSOCOM.
**Volume 5: Supporting Documents**
Potential Offerors shall submit a slide deck not to exceed 15 PowerPoint slides.
**Volume 6: Fraud, Waste and Abuse Training**

Not required by USSOCOM.

**Phase I proposals shall NOT include:**

1) Any travel for Government meetings. All meetings with the Government will be conducted via electronic media.
2) Government furnished property or equipment.
3) Priced or Unpriced Options.
4) A Technical Volume exceeding five pages. USSOCOM will only evaluate the first five pages of the Technical Volume. Additional pages will not be considered or evaluated.
5) "Basic Research" (or "Fundamental Research") defined as a "Systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and/or observable facts without specific applications toward processes or products in mind."
6) Human or animal studies.

**Phase I Evaluations:**

USSOCOM evaluates Phase I proposals using the evaluation criteria specified in section 6.0 of the DoD 20.2 SBIR Announcement except for:

The Technical Volume and slide deck will be reviewed holistically. Proposals missing the slide deck will not be evaluated. The two-part evaluation process is explained below:

> Part I: The evaluation of the Technical Volume will utilize the Evaluation Criteria provided in Section 6.0 of the DoD SBIR 20.2 BAA. Once the evaluations are complete, all Offerors will be notified as to whether they were selected to present the slide deck portion of their proposal.
>
> Part II: Selected Offerors will receive an invitation to present their slide deck (30 minute presentation time / 30 minute question and answer), in a virtual technical question and answer forum, to the USSOCOM evaluation team, on 21 - 22 July 2020. All selected firms will be required to provide a telephone conference number. This presentation will be evaluated by a panel against the criteria listed under Section 6.0 of the DoD SBIR 20.2 BAA. Notifications of selection/non-selection will be completed within the following five business days.

Additionally, input on technical aspects of the proposals may be solicited by USSOCOM from non-Government consultants and advisors who are bound by appropriate non-disclosure requirements. Non-Government personnel will not establish final assessments of risk, rate, or rank Offeror's proposals. These advisors are expressly prohibited from competing for USSOCOM SBIR awards. All administrative support contractors, consultants, and advisors having access to any proprietary data will certify that they will not disclose any information pertaining to this announcement, including any submission, the identity of any submitters, or any other information relative to this announcement; and shall certify that they have no financial interest in any submission. Submissions and information received in response to this announcement constitutes the Offeror's permission to disclose that information to administrative support contractors and non-Government consultants and advisors.

**Selection Notifications**:

For topic SOCOM202-001 the DEFENSEDWX Contracting Officer may notify each Offeror by e-mail whether they have been selected for award. The e-mail notification will be sent to the Corporate Official (Business) identified by the Offeror.

**Informal Feedback:**

A non-selected Offeror can make a written request to their respective Contracting Officer, within 30 calendar days of receipt of notification of non-selection, for informal feedback. The respective Contracting Officer will provide informal feedback in response to an Offeror's written request rather than a debriefing as specified in paragraph 4.10, entitled "Debriefing," of the DoD SBIR 20.2 Announcement.

**USSOCOM SBIR Program Point of Contact:**

Inquiries concerning the USSOCOM SBIR Program should be addressed to sbir@socom.mil.

# USSOCOM SBIR 20.2 Phase I Topic Index

SOCOM202-001 TITLE: Tactical Sensor Open Standards Integration

RT&L FOCUS AREA(S): Network Command, Control and Communications
TECHNOLOGY AREA(S): Information Systems, Sensors, Battlespace, Human 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 section 3.5 of 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 objective of this topic is to develop open standards integration between sensors providing battlespace awareness at the tactical, operational, and strategic level. Special Operations Forces utilizing tactical mobile devices in denied, degraded, intermittent and limited bandwidth communications environments have access to a number of sensor feeds that lack an open standard interface to synthesize information. Processing and exploitation of sensor data requires vertical integration with other platforms for near-real-time situational awareness between tactical and operational echelons. Open standards will also enable greater horizontal data sharing between SOF Operators, SOF Mission Planners, and partner nations across a limited bandwidth environment. The capability is intended for bi-directional integration with operational level Tactical Operation Centers and for SOF operating at the tactical level in austere environments to expand situational awareness and inform decisions required for execution of operations.

DESCRIPTION: USSOCOM is exploring options that provide SOF Operators with a fused tactical common operational picture (COP) for exercising mission command. The capability to stream open standard "Tactical COP" data from a range of applications on handheld devices such as the Tactical Assault Kit and National Geospatial-Intelligence Agency's Mobile Awareness GEOINT Environment to operational command systems will extend the reach of those devices as handheld sensors and for mission execution across the battle space. Open standard streaming data will enable vertical integration of the tactical COP into current and future operational level mission command and execution platforms. The tactical open standard will provide a data format for integration of synthetic data during mission rehearsal and exercise engagements and future 3D, virtual, and augmented reality capabilities.
Operating system key features shall include but not limited to the following:

1. Systems architecture must be able to process georeferenced imagery from both commercial Unmanned Aerial Systems (UAS) and U.S. DoD group classified one (1) and two (2) UAS.
2. Render current tactical handheld geospatial data and reporting in open standard format(s).
3. Assess the feasibility of combining open standard data across SOF Operator and partner nation forces to expand real-time situational awareness over a larger and joint operational footprint.
4. Assess the feasibility of enhancing the open standard tactical COP with 3D Virtual Reality and Augmented Reality.
5. As part of this feasibility study, the offeror shall address all viable overall system design options with respective specifications.

Key Military applications: Execution of Tactical Operations, Mission Planning, Tactical System Integration, Mission Command, Sensor Integration, Planning/Action Mission and Command:

1. Create Common Situational Understanding, Mission Command On-The-Move, Enable Unified Action Partner Collaboration
2. Unify Tactical and Operational Common Operational Picture

3. Create, Communicate, and Rehearse Orders during Exercises
4. Operational Adaptability and Decision-Making

PHASE I: Conduct a feasibility study to assess what is in the art of the possible that satisfies the requirements specified in the above paragraph entitled "Description." To stimulate advances in technology and innovation, solutions including reusable code should be considered as well as re-use of open source code and integrations with fielded SOF systems utilizing existing open standards.

The objective of this USSOCOM Phase I SBIR effort is to conduct and document the results of a thorough feasibility study to investigate what is in the art of the possible within the given trade space that will satisfy a needed technology. The feasibility study should investigate all known options that meet or exceed the minimum performance parameters specified in this write up. It should also address the risks and potential payoffs of the innovative technology options that are investigated and recommend the option that best achieves the objective of this technology pursuit. The funds obligated on the resulting Phase I SBIR contracts are to be used for the sole purpose of conducting a thorough feasibility study using scientific experiments and laboratory studies as necessary. Operational prototypes will not be developed with USSOCOM SBIR funds during Phase I feasibility studies. Operational prototypes developed with other than SBIR funds that are provided at the end of Phase I feasibility studies will not be considered in deciding what firm(s) will be selected for Phase II.

PHASE II: Develop, install, and demonstrate a prototype system determined to be the most feasible solution during the Phase I feasibility study. Incorporate user input received during quarterly hands on assessments and evaluations in operationally realistic environments.

PHASE III DUAL USE APPLICATIONS: This system could be used in a broad range of military applications where geospatial tactical data will support mission command at the operational level for near-real-time situational awareness between tactical and operational echelons. SOF and general purpose forces will use a wider range of deployed assets to collect and exploit tactical data to plan operations, conduct rehearsals, and remotely coordinate actions on the objective with organizations that are not collocated with the ground tactical commander. This capability could also be adopted by first responders, federal law enforcement (Secret Service), and for organizations that require a need to conduct planning and a "walk through" of a specific area prior to execution of a task.

REFERENCES:

1. "The Hyper Enabled Operator," Small Wars Journal, https://smallwarsjournal.com/jrnl/art/hyper-enabled-operator#_edn2, accessed 30 May 2019
2. Open Sensor Hub, Fun Times, and the Future of the Internet of Things," https://opensensorhub.org/2016/02/05/opensensorhub-funtimes-and-the-future-of-the-internet-of-things/, accessed 30 May 2019
3. NoCloud: Exploring Network Disconnection through On-Device Data Analysis, https://www.cs.dartmouth.edu/~dfk/papers/reza-nocloud.pdf, accessed 30 May 2019
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5. "Why is the OGC Involved in Sensor Webs?," http://www.opengeospatial.org/domain/swe, accessed 30 May 2019
6. Mobile Awareness GEOINT Environment, http://ngageoint.github.io/MAGE/, accessed 30 May 2019
7. "How Mobility Solutions are Transforming Military Tactical Operations and Driving Better Mission Outcomes," https://insights.samsung.com/2018/12/13/how-mobility-solutions-are-transforming-military-tactical-operations-driving-better-mission-outcomes/, accessed 30 May 2019

KEYWORDS: Tactical Sensor, Austere Environment, Virtualized Data, Human Machine Interface, Non-traditional ISR, Integrated Sensor Architecture, Georeferenced Imagery

TPOC-1:
Email: sbir@socom.mil

**UNITED STATES SPECIAL OPERATIONS COMMAND**
**20.2 Small Business Innovation Research (SBIR)**
**Direct to Phase II Proposal Submission Instructions**

## Introduction:

The United States Special Operations Command (USSOCOM) 20.2 Direct to Phase II proposal submission instructions cover Direct to Phase II proposals only and change/append the Department of Defense (DoD) instructions for Phase II submissions as they apply to USSOCOM Direct to Phase II requirements.

A thorough reading of the "Department of Defense Small Business Innovation Research (SBIR) Program, SBIR 20.2 Program Broad Agency Announcement (BAA)", located at https://rt.cto.mil/rtl-small-business-resources/sbir-sttr/, prior to reading these USSOCOM instructions is highly recommended. These USSOCOM instructions explain certain unique aspects of the USSOCOM SBIR Program that differ from the DoD Announcement and its instructions. The Offeror is responsible for ensuring that their proposal complies with the requirements in the most current version of these instructions. Prior to submitting your proposal, please review the latest version of these instructions as they are subject to change before the submission deadline.

These USSOCOM instructions explain USSOCOM specific aspects that differ from the DoD Announcement and its instructions.

**Table 1: Consolidated SBIR Topic Information**

| Topic | Technical Volume (Vol 2) | Additional Info. (Vol 5) | Period of Performance | Award Amount |
|---|---|---|---|---|
| *Direct to Phase II* SOCOM202-D002 | Not to exceed 10 pages not including Feasibility Appendix | 15-page PowerPoint | Typically 18 months | Not to Exceed $1,245,00 |

## Contract Awards:

SBIR awards for topic SOCOM202-D002 will be awarded as a fixed price (level of effort type), Other Transactions Agreement (OTA). Successful completion of the prototype under an OTA may result in a follow-on production OTA or contract. Successful completion of the prototype is meeting one or more threshold requirements. Firms may download the template at https://www.socom.mil/SOF-ATL/Pages/sbir-20-2.aspx. The terms and conditions as well as the requirements are included in the OTA template provided in this solicitation. The terms and conditions of the Template OTA and the latest version of the OTA are also subject to change until executed. The document deliverables required for the effort are under attachment 2 of the OTA and the statement of objectives is under attachment 3 of the OTA template. Offerors must review these documents to develop their proposal. The template needs to be filled only by those Offerors selected to present.
Those selected to present would be required to enter their company information, expected milestones (attachment 1), and provide a non-proprietary Statement of Work (SOW) following the format of the Statement of Objectives (SOO) (attachment 3). The Government will evaluate all responsive SOCOM202-D002 proposals.

## Proposal Submission:

Firms must upload their SOCOM202-D002 proposal to the Defense SBIR/STTR Innovation Portal Proposal Submissions at https://www.dodsbirsttr.mil/submissions/login . Additional USSOCOM specific submission requirements for each volume are detailed below.

**Technical Inquiries:**

During the Pre-release Period of the DoD SBIR 20.2 Program BAA, all questions must be submitted in writing either by e-mail to sbir@socom.mil or to the online SBIR/STTR Interactive Topic Information System (SITIS). All questions and answers submitted to SITIS will be released to the general public. USSOCOM does not allow inquirers to communicate directly in any manner to the topic authors (differs from Section 4.14.c. of the DoD SBIR 20.2 Program BAA instructions). **All inquiries must include the topic number in the subject line of the e-mail.**

During the Open Period, follow the instructions in section 4.14.d of the DoD SBIR 20.2 Program BAA Instructions.

***Site visits will not be permitted during the Pre-release and Open Periods of the DoD SBIR 20.2 Program BAA.***

**Proposal Volumes:**

**Volume 1:** Cover Page is created as part of the DOD Proposal Submissions process.

**Volume 2: Technical Volume**
The Technical Volume shall not exceed 10 pages and will include all required items under section 7.0 of the DoD SBIR 20.2 instructions. Any additional pages will be deleted from the proposal prior to evaluation.

Offerors must provide documentation to satisfy the Phase I feasibility requirement as specified in the direct to Phase II topic. The documentation shall be included as a Feasibility Appendix in the technical proposal volume; however, it is not included in the 10-page limit. Offerors are required to provide sufficient information to determine, to the extent possible, the scientific, technical, and commercial merit and feasibility of ideas submitted, and that the feasibility assessment was performed by the Offeror and/or the Principal Investigator. **If the Offeror fails to demonstrate the scientific and technical merit, feasibility, and/or the source of the work, USSOCOM will not continue to evaluate the Offeror's proposal.** Refer to the topic's Phase I description under the Direct to Phase II topic to review the minimum requirements needed to demonstrate feasibility.

The technical proposal shall include a Statement of Work (SOW) with the planned tasks and descriptions to meet the Statement of Objectives (SOO) and Contract Data Requirement Lists (CDRLs) detailed in Attachments 2 and 3 of the OTA Template. Do not upload the SOO or CDRLs with your proposal. The SOO, and CDRLs will be provided in the OTA Template and can be also be provided upon e-mail request sent to sbir@socom.mil or may be downloaded from https://www.socom.mil/SOF-ATL/Pages/sbir-20-2.aspx. The proposal must also include a completed Section K which does not count toward the page limit. Any templates are provided to help the Offerors consider the required work/deliverables when developing the proposal, but it is an Offerors responsibility to provide fully responsive, complete, and clear submissions. If an Offeror is selected for award, the Offeror will be required to submit a separate non-proprietary SOW with the planned tasks and descriptions from the proposal and all other sections of the SOO as Attachment 3 in the OTA Template. The SOW attached to the OTA shall include no proprietary information, data, or markings

The identification of foreign national involvement in a USSOCOM SBIR topic is required to determine if a firm is ineligible for award on a USSOCOM topic that falls within the parameters of the United States Munitions List, Part 121 of the International Traffic in Arms Regulation (ITAR). A firm employing a foreign national(s) (as defined in paragraph 3.5 entitled "Foreign Nationals" of the DoD SBIR 20.2

Announcement) to work on a USSOCOM ITAR topic must possess an export license to receive a SBIR Phase II contract.

**Volume 3: Cost Volume**

Offerors must complete the cost volume using the Phase II OTA Cost Proposal template posted on the USSOCOM Portal at https://www.socom.mil/SOF-ATL/Pages/sbir-20-2.aspx, and read instructions before completing it. The Cost Proposal information (PDF format) shall be appended to and submitted in Volume 3. Those recommended for award shall submit the original cost proposal in Excel format.

Phase II proposal base cost is typically $1,000,000 not to exceed $1,245,000 plus Technical and Business Assistance (TABA) cost (if applicable) not to exceed $50,000 over the period of performance. For this topic in particular, the limit is $1,245,000 to provide a testable prototype.

USSOCOM may provide TABA funds in Phase II awards to firms to meet up to Cybersecurity Maturity Model Certification (CMMC) Level 3 certification requirements. Draft of the CMMC is located at https://www.acq.osd.mil/cmmc/draft.html.

The TABA information must be included in the firm's cost proposal specifically identified as "Discretionary Technical and Business Assistance" and cannot be subject to any profit or fee by the requesting SBIR firm. In addition, the provider of the TABA may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider). Proposed TABA will be evaluated by the USSOCOM SBIR Program office. The proposed amount is in addition to the award amount for Phase II and cannot exceed $50,000. The firm's proposal must (1) clearly identify the need for assistance (purpose and objective of required assistance); (2) provide details on the provider of the assistance (name and point of contact for performer and unique skills/specific experience to carry out the assistance proposed); and (3) the cost of the required assistance (costs and hours proposed or other details on arrangement that would justify the proposed expense).

The final negotiated price of a USSOCOM Phase II SBIR contract will result from a determination of price fairness and reasonableness commensurate with the magnitude and complexity of the required research and development effort. The resulting agreement will be a firm priced/level of effort. Price/Cost proposal information should include the itemized listing (a-h) specified below. . For the OTA, the Government is not going to analyze indirect cost, but the prices (including all burdens) of the cost proposal information must be at a level of detail that would enable the Government personnel to determine the purpose, necessity, and reasonability of each cost element. The itemized listing may be placed in the "Explanatory Material" section of the on-line Cost Proposal form, or as the last page(s) of the Cost Proposal Upload. The Contracting Officer may request additional information to support price analysis or understand the approach if needed.

a. Special Tooling and Test Equipment and Material: The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness of the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and relate directly to the specific effort. They may include such items as innovative instrumentation and/or automatic test equipment. The reason for the requirement and the intention of offeror on disposition of the special material/ equipment shall be documented in the proposal.

b. Direct Cost Materials: Justify costs for materials, parts, and supplies with an itemized list that includes item description, part number, quantities, and price.

c. Other Direct Costs: This category of costs includes specialized services such as machining or milling, special testing or analysis, and costs incurred in obtaining temporary use of specialized equipment. Proposals that include leased hardware must provide an adequate lease vs. purchase justification or rationale.

d. Direct Labor: For each individual, include the number of hours, and loaded rate to include all indirect costs. Identify key personnel by name if possible and labor category.

e. Travel: Travel costs must relate to the needs of the project. Proposed travel cost must be in accordance with the Federal Travel Regulation (FTR).

1. Per Diem Rates can be obtained at: http://www.gsa.gov/perdiem
2. The following information is documented –
   (i) Date (estimated), length and place (city, town, or other similar designation) of the trip;
   (ii) Purpose of the trip; and
   (iii) Number of personnel included in the estimate.

f. Cost Sharing: Cost sharing is permitted. However, cost sharing is not required, nor will it be an evaluation factor in the consideration of a proposal. Please note that cost share contracts do not allow fees.

g. Subcontracts: Involvement of university or other consultants in the planning and/or research stages of the project may be appropriate. If the Offeror intends such involvement, describe in detail and include information in the cost proposal. The proposed total of all consultant fees, facility leases or usage fees, and other subcontract or purchase agreements may not exceed one-half of the total contract price or cost, unless otherwise approved in writing by the Contracting Officer.

Support subcontract costs with copies of the subcontract agreements. The supporting agreement documents must adequately describe the work to be performed (i.e., cost proposal) or provide a statement of work with a corresponding detailed proposal for each planned subcontract.

h. 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 rate.

**Volume 4: Company Commercialization Report**
Not used for 20.2 BAA and not evaluated by USSOCOM.
**Volume 5: Supporting Documents**
Potential Offerors shall submit a slide deck not to exceed 15 PowerPoint slides.
**Volume 6: Fraud, Waste and Abuse Training**
Not required by USSOCOM.

**Direct to Phase II Evaluations:**

USSOCOM evaluates Direct to Phase II proposals using the evaluation criteria specified in section 8.0 of the DoD 20.2 SBIR Announcement with the following exceptions:

1. Proposals missing technical volume, feasibility appendix, cost volume, or slide deck will not be evaluated.

2. Feasibility determination. The Feasibility Appendix to the Phase II proposal will be evaluated first to determine that the Offerors demonstrated they have completed research and development to establish the feasibility of the proposed Phase II effort based on the criteria outlined in the topic description**. USSOCOM will not continue evaluating the Offeror's related Phase II**

**proposal if it determines that the Offeror failed to demonstrate that feasibility** has been established **or** the Offeror failed to demonstrate work submitted in the feasibility documentation was substantially performed by the Offeror and/or the Principal Investigator. Refer to the Phase I Topic description included in the Direct to Phase II topic to review the minimum requirements that need to be demonstrated in the feasibility documentation.

3. The technical evaluation will utilize the Evaluation Criteria provided in Section 8.0 of the DoD SBIR 20.2 BAA. The Technical Volume and slide deck will be reviewed holistically. The technical evaluation is performed in two parts:

   Part I: The evaluation of the Technical Volume will utilize the Evaluation Criteria provided in Section 8.0 of the DoD SBIR 20.2 BAA. Once the evaluations are completed, all Offerors will be notified as to whether they were selected to present their slide deck portion of their proposal.

   Part II: Selected Offerors will receive an invitation to present their slide deck (30-minute presentation time / 30-minute question and answer) to the USSOCOM evaluation team, on 21 - 22 July 2020 in a virtual teleconference. All selected firms will be required to provide a teleconference number for the presentation. This presentation will be evaluated by a panel against the criteria listed under Section 8.0 of the DoD SBIR 20.2 BAA. Notifications of selection/non-selection for Phase II award will be completed within the following five business days.

4. The Cost Volume (Volume3) evaluation:

   For this direct to phase II, the award amount is set at a not to exceed (NTE), a technical evaluation of the proposal cost will be completed to assess the probability of success to obtain a working prototype. Proposal above the set NTE for the effort will not be considered for award. The team will assess the technical approach presented for the effort based on the number of labor hours by labor categories, the key personnel level of involvement, materials, equipment, subcontractors and consultants (scope of work, expertise, participation and proposed effort), travel and other direct cost as proposed.
   The resulting award/s will be a fixed price OTA prototyping agreements and a successful prototype may lead to follow on production. Follow on production awards may be FAR based, Fixed Price or Cost-Plus Fixed Fee contracts. A Defense Contracts Audit Agency approved accounting system will be required to issue a Cost-Plus Fixed Fee contract.

Additionally, input on technical aspects of the proposals may be solicited by USSOCOM from non-Government consultants and advisors who are bound by appropriate non-disclosure requirements. Non-Government personnel will not establish final assessments of risk, rate, or rank Offeror's proposals. These advisors are expressly prohibited from competing for USSOCOM SBIR awards. All administrative support contractors, consultants, and advisors having access to any proprietary data will certify that they will not disclose any information pertaining to this announcement, including any submission, the identity of any submitters, or any other information relative to this announcement; and shall certify that they have no financial interest in any submission. Submissions and information received in response to this announcement constitutes the Offeror's permission to disclose that information to administrative support contractors and non-Government consultants and advisors.

**Selection Notifications**:

The USSOCOM Contracting Officer notifies the Offeror by e-mail of selection/non-selection for award. The e-mail notification will only be sent to the Corporate Official (Business) identified by the Offeror.

**Informal Feedback:**

A non-selected Offeror can make a written request to the Contracting Officer, within 30 calendar days of receipt of notification of non-selection, for informal feedback. The Contracting Officer will provide informal feedback after receipt of an Offeror's written request rather than a debriefing as specified in paragraph 4.10, entitled "Debriefing," of the DoD SBIR 20.2 Announcement.

**USSOCOM SBIR Program Point of Contact:**

Inquiries concerning the USSOCOM SBIR Program should be addressed to sbir@socom.mil.

## USSOCOM SBIR 20.2 Direct to Phase II Topic Index

SOCOM202-D002 TITLE: Interoperable Simulation & Gaming Mesh

RT&L FOCUS AREA(S): Information Systems
TECHNOLOGY AREA(S): Data Processing and Automation, Information Systems, Geospatial Intelligence

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 section 3.5 of 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: This topic seeks to demonstrate automated interoperability of simulation and gaming by taking tactical sensor data collected as gaming mesh that can be correctly georeferenced to the earth's surface and transforming it into Open Geospatial Consortium (OGC) CDB data segmented into appropriate data layers.

DESCRIPTION: USSOCOM provides Special Operation Forces (SOF) with operational intelligence that enables joint SOF mission planning and rehearsal for real-world combat environments. Current processes, mostly manual, leverage source data including imagery of varying types and resolutions, vector data, and elevation data to produce three-dimensional (3D) scene visualization databases and enhanced Geospatial Intelligence (GEOINT) data such as maps, imagery, and terrain models. 3D databases support battlespace visualization and simulation so that SOF units know the areas where they will operate in before they get there. This SBIR topic will investigate automated processes to accelerate production of OGC CDB data stores using sensor data source collected from small tactical UAS in meshed terrain format not traditionally associated with geographic information systems or Defense modeling and simulation.

The solution needs to recognize sensor data as points, imagery raster and/or meshed data and produce the appropriate OGC CDB layers. Most of the tactically collected data has some geo-referencing data to get it close to where the data exists in the real world and the data has good relative accuracy. If the data can be edge matched via pattern recognition to existing imagery to transform it into the correct place on the earth surface, it will improve the geospatial accuracy of the source data. Once the data is in the right location then the data needs to be segmented to provide a good Digital Terrain Model or Digital Elevation Model, and the rest of the 3D features extracted into OGC CDB models. Potential solutions may use OGC CDB raster material data and/or multi- or hyper-spectral imagery signatures to improve segmentation and then apply those material codes to the polygonal surfaces to improve the data for simulation ready applications like Unity and Semi-Automated Forces support. Artificial intelligence and/or machine learning algorithms be used to train and then invoke these procedures, reducing the need for manual intervention to pick tie points between the imagery and the vector data after enough tie points are established to transform the vector data to the imagery to correlate the data. Solutions should learn and, given a set of data, be able to recognize patterns in the data to automatically tie the vectors to the imagery.

High-level goals include:

1. Reduce (T)/eliminate (O) manual intervention necessary to build CDB data layers.
2. Minimal training (T) / no expert knowledge (O) required for basic use.
3. Customization through a drag-and-drop workflow creation/editing tool (O).

4. Implementation of AI/ML techniques to provide for a guided training mode that can be used to improve or customize autonomous processing outcomes (O) (ex: correlation of vector data with underlying imagery).
5. Ability for user to manually identify sets of source data for processing (T/O), including standardized OGC web services (O).
6. Ability to monitor a Watch Folder for input data (T/O).
7. Ability to accept and recursively follow links in the Watch Folder and defined data stores (T/O).
8. Execute autonomous actions and CDB creation workflows when presented with appropriate geospatial input data (T/O).
9. Process appropriate input data formats including, but not limited to, strategic imagery, elevation-data, vector-data, passive/active point cloud, triangular/polygonal mesh, etc. (T/O).

PHASE I: The objective of this USSOCOM Phase I SBIR effort is to conduct and document the results of a thorough feasibility study to investigate what is in the art of the possible within the determined trade space that will satisfy the requirements specified by this topic. As a part of this feasibility study, respondents shall investigate all viable system design options and meet or exceed the performance parameter specifications provided herein. It shall also consider programmatic, schedule, and technical risks and potential payoffs of the innovative technology options that are investigated culminating in a recommended development strategy that best achieves the objectives of this technology pursuit.

Government funds obligated on Phase I SBIR contracts are to be used for the sole purpose of conducting a thorough feasibility study using scientific experiments and laboratory studies as necessary. Operational prototypes shall not be developed with USSOCOM funds during Phase I feasibility studies. If an operational prototype is developed during Phase I with funding from sources other than the SBIR award, that prototype will influence the Government's whether and with whom to pursue a Phase II effort.

PHASE II: Develop, install, and demonstrate a prototype system determined, during the Phase I feasibility study, to be the most feasible and efficacious solution to this technology pursuit. Phase II will likely include additional performance and technical requirements developed during, or revealed by, Phase I investigations. In addition, as a system intended for operational evaluation, the Phase II prototype may be required to satisfy security requirements that will allow its implementation and use on the SOF information enterprise.

PHASE III DUAL USE APPLICATIONS: Once adequately matured, this system would be used in a broad range of military, Government, and commercial applications where it is desirable to construct detailed, OGC CDB compliant databases for use in terrestrial modeling, visualization, and simulation. This capability addresses the intersection of simulation and gaming and has the potential to rapidly move the commercial gaming industry out of artistically rendered fantasy and into the real world.

REFERENCES:
1. Open Geospatial Consortium, CDB Standard, http://www.opengeospatial.org/standards/cdb
2. "Overview of the OGC CDB Standard for 3D Synthetic Environment Modeling and Simulation," Saeedi, S.; Liang, S.; Graham, D.; Lokuta, M.F.; Mostafavi, M.A. International Society for Photogrammetry and Remote Sensing, International Journal of Geo-Information. 2017, 6, 306. https://www.mdpi.com/2220-9964/6/10/306
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