DEPARTMENT OF THE AIR FORCE (DAF)
23.3 SMALL BUSINESS INNOVATION RESEARCH (SBIR) DIRECT TO PHASE II (D2P2)
PROPOSAL SUBMISSION INSTRUCTIONS
AMENDMENT 2

This Amendment adds language to the **METHOD OF SELECTION AND EVALUATION CRITERIA** section of these Component-specific instructions:

In accordance with Section 4 of the SBIR and STTR Extension Act of 2022, the DAF will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. The DAF will use information provided by the small business concern in response to the Disclosure of Foreign Affiliations or Relationships to Foreign Countries and the proposal to conduct a risk-based due diligence review on the cybersecurity practices, patent analysis, employee analysis, and foreign ownership of a small business concern, including the small business concern and employees of the small business concern to a foreign country, foreign person, foreign affiliation, or foreign entity. The DAF will also assess proposals utilizing open-source analysis and analytical tools, for the nondisclosures of the information set forth in 15 U.S.C. 638(g)(13). If DAF assesses that a small business concern has security risk(s), DAF will review the proposal, the evaluation, and the security risks and may choose to either 1) create a plan to mitigate the risk(s) or 2) DAF may decide not to select the proposal for award based upon a totality of the review.

All other terms and provisions remain unchanged as a result of this Amendment.

DEPARTMENT OF THE AIR FORCE (DAF)
23.3 SMALL BUSINESS INNOVATION RESEARCH (SBIR) DIRECT TO PHASE II (D2P2)
PROPOSAL SUBMISSION INSTRUCTIONS
AMENDMENT 1

This Amendment modifies several of the topics associated with the DAF SBIR D2P2 offering. Topic numbers that are highlighted have been updated. That includes the following topics:

Topic Number	**Topic Name**
SF233-D001	Miniature Smart Satellite Threat Warning Sensor
AF233-D002	Aircraft Vibration Harvester (AVH)
SF233-D007	Laser pre-compensation to improve sodium beacon coherence
AF233-D008	AR for Equipment Maintenance
AF233-D009	Robotic Defastening
AF233-D010	Field-level Detection of Hydraulic Fluid Contamination in Jet Fuel
AF233-D011	Functional Gradient Coatings for Landing Gear
AF233-D012	Materials for High-Temperature Performance Electronics: Memory and Packaging
AF233-D013	Development of New Oxidation Resistant Refractory Alloys for Additively Manufactured (AM) Components
AF233-D014	Advanced Nano-Composite Radiation Shielding Manufacturing
AF233-D015	Manufacturing of Nitrogen Vacant (NV) Diamond Substrates for Quantum Sensors
AF233-D016	Technical Data Package (TDP) Modernization for As-Built Data
AF233-D017	Next-Generation SAL Pulse Code
AF233-D018	Conformal Forward Looking Multi-Aperture Seeker for High Speed EO/IR Demonstrator
AF233-D019	Hardened Scalar and Vector Magnetometer Development
AF233-D020	Real-time Sensor Fusion ATA in Golden Horde Colosseum

AF233-D021	Subscription-Based, Real-Time UAS Detection, Tracking, and Identification
AF233-D022	Austere Cargo Offload and Onload System
AF233-D023	TAK Mobile Machine Learning (MML) Model Development
AF233-D024	Integration of Machine Learning (ML) Platforms with a Mobile Device Manager (MDM) for the TAK Ecosystem
AF233-D025	Improved Data Collection and Knowledge Graphing in the TAK Ecosystem
AF233-D026	OptiFrame Topology Optimized Load-Bearing Airframe with Additive Manufacturing
AF233-D027	GPU Accelerated Large Eddy Simulation for Low Pressure Turbine Design
AF233-D028	Video Imaging for Patrol and Emergency Management
AF233-D029	Low-Loss Magnetless Optical Isolators for Quantum Integrated Photonics Applications
AF233-D030	Autonomous Airfield Repair Robotics Swarm Platform
AF233-D031	Rapid Fly Mobile UAS

All other terms and provisions remain unchanged as a result of this Amendment.

DEPARTMENT OF THE AIR FORCE (DAF)
23.3 SMALL BUSINESS INNOVATION RESEARCH (SBIR) DIRECT TO PHASE II (D2P2)
PROPOSAL SUBMISSION INSTRUCTIONS

The DAF intends these proposal submission instructions to clarify the Department of Defense (DoD) Broad Agency Announcement (BAA) as it applies to the topics solicited herein. **Firms must ensure proposals meet all requirements of the 23.3 SBIR BAA posted on the DoD SBIR/STTR Innovation Portal (DSIP) at the proposal submission deadline date/time.**

Proposers are encouraged to thoroughly review the DoD Program BAA and register for the DSIP Listserv to remain apprised of important programmatic and contractual changes.

- The DoD Program BAA is located at: https://www.defensesbirsttr.mil/SBIR-STTR/Opportunities/#announcements. Be sure to select the tab for the appropriate BAA cycle.
- Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

Complete proposals **must** be prepared and submitted via https://www.dodsbirsttr.mil/submissions/ (DSIP) on or before the date published in the DoD 23.3 SBIR BAA. Offerors are responsible for ensuring proposals comply with the requirements in the most current version of this instruction at the proposal submission deadline date/time.

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

Please ensure all e-mail addresses listed in the proposal are current and accurate. The DAF is not responsible for ensuring notifications are received by firms changing mailing address/e-mail address/company points of contact after proposal submission without proper notification to the DAF. **If changes occur to the company mail or email addresses or points of contact after proposal submission, the information must be provided to the AF SBIR/STTR One Help Desk.** The message shall include the subject line, “23.3 Address Change”.

Points of Contact:

- General information related to the AF SBIR/STTR program and proposal preparation instructions, contact the AF SBIR/STTR One Help Desk at usaf.team@afsbirsttr.us.
- Questions regarding the DSIP electronic submission system, contact the DoD SBIR/STTR Help Desk at dodsbirsupport@reisystems.com.
- For technical questions about the topics during the pre-announcement and open period, please reference the DoD 23.3 SBIR BAA.
- Air Force SBIR/STTR Contracting Officer (CO):
  Mr. Daniel J. Brewer, Daniel.Brewer.13@us.af.mil

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

DIRECT TO PHASE II

15 U.S.C. §638 (cc), as amended by the SBIR AND STTR EXTENSION ACT OF 2022, allows DoD to make a SBIR Phase II award to a small business concern 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. DAF is conducting a "Direct to Phase II" implementation of this authority for these 23.3 SBIR topics and does not guarantee D2P2 opportunities will be offered in future solicitations. Each eligible topic requires documentation to determine whether the feasibility requirement described in the Phase I section of the topic has been met.

DIRECT TO PHASE II PROPOSAL SUBMISSION

The DoD SBIR 23.3 Broad Agency Announcement, https://www.dodsbirsttr.mil/submissions/login, includes all program requirements. Phase I efforts should address the feasibility of a solution to the selected topic's requirements.

The complete proposal must be submitted electronically through DSIP. Ensure the complete technical volume and additional cost volume information is included in this sole submission. The preferred submission format is Portable Document Format (.pdf). Graphics must be distinguishable in black and white. **VIRUS-CHECK ALL SUBMISSIONS.**

The System for Award Management (SAM) allows proposing small business concerns interested in conducting business with the Federal Government to provide basic information on business structure and capabilities as well as financial and payment information. Proposing small business concerns must be registered in SAM. To register, visit www.sam.gov. A proposing small business concern that is already registered in SAM should login to SAM and ensure its registration is active and its representations and certifications are up-to-date to avoid delay in award.

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

For new proposing small business concern registrations, follow instructions during SAM registration on how to obtain a Commercial and Government Entry (CAGE) code and be assigned the UEI (SAM). Once a CAGE code and UEI (SAM) are obtained, update the Small business concern's profile on the DSIP at https://www.dodsbirsttr.mil/submissions/.

INTRODUCTION: Direct to Phase II proposals must follow the steps outlined below:

1. Offerors must create a Cover Sheet in DSIP; follow the Cover Sheet instructions provided in the DoD SBIR 23.3 BAA.Offerors must provide documentation satisfying the Phase I feasibility requirement* to be included in the Phase II proposal. Offerors must demonstrate completion of research and development through means other than the SBIR/STTR Programs to establish the feasibility of the proposed Phase II effort based on the criteria outlined in the topic description.
2. Offerors must submit D2P2 proposals using the instructions below.

*NOTE: DAF will not consider the offeror's D2P2 proposal if the offeror fails to demonstrate technical merit and feasibility have been established. It will also not be considered if it fails to demonstrate the feasibility effort was substantially performed by the offeror and/or the principal investigator (PI). Refer to the topics' Phase I descriptions for minimum requirements needed to demonstrate feasibility. <u>Feasibility documentation MUST NOT be solely based on work performed under prior or on-going Federally funded SBIR and/or STTR work.</u>

DIRECT TO PHASE II PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

A. <u>Proposal Requirements</u>. A Direct To Phase II proposal shall provide sufficient information to persuade the AF the proposed technology advancement represents an innovative solution to the scientific or engineering problem worthy of support under the stated criteria. All sections below count toward the page limit, unless otherwise specified.

B. <u>Proprietary Information</u>. Information constituting a trade secret, commercial/financial information, confidential personal information, or data affecting National Security must be clearly marked. It shall be treated in confidence to the extent permitted by law. Be advised, in the event of proposal selection, the Work Plan will be incorporated into the resulting contract by reference. Therefore, DO NOT INCLUDE PROPRIETARY INFORMATION in the work plan. See the DoD BAA regarding proprietary information marking.

C. <u>General Content</u>. Proposals should be direct, concise, and informative. Type shall be no smaller than 11-point on standard 8 ½ X 11 paper, with one-inch margins and pages consecutivelynumbered. Offerors are discouraged from including promotional and non-programmatic items. If included, such material will count toward the page limit.

DIRECT TO PHASE II PROPOSAL FORMAT

Complete proposals must include all of the following:

Volume 1: DoD Proposal Cover Sheet

Note: If selected for funding, the proposal's technical abstract and discussion of anticipated benefits will be publicly released. Therefore, do not include proprietary information in this section.

Volume 2: Technical Volume

Volume 3: Cost Volume

Volume 4: Company Commercialization Report

Volume 5: Supporting Documents, e.g. DoD Form 2345 (if applicable), Militarily Critical Data Agreement (if applicable); etc.

Volume 6: Fraud, Waste, and Abuse Training Completion

Phase II proposals require a comprehensive, detailed description of the proposed effort. AF D2P2 efforts are to be proposed in accordance with the information in these instructions. 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.

All D2P2 research or research and development (R/R&D) must be performed by the small business and its team members in the United States, as defined in the DoD SBIR 23.3 BAA. The Principal Investigator's (PI's) primary employment must be with the small business concern at the time of awardand during the entire period of performance. Primary employment means more than one-half the PI's time is spent in the small business' employ. This precludes full-time employment with another entity.

Knowingly and willfully making false, fictitious, or fraudulent statements or representations may be a felony under18 U.S.C. Section 1001, punishable by a fine up to $250,000, up to five years in prison, or both.

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

<u>DOD PROPOSAL COVER SHEET (VOLUME 1)</u>

Complete the proposal Cover Sheet in accordance with the instructions provided via DSIP. The technical abstract should include a brief description of the program objective(s), a description of the effort, anticipated benefits and commercial applications of the proposed research, and a list of keywords/terms. The technical abstract of each successful proposal will be submitted to the Office of the Secretary of Defense (OSD) for publication and, therefore, <u>must not contain</u> <u>proprietary or classified information</u>.

TECHNICAL VOLUME (VOLUME 2)

The technical proposal includes all items listed below in the order provided.

(1) **<u>Table of Contents</u>:** A table of contents should be located immediately after the Cover Sheet.

(2) **<u>Glossary</u>:** Include a glossary of acronyms and abbreviations used in the proposal.

(3) **<u>Milestone Identification</u>:** Include a program schedule with all key milestones identified.

(4) **<u>Identification and Significance of the Problem or Opportunity</u>:** Briefly reference thespecific technical problem/opportunity to be pursued under this effort.

(5) **<u>Phase II Technical Objectives</u>:** Detail the specific objectives of the Phase II work and describe the technical approach and methods to be used in meeting these objects. The proposal should also include an assessment of the potential commercial application for eachobjective.

(6) **<u>Work Plan</u>:** The work plan shall be a separate and distinct part of the proposal package, using a page break to divide it from the technical proposal. It must contain a summary description of the technical methodology and task description in broad enough detail to provide contractual flexibility. The following is the recommended format for the work plan; begin this section on a new page. **DO NOT include proprietary information.**

a) <u>1.0 – Objective</u>: This section is intended to provide a brief overview of thespecialty area. It should explain the purpose and expected outcome.

b) 2.0 – Scope: This section should provide a concise description of the work to beaccomplished, including the technology area to be investigated, goals, and majormilestones. The key elements of this section are task development and deliverables, i.e., the anticipated end result and/or the effort's product. This section must also be consistent with the information in Section 4.0 below.

c) 3.0 – Background: The offeror shall identify appropriate specifications, standards, andother documents applicable to the effort. This section includes information or explanation for, and/or constraints to, understanding requirements. It may include relationships to previous, current, and/or future operations. It may also include techniques previously determined ineffective.

d) 4.0 – Task/Technical Requirements: The detailed individual task descriptions must be developed in an orderly progression with sufficient detail to establish overall program requirements and goals. The work effort must be segregated into major tasks and identified in separately numbered paragraphs.

Each numbered major task should delineate the work to be performed by subtask. The work plan MUST contain every task to be accomplished in definite, realistic, and clearlystated terms. Use "shall" whenever the work plan expresses a binding provision. Use "should" or "may" to express a declaration or purpose. Use "will" when no contractor requirement is involved, i.e., "... power will be supplied by the Government."

(7) **Deliverables:** Include a section clearly describing the specific sample/prototype hardware/ software to be delivered, as well as data deliverables, schedules, and quantities. Be aware of the possible requirement for unique item identification IAW DFARS 252.211-7003, ItemIdentification and Valuation, for hardware. If hardware/ software will be developed but not delivered, provide an explanation. At a minimum, the following reports will be required under ALL Phase II contracts.

a) Scientific and Technical Reports: Rights in technical data, including software, developed under the terms of any contract resulting from a SBIR Announcement generally remain with the contractor. The Government obtains SBIR/STTR data rights in all data developed or generated under the SBIR/STTR contract for a period of 20 years, commencing at contract award. Upon expiration of the 20-year SBIR/STTR license, the Government has Government purpose rights to the SBIR data.

i. Final Report: The draft is due 30 days after Phase II technical effort. The first page of the final report will be a single-page project summary, identifying the work's purpose, providing a brief description of the effort accomplished, and listing potential result applications. The summary may be published by DoD. Therefore, it must not contain any proprietary or classified information. The

remainder of the report should contain details of project objectives met, work completed, results obtained, and technical feasibility estimates.

ii. Status Reports: Status reports are due quarterly at a minimum.

b) Additional Reporting: AF may require additional reporting documentation including:

i. Software documentation and users' manuals;
ii. Engineering drawings;
iii. Operation and maintenance documentation
iv. Safety hazard analysis when the project will result in partial ortotal development and delivery of hardware; and
v. Updates to the commercialization results.

(8) **Related Work:** Describe significant activities directly related to the proposed effort, including any previous programs conducted by the Principal Investigator, proposing firm, consultants, or others, and their application to the proposed project. Also list any reviewersproviding comments regarding the offeror's knowledge of the state-of-the-art in the specificapproach proposed.

(9) Company Commercialization Report (CCR)/Commercialization Potential:

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

b) The DoD requires a commercialization plan be submitted with the Phase II proposal,specifically addressing the following questions:

i. What is the first planned product to incorporate the proposed technology?
ii. Who are the probable customers, and what is the estimated market size?
iii. How much money is needed to bring this technology to market and how will it be raised?
iv. Does your firm have the necessary marketing expertise and, if not, how will your firm compensate?
v. Who are the probable competitors, and what price/quality advantage is anticipated by your firm.

c) The commercialization strategy plan should briefly describe the commercialization potential for the proposed project's anticipated results, as well as plans to exploit it. Commercial potential is evidenced by:

i. The existence of private sector or non-SBIR/STTR Governmentalfunding sources demonstrating commitment to Phase II efforts/results.
ii. The existence of Phase III follow-on commitments for the research subject.
iii. The presence of other indicators of commercial technology potential,including the firm's commercialization strategy.

d) If awarded a D2P2, the contractor is required to periodically update the commercialization results of the project via SBA. These updates will be required at completion of the effort, and subsequently when the contractor submits a new SBIR/STTR proposal to DoD. Firms not submitting a new proposal to DoD will be requested to provide updates annually after the D2P2 completion.

(10) **Military Applications:** Briefly describe the existing/potential military requirement and the military potential of the SBIR/STTR Phase II results. Identify the DoD agency/organization most likely to benefit from the project. State if any DoD agency has expressed interest in, or commitment to, a non-SBIR, Federally funded Phase III effort. This section should include not more than one to two paragraphs. Include agency point of contact names and telephone numbers.

(11) **Relationship with Future R/R&D Efforts**:

i. State the anticipated results of the proposed approach, specifically addressing plans for Phase III, if any.

ii. Discuss the significance of the D2P2 effort in providing a basis for the Phase III R/R&D effort, if planned.

D. **Key Personnel:** In the technical volume, identify all key personnel involved in the project. Include information directly related to education, experience, and citizenship. Atechnical resume for the Principal Investigator, including publications, if any, must also be included. Concise technical resumes for subcontractors and consultants, if any, are also useful. Identify all non-U.S. citizens expected to be involved in the project as direct employees, subcontractors, or consultants. For these individuals, in addition to technical resumes, please provide countries of origin, type of visas or work permits held, and identify the tasks they are anticipated to perform.

Foreign Nationals (also known as Foreign Persons) means any person who is NOT:

a. a citizen or national of the United States; or
b. a lawful permanent resident; or
c. a protected individual as defined by 8 U.S.C. § 1324b

ALL offerors proposing to use foreign nationals MUST follow the DoD 23.3 BAA and disclose this information regardless of whether the topic is subject to ITAR restrictions.

When the topic area is subject to export control, these individuals, if permitted to participate, are limited to work in the public domain. Further, tasks assigned must not becapable of assimilation into an understanding of the project's overall objectives. This prevents foreign citizens from acting in key positions, such as Principal Investigator, Senior Engineer, etc. Additional information may be requested during negotiations in order to verify foreign citizens' eligibility to perform on a contract awarded under this BAA.

The following will apply to all projects with military or dual-use applications developing beyond fundamental research (basic and applied research ordinarily published and sharedbroadly within the scientific community):

(1) The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, andthe Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of (including deemed exports) hardware, technical data,and software, or for the provision of technical

assistance.

(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where thework is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technologies,including technical data or software.

(3) The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

(4) The Contractor shall be responsible for ensuring that these provisions apply to its subcontractors.

E. **<u>Facilities/Equipment</u>:** Describe instrumentation and physical facilities necessary and available to carry out the D2P2 effort. Justify equipment to be purchased (detail in cost proposal). State whether proposed performance locations meet environmental laws andregulations of Federal, state, and local Governments for, but not limited to, airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulkwaste disposal practices, and handling and storage of toxic and hazardous materials.

F. **<u>Consultants/Subcontractors</u>**: Private companies, consultants, or universities may be involved in the project. All should be described in detail and included in the cost proposal. In accordance with the Small Business Administration (SBA) SBIR Policy Directive, <u>a minimum of 50% of the R/R&D must be performed by the proposing firm</u>, unless otherwise approved in writing by the Contracting Officer. These requests can only be made upon proposal submission. Signed copies of all consultant or subcontractor letters of intent must be attached to the proposal. These letters should briefly state the contribution or expertise being provided. Include statements of work and detailed cost proposals. Include information regarding consultant or subcontractor unique qualifications. Subcontract copies and supporting documents do not count against the Phase II page limit. Identify any subcontract/consultant foreign citizens per E above.

G. <u>Prior, Current, or Pending Support of Similar Proposals or Awards</u>:
WARNING: While it is permissible, with proper notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work forconsideration under numerous Federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. Any potential for this situation must be disclosed to the solicitation agency(ies) before award. If a proposal submitted in response to this BAA is substantially the same as another proposal previously, currently, or in the process of being funded by another Federal agency/DoD Component or the DAF, the offeror must so indicate on the Cover Sheet and provide the following:

a) The name and address of the Federal agency(ies) or DoD Component(s) towhich proposals were or will be submitted, or from which an awarded is expected or has been received;
b) The proposal submission or award dates;
c) The proposal title;
d) The PI's name and title for each proposal submitted or award received; and
e) Solicitation(s) title, number, and date under which the proposal was or

will besubmitted, or under which an award is expected or has been received.

f) If award was received, provide the contract number.
g) Specify the applicable topics for each SBIR proposal submitted or award received.

NOTE: If this section does not apply, state in the proposal, “No prior, current, or pending support for proposed work.”

COST VOLUME (VOLUME 3)

A detailed cost proposal must be submitted. Cost proposal information will be treated as proprietary. Proposed costs must be provided by both individual cost element and contractor fiscal year (FY) in sufficient detail to determine the basis for estimates, as well as the purpose, necessity, and reasonableness of each. This information will expedite award if the proposal is selected. Generally, Firm-Fixed-Price contracts are appropriate for Phase II awards. In accordance with the SBA SBIR/STTR Policy Directive, Phase II contracts must include profit or fee.

Cost proposal attachments do not count toward proposal page limitations. The cost proposalincludes:

a) **Direct Labor:** Identify key personnel by name, if possible, and labor category, if not. Direct labor hours, labor overhead, and/or fringe benefits, and actual hourly rates for each individual are also necessary for the CO to determine whether these hours, fringe rates, and hourly rates are fair and reasonable.

b) **Direct Cost Materials:** Costs for materials, parts, and supplies must be justified and supported. Provide an itemized list of types, quantities, prices, and, where appropriate, purpose. If computer or software purchases are planned, detailed information such as manufacturer, price quotes, proposed use, and support for theneed will be required.

c) **Other Direct Costs:** This includes specialized services such as machining or milling, special test/analysis, and costs for temporary use/lease of specialized facilities/ equipment. Provide usage (hours) expected, rates, and sources, as well as brief discussion concerning the purpose and justification. Proposals including leased hardware must include an adequate lease versus purchase rationale.

d) **Special Tooling, Special Test Equipment, and Material:** The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness to the work proposed. Special tooling and special test equipment purchases must, in the CO’s opinion, be advantageous to the Government and relate directly to the effort. These toolings or equipment should not be of a type that an offeror would otherwise possess in the normal course of business. These may include such items as innovative instrumentation and/or automatic test equipment.

e) **Subcontracts:** Subcontract costs must be supported with copies of subcontract agreements. Agreement documents must adequately describe the work to be performed and cost bases. The agreement document should include a SOW, assignedpersonnel, hours and rates, materials (if any), and proposed travel (if any). A letter from the subcontractor agreeing to perform a task or tasks at a fixed price is not considered sufficient. 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, unless otherwise approved in writing by the Contracting Officer.

The prime contractor must accomplish price analysis, including reasonableness, of the proposed subcontractor costs. If based on comparison with prior efforts, identify the basis upon which the prior prices were determined reasonable. If price analysis techniques are inadequate or the FAR requires subcontractor cost or pricing data submission, provide a cost analysis. Cost analysis includes but is not limited to, consideration of materials, labor, travel, other direct costs, and proposed profit rates.

f) **<u>Consultants</u>:** For each consultant, provide a separate agreement letter briefly stating the service to be provided, hours required, and hourly rate, as well as ashort, concise resume.

g) **<u>Travel</u>:** Each effort should include, at a minimum, a kickoff or interim meeting. Travel costs must be justified as required for the effort. Include destinations, numberof trips, number of travelers per trip, airfare, per diem, lodging, ground transportation, etc. Per Diem and lodging rates may be found in the Joint Travel Regulation (JTR),Volume 2, www.defensetravel.dod.mil.

h) **<u>Indirect Costs</u>:** Indicate proposed rates' bases, e.g., budgeted/actual rates per FY, etc. The proposal should identify the specific rates used and allocation bases to which they are applied. Do not propose composite rates; proposed rates and applications per FY throughout the anticipated performance period are required.

i) **<u>Non-SBIR Governmental/Private Investment</u>:** Non-SBIR Governmental and/or private investment is allowed. However, it is not required, nor will it be a proposal evaluation factor.

NOTE: If no exceptions are taken to an offeror's proposal, the Government may award a contract without exchanges. Therefore, the offeror's initial proposal should contain the offeror's best terms from a cost or price and technical standpoint. If there are questions regarding the award document, contact the Phase I CO identified on the cover page. The Government reserves the right to reopen negotiations later if the CO determines doing so to be necessary.

<u>COMPANY COMMERCIALIZATION REPORT (VOLUME 4)</u>

Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD SBIR 23.3 BAA for full details on this requirement. Information contained in the CCR will not be considered by the Air Force during proposal evaluations.

<u>SUPPORTING DOCUMENTS VOLUME (VOLUME 5)</u>

The following documents are required for all proposal submissions:

1. Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1 to the DOD SBIR 23.3 BAA)

2. Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Attachment 2 to the DOD SBIR 23.3 BAA)
3. Disclosure of Funding Sources (Attachment 4 to the DOD SBIR 23.3 BAA)

The following documents may be required if applicable to your proposal:
1. DD Form 2345: For proposals submitted under export-controlled topics, either International Traffic in Arms or Export Administration Regulations (ITAR/EAR), a copy of the certified DD Form 2345, Militarily Critical Technical Data Agreement, or evidence of application submission must be included. The form, instructions, and FAQs may be found at the United States/Canada Joint Certification Program website, http://www.dla.mil/HQ/InformationOperations/Offers/Products/LogisticsApplications/JCP/DD2315Ins tructions.aspx. DD Form 2315 approval will be required if proposal if selected for award.
2. Verification of Eligibility of Small Business Joint Ventures (Attachment 3 to the DOD SBIR 23.3 BAA)
3. Technical Data Rights Assertions (if asserting data rights restrictions)

Feasibility Documentation (required for all proposal submissions)
1. Offerors must adequately document completion of the Phase I feasibility requirement*. Offerors must demonstrate completion of R/R&D through means not solely based on previous efforts under the SBIR/STTR Programs to establish Phase II proposal feasibility based on criteria provided in the D2P2 topic descriptions. Phase II proposals require a comprehensive, detailed effort description. Proposals should demonstrate sufficient technical progress or problem-solving results to warrant more extensive RDT&E. Developing technologies with commercial and military potential is extremely important. Particularly, AF is seeking proposals emphasizing technologies' dual-use applications and commercialization.
2. * NOTE: The offeror shall provide information to enable the agency to make the 15 U.S.C. 638(cc) determination of scientific and technical feasibility and merit. Offerors are required to provide information demonstrating scientific and technical merit and feasibility has been established as part of the Technical Volume (Volume 2). The DAF will not review the Phase II proposals if it is determined the offeror 1) fails to demonstrate technical merit and feasibility are established or 2) the feasibility documentation does not support substantial performance by the offeror and/or the PI. Refer to the Phase I description within the topic to review the minimum requirements needed to demonstrate scientific and technical feasibility. **Feasibility documentation MUST NOT be solely based on work performed under prior or ongoing Federally-funded SBIR or STTR work.**
3. If appropriate, include a reference or works cited list as the last page.
4. Feasibility efforts detailed must have been substantially performed by the offeror and/or the PI. If technology in the feasibility documentation is subject to intellectual property (IP) rights, the offeror must provide IP rights assertions. Additionally, proposers shall provide a short summary for each item asserted with less than unlimited rights describing restriction's nature and intellectual property intended for use in the proposed research. Please see DoD SBIR 23.3 BAA for technical data rights information.
5. DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated.

FRAUD, WASTE, AND ABUSE TRAINING (VOLUME 6)

Note that the FWA Training must be completed prior to proposal submission. When training is complete and certified, DSIP will indicate completion of the Volume 6 requirement. The proposal cannot be submitted until the training is complete.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The DAF does not participate in the Discretionary Technical and Business Assistance (TABA) Program. Proposals submitted in response to DAF topics should not include TABA.

METHOD OF SELECTION AND EVALUATION CRITERIA

D2P2 proposals are evaluated on a competitive basis by subject matter expert (SME) scientists, engineers, or other technical personnel. Throughout evaluation, selection, and award, confidential proposal and evaluation information will be protected to the greatest extent possible. D2P2 proposals will be disqualified and not evaluated if the Phase I equivalency documentation does not establish the proposed technical approach's feasibility and technical merit.

Proposals will be evaluated for overall merit in accordance with the criteria discussed in the 23.3 BAA.

In accordance with Section 4 of the SBIR and STTR Extension Act of 2022, the DAF will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. The DAF will use information provided by the small business concern in response to the Disclosure of Foreign Affiliations or Relationships to Foreign Countries and the proposal to conduct a risk-based due diligence review on the cybersecurity practices, patent analysis, employee analysis, and foreign ownership of a small business concern, including the small business concern and employees of the small business concern to a foreign country, foreign person, foreign affiliation, or foreign entity. The DAF will also assess proposals utilizing open-source analysis and analytical tools, for the nondisclosures of the information set forth in 15 U.S.C. 638(g)(13). If DAF assesses that a small business concern has security risk(s), DAF will review the proposal, the evaluation, and the security risks and may choose to either 1) create a plan to mitigate the risk(s) or 2) DAF may decide not to select the proposal for award based upon a totality of the review.

DAF USE OF SUPPORT CONTRACTORS

Restrictive notices notwithstanding, proposals may be handled for administrative purposes only, by support contractors: APEX, Peerless Technologies, Engineering Services Network, HPC- COM, Mile Two, REI Systems, MacB (an Alion company), Montech, Oasis, and Infinite Management Solutions. In addition, only Government employees and technical personnel from Federally Funded Research and Development Centers (FFRDCs) MITRE and Aerospace Corporations working under contract to provide technical support to AF Life Cycle Management Center and Space Force may evaluate proposals. All support contractors are bound by appropriate non-disclosure agreements. **Contact the AF SBIR/STTR Contracting Officer (Daniel.Brewer.13@us.af.mil) with concerns about any of these contractors**.

PROPOSAL STATUS AND FEEDBACK

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

Automated feedback will be provided for proposals designated Not Selected. Additional feedback may be provided at the sole discretion of the DAF.

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

The Air Force anticipates that all proposals will be evaluated and selections finalized within approximately 90 calendar days of solicitation close. Please refrain from contacting the BAA CO for proposal status before that time.

Refer to the DoD SBIR Program BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Air Force SBIR/STTR Contracting Officer Daniel J. Brewer, Daniel.Brewer.13@us.af.mil.

AIR FORCE SUBMISSION OF FINAL REPORTS
All Final Reports will be submitted to the awarding DAF organization in accordance with Contract instructions. Companies will not submit Final Reports directly to the Defense Technical Information Center (DTIC).

Air Force SBIR 23.3 Direct to Phase II Topic Index

Topic Number	Topic Name	Maximum Value*	Maximum Duration** (in months)	Technical Volume Page Limit***
SF233-D001	Miniature Smart Satellite Threat Warning Sensor	$1,900,000.00	24	35
AF233-D002	Aircraft Vibration Harvester (AVH)	$1,760,000.00	27	35
AF233-D003	Novel high resolution distributed radar processing for littoral and open ocean environments	$1,760,000.00	24	35
SF233-D004	Uncertainty Management for Space Domain Awareness of Non-Standard Threats	$1,900,000.00	24	35
AF233-D005	Ultra-High Laser Damage Threshold Broad Bandwidth Anti-Reflection Treatments	$1,760,000.00	24	35
SF233-D006	Aircraft avoidance for small telescopes using passive detection	$1,900,000.00	24	35
SF233-D007	Laser pre-compensation to improve sodium beacon coherence	$1,900,000.00	24	35
AF233-D008	AR for Equipment Maintenance	$1,760,000.00	24	35
AF233-D009	Robotic Defastening	$1,760,000.00	24	35
AF233-D010	Field-level Detection of Hydraulic Fluid Contamination in Jet Fuel	$1,760,000.00	24	35
AF233-D011	Functional Gradient Coatings for Landing Gear	$1,760,000.00	24	35
AF233-D012	Materials for High-Temperature Performance Electronics: Memory and Packaging	$1,760,000.00	24	35
AF233-D013	Development of New Oxidation Resistant Refractory Alloys for Additively Manufactured (AM) Components	$1,760,000.00	24	35
AF233-D014	Advanced Nano-Composite Radiation Shielding Manufacturing	$1,760,000.00	24	35
AF233-D015	Manufacturing of Nitrogen Vacant (NV) Diamond Substrates for Quantum Sensors	$1,760,000.00	24	35
AF233-D016	Technical Data Package (TDP) Modernization for As-Built Data	$1,760,000.00	24	35
AF233-D017	Next-Generation SAL Pulse Code	$1,760,000.00	24	35

AF233-D018	Conformal Forward Looking Multi-Aperture Seeker for High Speed EO/IR Demonstrator	$1,760,000.00	24	35
AF233-D019	Hardened Scalar and Vector Magnetometer Development	$1,760,000.00	24	35
AF233-D020	Real-time Sensor Fusion ATA in Golden Horde Colosseum	$1,760,000.00	24	35
AF233-D021	Subscription-Based, Real-Time UAS Detection, Tracking, and Identification	$1,760,000.00	15	35
AF233-D022	Austere Cargo Offload and Onload System	$1,760,000.00	15	35
AF233-D023	TAK Mobile Machine Learning (MML) Model Development	$1,760,000.00	24	35
AF233-D024	Integration of Machine Learning (ML) Platforms with a Mobile Device Manager (MDM) for the TAK Ecosystem	$1,760,000.00	24	35
AF233-D025	Improved Data Collection and Knowledge Graphing in the TAK Ecosystem	$1,760,000.00	24	35
AF233-D026	OptiFrame Topology Optimized Load-Bearing Airframe with Additive Manufacturing	$1,760,000.00	24	35
AF233-D027	GPU Accelerated Large Eddy Simulation for Low Pressure Turbine Design	$1,760,000.00	24	35
AF233-D028	Video Imaging for Patrol and Emergency Management	$1,760,000.00	24	35
AF233-D029	Low-Loss Magnetless Optical Isolators for Quantum Integrated Photonics Applications	$1,760,000.00	24	35
AF233-D030	Autonomous Airfield Repair Robotics Swarm Platform	$1,760,000.00	24	35
AF233-D031	Rapid Fly Mobile UAS	$1,760,000.00	24	35

***Proposals that exceed this amount will be disqualified**
**** Proposals that exceed this duration will be disqualified**
*****Pages in excess of this count will not be considered during evaluations**

SF233-D001 TITLE: Miniature Smart Satellite Threat Warning Sensor

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

OBJECTIVE: Brass-board level demonstration of a low SWaP smart multi-threat warning autonomous sensor with an extremely low false alarm rate. The design must have inherent manufacturing-friendly characteristics and be launch- and space-qualified for the SDA transport and tracking constellations in low earth orbit (LEO).

DESCRIPTION: Miniature Smart satellite threat warning sensor: Brass-board level demonstration of a low SWaP smart multi-threat warning autonomous sensor with an extremely low false alarm rate. The design must have inherent manufacturing-friendly characteristics and be launch- and space-qualified for the SDA transport and tracking constellations in low earth orbit (LEO).

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. "Phase 1-type" feasibility documentation for this DP2 effort consists of: a.) List of threat sensor microelectronic components and structural materials that have either flown in LEO or can be space certified within the work period. b.) Identifying machine learning software modifiable for whatever threat sensor suite is chosen. c.) Candidate list of low-power space-qualified processors. d.) Conceptual sketches to scale of minimum SWaP earth pointing observing system providing coarse quadrant angle-of-arrival of DEW threats and an Omni-directional burst signal warning communication capability to initiate threat warning relay throughout the SDA tranche constellations.

PHASE II: At Phase II, a laboratory brass-board demonstration is undertaken in a vacuum chamber with suitable access ports to stimulate the threat sensor prototype system with low-power threat-based RF and laser signals. A test plan will be devised and approved by the government before the demonstration. In addition, a draft manufacturing plan proving the capability to build the intelligent threat sensor system with minimal SWaP and ease of installation on spacecraft designs for SDA Tranches. A follow-up program (Phase III) draft flight test plan to examine sensor performance utilizing national ranges' resources to evaluate the system's LEO space environmental endurance and low false alert rate. The threat sensor system can only assume that the proposed spacecraft designs can only provide unregulated power and structural attachment.

PHASE III DUAL USE APPLICATIONS: Threat warning systems are valuable to commercial constellation systems for failure diagnostics. Commercial ISR services provide useful information to both the IC and DoD and commercial customers. Phase III is envisioned as a joint government and commercial-funded flight test experiment.

REFERENCES:

1. Hilland, Dave, et al., “Satellite Threat Warning and Attack Reporting,” IEEE Aerospace Conference, 1998 Obal, Michael, et al.,” The Satellite Attack Warning and Assessment Flight Experiment (SAWAFE),” AGARD Conference Proceeding 531 on Smart Structures for Aircraft and Spacecraft, Lindau, Germany, Oct 1992 Moss, C.E. et al.,” A Space Fiber-Optic X-ray Burst Detector,” LA-UR-1993-3807

KEYWORDS: RF; DEW; lasers; threat warning; machine learning; low power space-qualified processors; manufacturability

AF233-D002 TITLE: Aircraft Vibration Harvester (AVH)

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

OBJECTIVE: Develop and manufacture an energy harvesting system to be used in airborne applications.

DESCRIPTION: Current solutions for installing instrumentation systems on flight-test aircrafts are time consuming, consist of large amounts of cabling, and require extensive aircraft downtimes. Generating electrical power near instrumentation sensors reduces the need to install wiring dedicated for power. Also, locally generated power can be used to power wireless systems that can wirelessly connect the sensor to the data acquisition system. Thus, reducing the need to install dedicated signal wiring for the sensor. Reducing the need for dedicated power and sensor wiring will reduce aircraft downtimes during instrumentation installations. Previous research has demonstrated an energy harvesting system that included a piezoelectric structure with a power conditioning circuit. Any solutions must have the following capabilities: 1. Self-tunable frequency range of 85 Hz to 200 Hz 2. Output voltage of 12 to 28 VDC 3. Output power of 650 mW to 9500 mW 4. Comply with Air Force Airworthiness standards 5. Comply with Air Force environmental testing The AVH system will be available for flight testing at least 6 months prior to the end of the Period of Performance. The system shall be at a Technical Readiness Level (TRL) of 6 at this time. If a test aircraft is available, the 812 Aircraft Instrumentation Test Squadron will be responsible for installing the energy harvesting system in the test aircraft.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. No Phase I SBIR is necessary as this topic is intended to compete for a Direct-to-Phase-2 (D2P2) topic. The ability to test the proof-of-concept directly on an aircraft and increase the Test Readiness Level (TRL) based off the existing findings and developments is fundamental, which can only be implemented through a D2P2. Furthermore, testing and evaluating the system is highly desired in this environment and needs to be executed for refining parameters, increasing the overall system power generation, and interfacing with sensors in a relevant application. Flight worthiness is crucial for this design; deliverables include being able to demonstrate the feasibility in converting vibrations similar in amplitude to an aircraft’s and generate energy through sufficient studies, analysis of solutions, and lab experiments/procedures.

PHASE II: Develop and manufacture an energy harvesting system that can withstand airborne environments associated with high performance military aircraft. Obtain a TRL of 6 based on Air Force standards and ready to test in an airborne operational environment.

PHASE III DUAL USE APPLICATIONS: Military Application: Energy harvesting system to provide electrical power generation to be used for wireless sensors in an airborne application. Commercial Application: Harvest energy in commercial environments, such as in the auto industry or other vehicular applications.

REFERENCES:

1. Samson, D.; Energy Harvesting for Autonomous Wireless Sensor Nodes in Aircraft. Procedia Engineering, Sept 2010 ;
2. Seah, W.; Wireless Sensor Networks Powered by Ambient Energy Harvesting (WSN-HEAP) – Survey and Challenges. Institute for Infocomm Research, May 2009

KEYWORDS: Energy Harvester; Aircraft Energy Harvester; Aerospace Energy Harvester; Piezoelectric;

Vibration Energy; Vibration Harvester; Aircraft Power Piezoelectric; Sensor Vibration Harvester

AF233-D003 TITLE: Novel high resolution distributed radar processing for littoral and open ocean environments

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

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

OBJECTIVE: The objective is to develop novel signal processing for distributed radar operation over open ocean and littoral regions. A team of radar platforms will operate collaboratively with the purpose (threshold) of detecting, tracking, geolocating and imaging with sufficient quality (objective) to enable classifying and identifying surface targets. Operating collaboratively means overlap of beam patterns from different platforms. It is important to be able to work in conjunction with legacy radar systems. It is anticipated that this type of processing technology could enable sensing on airborne platforms of various classes operating over the ocean.

DESCRIPTION: Develop combined distributed radar system-of-system concepts for surveillance of littoral and open ocean environments. Emphasis will be on signal processing techniques, geolocation, and imaging.

PHASE I: This is a Direct to Phase II SBIR. Offerors are expected to demonstrate relevant past experience and subject matter expertise. Offerors should list past projects and programs connect with bistatic radar.

PHASE II: Accurate geolocation over ocean is of particular interest. In addition to geolocation, it is expected that offerors will be able to perform imaging of surface targets, both for pitching and rolling inverse synthetic aperture radar (ISAR) conditions and for ships in calm waters. Basic processing requirements are detection, short time tracking within a coherent dwell (generally less than 10 seconds), motion stabilization, geolocation and imaging. The scope of Phase II does not extend to classification or identification of images produced. Efficiency of algorithms is important in order to make use of low cost, size, weight and power (low C-SWAP) platforms. Offerors are expected to develop simulated data to prove out algorithms as part of the effort, and the government may additionally supply measured data to process.

PHASE III DUAL USE APPLICATIONS: Coastal monitoring of commercial sea traffic including container ships and tankers. Support for search and rescue activities. Wildlife monitoring including detecting when whales breach the surface. Monitoring of commercial fisheries and fleets operating in those locations. Monitoring oil spills and ecological disasters.

REFERENCES:

1. Jakowatz, Wahl, Eichel, Ghiglia, Thompson, “Spotlight-Mode Synthetic Aperture Radar: A Signal Processing Approach”, Springer, 1996, Section 2.7, Tomographic Development of Bistatic SAR.

KEYWORDS: Bistatic Radar; Inverse Synthetic Aperture Radar; ISAR; SAR; Synthetic Aperture Radar; Open Ocean Surveillance; Littoral; Brown Ocean; Blue Ocean; Geolocation

SF233-D004 TITLE: Uncertainty Management for Space Domain Awareness of Non-Standard Threats

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Space Technology

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

OBJECTIVE: The objective of this topic is to develop algorithms and methodology to allow for better uncertainty propagation of beyond-GEO trajectories, which are subjected to more highly nonlinear dynamics, stochastic excitation, and uncertain initial conditions than typical GEO-and-below trajectories.

DESCRIPTION: One of the significant technical challenges in space domain awareness is the accurate and consistent propagation of uncertainty for objects governed by highly nonlinear dynamics with stochastic excitation and uncertain initial conditions. This challenge is even greater in the beyond-GEO region where three-body gravity becomes significant, resulting in the dynamics being more nonlinear. Additionally, the increased distance between an Earth-based sensor and the object reduces the apparent motion between them, resulting in little independent information to initialize an orbit. The initial uncertainties in xGEO orbits are therefore highly non-Gaussian, which inhibits the effectiveness of traditional propagation and filtering methods. Orbits within this area of regard enable low-cost options for spacecraft to rapidly alter course and threaten terrestrial and space-based assets. Being able to accurately understand and propagate the uncertainty of objects within this area is necessary to assess whether they pose a threat.

PHASE I: This is a Direct to Phase 2 (D2P2) topic. Phase 1 proposals will not be evaluated and will be rejected. For this D2P2 topic, the Government expects that the small business would have accomplished the following in a Phase I-type effort via some other means (e.g. IRAD, or other funded work). It must have developed a concept for a workable prototype or design to address at a minimum the basic capabilities of the stated objective. Proposal must show, as appropriate to the proposed effort, a demonstrated technical feasibility to meet the capabilities of the stated objective. The documentation provided must substantiate that the proposer's technology is currently at an acceptable stage to be funded at the D2P2 level. Documentation may include reports demonstrating prior work demonstrating feasibility, results of prior efforts, success criteria of a prototype, or any other relevant documentation as applicable.

PHASE II: Develop algorithms and methodology to characterize uncertainty propagation, including contribution of higher-order moments, of xGEO trajectories. Identify uncertainty propagation behavior in presence of variety of mission profiles, including low-thrust, long-duration maneuvers, quasi-periodic trajectories, and Lyapunov and transfer orbits. Evaluate uncertainty propagation across sensor exclusion and occultation geometries and assess impact of maneuvers in this space. Identify sensor network placement and tasking strategies to maximize information gain of xGEO objects and satisfy object custody requirements. Identify and develop estimation techniques applicable to the identified uncertainty distributions. Evaluate the resultant uncertainty from initial orbit determination as well as catalog maintenance (filtering) algorithms.

PHASE III DUAL USE APPLICATIONS: Develop a strategy to transition prototype residual capabilities and incremental proliferation based on operational USSF requirements.

REFERENCES:

1. T. Wolf, E.M. Zucchelli and B. A. Jones, "Multi-Fidelity Uncertainty Propagation for Objects in Cislunar Space," AIAA 2022-1774. AIAA SCITECH 2022 Forum. January 2022;
2. C. Freuh, K. Howell, K.J. DeMars, S. Bhadauria, and M. Gupta, "Cislunar Space Traffic Management: Surveillance Through Earth-Moon Resonance Orbits," 8th European Conference on Space Debris, ESA Space Debris Office, Darmstadt, Germany, Apr. 2021;
3. M.R. Thompson, N.P. Re, C. Meek, and B. Cheetham, "Cislunar Orbit Determination and Tracking via Simulated Space-Based Measurements," Advanced Maui Optical and Space Surveillance Conference, Maui, HI, Sept. 2021

KEYWORDS: beyond-GEO; xGEO; cislunar; space traffic management; space domain awareness; uncertainty propagation; orbit determination; space sensor tasking

AF233-D005 TITLE: Ultra-High Laser Damage Threshold Broad Bandwidth Anti-Reflection Treatments

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

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

OBJECTIVE: Develop and demonstrate an anti-reflection treatment for tungstate laser materials with a surface optical damage threshold exceeding 50 Joules per square cm in 10 nanosecond pulses over three separate wavebands (500-700 nm, 1000-1500 nm, 2000-5000 nm)

DESCRIPTION: Nonlinear optical materials are key components in modern high-intensity laser systems which require very high damage threshold anti-reflection treatments. Conventional multi-layer dielectric coatings are frequently prone to surface damage, especially when required to be effective over a wide spectral range. Stress within multilayer dielectrics often leads to failure during temperature cycling, especially over an extended timeframe. These issues are accentuated when higher-order optical nonlinearities are needed, as these require increased optical intensities to drive the nonlinearity. Third-order nonlinearities, such as direct third harmonic generation, Raman generation, and Stimulated Brillouin Scattering (SBS) are frequently difficult to employ in real-world laser systems due to the excessive pump intensities needed to drive the nonlinearity with high efficiency without incurring surface optical damage to the laser components. The frequently required broad bandwidths needed to encompass pump and emission wavelengths at high intensities is extremely challenging for conventional dielectric coating technology. A preferable option would be to develop anti-reflection treatments based on surface texturing. This approach provides a technical path to achieving surface optical damage thresholds that approach those of the internal bulk material. Anti-reflection treatments based on surface texturing comprise a dense “forest” of microscopic rod or cone-like structures which are etched into the surface of an optical component. The morphology of these structures varies and may be regularly spaced structures of identical size (often referred to a “moth eye” structures) or may be random in size and density within prescribed dimension bounds (called Random Anti-Reflection, or “RAR” structures). The process for creating these structures varies considerably according to the specific optical materials involved. This topic seeks to develop surface anti-reflection treatments specifically for tungstate based third order nonlinear optical media, such as potassium gadolinium tungstate (KGW). The goal is to demonstrate surface optical damage thresholds exceeding 50 Joules per square cm for laser pulse widths in the nanosecond regime (e.g. 10 ns). Three separate spectral regions are sought; 500-700 nm, 1000-1500 nm, 2000-5000 nm, each designed for normal incidence operation. The spectral coverage may be three separate surface treatment designs, but a single design to span all three spectral regions would also be acceptable. The reflectivity at normal incidence should not exceed 1% at any wavelength of interest, with a goal of less that 0.5%.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. Qualifying “Phase I-type” efforts would include the prior design, development, and demonstration of surface textured anti-reflection treatments for broadly transparent solid state laser media with a damage threshold of 10 Joules per square cm, or greater, for nanosecond type pulse durations. Examples of appropriate laser media include yttrium aluminum garnet (YAG), yttrium lithium fluoride (YLF), potassium gadolinium tungstate (KGW), and zinc selenide (ZnSe), with broad band reflection values of less than 1 % peak across an optical bandwidth of at least 20% of the design center wavelength. For example, 200 nm bandwidth of anti-reflection treatment with less than 1% reflectivity at normal incidence from 900 nm to 1100 nm with a damage threshold of 10 Joules per square cm, or greater, would qualify as a "Phase I-type" effort.

PHASE II: This topic seeks to develop surface anti-reflection treatments specifically for tungstate based third order nonlinear optical media, such as potassium gadolinium tungstate (KGW). The goal is to demonstrate surface optical damage thresholds exceeding 50 Joules per square cm for laser pulse widths in the nanosecond regime (e.g. 10 ns). Three separate spectral regions are sought; 500-700 nm, 1000-1500 nm, 2000-5000 nm, each designed for normal incidence operation. The spectral coverage may be three separate surface treatment designs, but a single design to span all three spectral regions would be acceptable. The reflectivity at normal incidence should not exceed 1% at any wavelength of interest, with a goal of less than 0.5%. The demonstration should be initially characterized using small scale samples of KGW (to be sourced by the awardee), and then demonstrated at both ends of KGW rods, 5 mm square by at least 50 mm long. Demonstrate that all topic goals are met and develop a plan to scale to 25 mm or larger diameter rods. Deliver five rods of AR treated KGW at all three wavebands of interest.

PHASE III DUAL USE APPLICATIONS: Develop scaling and manufacturing capability for anti-reflection treatments in KGW with crystal apertures exceeding 25mm in diameter and at least 50mm in length. Identify and procure samples of KGW, or similar, in sufficient sizes to meet these requirements, and verify optical damage threshold of the completed crystals exceeds 50 J per square cm in 10 ns pulses across each of the three wavebands of interest (500-700 nm, 1000-1500 nm, 2000-5000 nm).

REFERENCES:

1. US Patent 8187481B, "Random texture anti-reflection optical surface treatment"; Stefaan Vandendriessche, Gregg Fales, Jim Nole, "Laser Optics: Antireflection nanotextures for laser optics go commercial", Laser Focus World, Article 16546961, September 2016;
2. B Mousavi, A Mousavu, T Busani, M Zadeh, S Brueck, "Nanostructured Anti-Reflection Coatings for Enhancing Transmission of Light", Journal of Applied Mathematics and Physics, 7, 3083-3100, (2019); S McDaniel, D Hobbs, B MacLeod, E Sabatino, P Berry, K Schepler, W Mitchell, and G Cook, "Cr:ZnSe laser incorporating anti-reflection microstructures exhibiting low-loss, damage-resistant lasing at near quantum limit efficiency," Opt. Mater. Express 4, 2225-2232 (2014);
3. https://www.laserfocusworld.com/optics/article/16546961/laser-optics-antireflection-nanotextures-for-laser-optics-go-commercial;
4. https://www.newport.com/medias/sys_master/images/images/hf3/hcf/9134343913502/DS-041801-Nano-Texture-Optics.pdf

KEYWORDS: Motheye; random anti-reflection; SBS; Raman; nonlinear; high laser damage threshold

SF233-D006 TITLE: Aircraft avoidance for small telescopes using passive detection

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE);Space Technology

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

OBJECTIVE: The objective of this project is to develop and demonstrate an aircraft detection and avoidance system that would allow astronomical and space situational awareness observatories and other atmospheric laser operators to avoid accidental illumination of aircraft from eye-hazardous lasers. Specifically, the system would need to be configured in a way that's appropriate for small (e.g., less than 1 meter) telescopes. The objective is to develop the necessary aircraft detection and avoidance components and demonstrate them on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. These components could be demonstrated on government, university, or civilian telescopes.

DESCRIPTION: AFRL supports the US Space Force in researching and developing effective, affordable techniques to identify, track, and characterize satellites in Earth orbit. Radar, although it is expensive to build and operate, works for satellites in low-Earth orbit. However, because of the distances involved, only a few specialized ground-based radars are capable of tracking satellites in geosynchronous orbit. Compared to ground-to-space radars, ground-based optical telescopes are less expensive to build and operate; in addition, they work well for satellites in all orbits. However, atmospheric turbulence limits the resolution and effectiveness of ground-based optical telescopes. Laser-beacon adaptive optics is an established technique to overcome the effects of atmospheric turbulence. However, laser beacons are not usually eye-safe and present a significant hazard to pilots and the safe operation of aircraft. One type of laser beacon that is not hazardous to pilots is ultraviolet (UV) Rayleigh laser beacons. However, UV laser beacons have a number drawbacks. Before discussing these drawbacks, it is helpful to discuss the different types of laser beacons used for adaptive optics. There are two main types of laser beacons used in adaptive optics, Rayleigh beacons and sodium beacons. Rayleigh beacons are formed by scattering light from molecules of nitrogen and oxygen lower in the atmosphere; typical altitudes range from 10 km to 20 km. Pulsed lasers are typically used for Rayleigh beacons so that the light may be sampled from a particular altitude by using a technique called range gating. Because Rayleigh scattering is much stronger for shorter wavelengths of light, common wavelengths for Rayleigh beacons are 355 nm and 532 nm. Typically, the 355 nm (UV) beacons are eye-safe, but the 532 nm (visible) beacons are not eye-safe. Because Rayleigh beacons rely on scattering from air molecules, they are limited to relatively low altitudes where the density of air molecules is higher. Light from the beacon traverses a cone of air above the telescope, with the beacon at the apex of the cone and the telescope pupil at the base of the cone. If a Rayleigh beacon is used for a larger telescope, the cylindrical column of air above the telescope will not be well sampled. Because of this cone effect, Rayleigh beacons are suitable only for smaller telescopes of up to about 2 m in diameter. Sodium beacons are formed from scattering light from a layer of ionic sodium that is centered at an altitude of 90 km above the ground. Because of their high altitude, sodium beacons sample a much larger cone of air when compared to Rayleigh beacons. So, they are better suited for use with large telescopes. So, UV Rayleigh beacons are suited only for smaller telescopes. Now that we have discussed the different types of laser beacons, we can put the drawbacks of UV laser beacons in context. Astronomical telescopes usually use a series of mirrors to reflect and focus light onto sensors.

The best coating for these mirrors, especially in smaller telescopes, is protected silver. However, silver does not reflect UV light efficiently. The reflectivity of typical silver coatings at 355 nm wavelength is about 0.5. A typical AO system at Nasmyth focus would have at least 5 silver-coated mirrors before the wavefront sensor. This mean about 3 percent of the UV light would make it to the wavefront sensor. Now, UV-enhanced silver coatings have much higher reflectivity at 355 nm, but that would required recoating several large mirrors, which would be costly. In addition to the issue with silver-coated mirrors, pulsed UV lasers with good beam quality required for laser beacons do not have sufficient power to form beacons bright enough for observatories with strong turbulence. For most astronomical observatories, this is not a problem, because they are located in places with weak atmospheric turbulence. However, observatories for space situational awareness (SSA) and ground stations for laser communications (lasercom) are typically located in places with stronger atmospheric turbulence. To make matters worse for SSA observatories, when a ground-based telescope tracks a satellite in low-Earth orbit, it must slew quickly across the sky. This, in effect, creates a situation that is equivalent to a strong wind blowing across the aperture of the telescope. This means the adaptive optics system must operate at a higher frame rate and higher gain to compensate for atmospheric turbulence. In addition, there's a growing need for SSA and lasercom systems to operate during the day, which means the atmospheric turbulence is much wors than it is at night. The combination of these factors means a laser beacon for SSA and lasercom purposes must be much brighter than a laser beacon for astronomy. Thus, UV Rayleigh beacons are not ideal for some applications. In the past, observatories have used human aircraft spotters and radar systems to avoid illuminating aircraft. However, human spotters are expensive to employ and they can not observe for long periods of time in potentially very cold weather. In addition, human aircraft spotters have a very difficult time spotting aircraft during the day. As for radar systems, they produce radio-frequency interference, which can adversely affect sensitive electro-optical equipment. Radar systems are expensive to operate, maintain, and calibrate, plus they produce ionizing radiation that is hazardous to personnel. Radar system also have a difficult time detecting aircraft that have a small radar cross-section. One system that meets many of the requirements is the Transponder-Based Aircraft Detector (TBAD). (http://www.aircraft-avoid.com/). However, the TBAD antenna system is too large to install on small-aperture telescopes, which may have domes with relatively small openings. Furthermore, the current antenna format can act as a sail and catch wind, which may cause jitter of the optical telescope. Passive infrared detectors have been developed and used in the past, but these systems were less effective than TBAD. That said, passive infrared detectors do not rely on the aircraft having a transponder, thus they may be able to detect experimental aircraft, such as hang gliders. Thus, AFRL is seeking development of reliable, passive systems that would allow astronomical and space situational awareness observatories and other atmospheric laser operators to avoid accidental illumination of aircraft from eye-hazardous lasers, but is suitable for small telescopes and avoids the issues of telescope jitter due to wind buffeting.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. "Phase I-type" deliverables include a report that describes thoroughly concepts, analyses, and simulations for aircraft avoidance systems that are suitable for SSA ground-to-space imaging applications that use small telescopes. These analyses and simulations must show that the proposed components are effective and affordable. The report should describe the components at a level suitable for a conceptual design review. (See https://en.wikipedia.org/wiki/Engineering_design_process#Concept_Generation) The report shall include a plan for demonstrating the aircraft avoidance systems on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. (Since this is a D2P2 topic, this section describes the content expected to substantiate that the proposer's technology is currently at an acceptable stage to award a D2P2.)

PHASE II: Phase II deliverables include a detailed design of aircraft avoidance systems that are suitable for SSA ground-to-space imaging applications that use small telescopes. This design must illustrate that the proposed components are effective and affordable. The design documents should describe the components at a level suitable for preliminary and critical design reviews. (See https://en.wikipedia.org/wiki/Design_review_(U.S._government)#Preliminary_Design_Review_(PDR), and https://en.wikipedia.org/wiki/Design_review_(U.S._government)#Critical_Design_Review_(CDR)) The report shall include a detailed plan for demonstrating the aircraft avoidance systems on-sky, in conditions that are representative of typical sites that use small telescopes for ground-based observations of earth-orbiting satellites. As cost and schedule constraints allow, a prototype aircraft avoidance system shall be built, tested, and demonstrated on-sky at government, university, or civilian observatory.

PHASE III DUAL USE APPLICATIONS: A Phase III effort would require identifying a suitable transition partner, which could be a government program office, a government contractor or other commercial entity, or a civilian astronomical observatory. Potential phase III applications include other defense SSA observatories in the US, Europe, and Australia; civilian astronomical observatories that wish to observe at visible wavelengths, which requires improved adaptive optics performance; and ground-to-space laser communications research facilities or ground sites.

REFERENCES:

1. A Radio System for Avoiding Illuminating Aircraft with a Laser Beam, Author(s): W. A. Coles, T. W. Murphy Jr., J. F. Melser, J. K. Tu, G. A. White, K. H.Kassabian, K. Bales, B. B. Baumgartner, Source:Publications of the Astronomical Society of the Pacific,Vol. 124, No. 911 (January2012), pp. 42-50;
2. Seán Meenehan, Emily Dunkel, Michael Cheng, "Automatic aircraft avoidance for laser uplink safety," Proc. SPIE 11993, Free-Space Laser Communications XXXIV, 119930S (4 March 2022)

KEYWORDS: laser beacons; adaptive optics; aircraft laser safety; aircraft avoidance

SF233-D007 TITLE: Laser pre-compensation to improve sodium beacon coherence

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE);Space Technology

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

OBJECTIVE: The objective of this project is to develop and demonstrate key components that would increase the spatial coherence of laser beacons (i.e., generate smaller laser beacons) to help improve the performance of adaptive optics systems for ground-to-space imaging applications. The final design should not require a light source external to the system itself (i.e., light from a star or satellite) to preserve the dim object imaging capability of a laser beacon adaptive optics system. For this effort, we are primarily focused on continuous wave sodium beacons in a side-launched or bi-static configuration. That said, pulsed sodium or Rayleigh beacons, are also of interest. The primary focus of this topic is to develop, build, and test the necessary adaptive optics components to achieve reliable pre-compensation of the beacon. It is also highly desired that an on-sky demonstration of the system be completed in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. The system demonstration can be performed on government, university, or civilian telescopes; however, our primary goal is to demonstrate the pre-compensation system on the island of La Palma in the Canary Islands, Spain.

DESCRIPTION: AFRL supports the US Space Force in researching and developing effective, affordable techniques to identify, track, and characterize satellites in Earth orbit. Radar, although it is expensive to build and operate, works for satellites in low-Earth orbit. However, because of the distances involved, only a few specialized ground-based radars are capable of tracking satellites in geosynchronous orbit. Compared to ground-to-space radars, ground-based optical telescopes are less expensive to build and operate; in addition, they work well for satellites in all orbits. However, atmospheric turbulence limits the resolution and effectiveness of ground-based optical telescopes. Laser-beacon adaptive optics is an established technique to overcome the effects of atmospheric turbulence. However, there remain significant challenges to improving the utility and effectiveness of laser beacon adaptive optics for defense applications. There are two main types of laser beacons used in adaptive optics, Rayleigh beacons and sodium beacons. Rayleigh beacons are formed by scattering light from molecules of nitrogen and oxygen lower in the atmosphere; typical altitudes range from 10 km to 20 km. Pulsed lasers are typically used for Rayleigh beacons so that the light may be sampled from a particular altitude using a technique called range gating. Because Rayleigh scattering is much stronger for shorter wavelengths of light, common wavelengths for Rayleigh beacons are 355 nm and 532 nm. Because Rayleigh beacons rely on scattering from air molecules, they are limited to relatively low altitudes where the density of air molecules is higher. Light from the beacon traverses a cone of air above the telescope, with the beacon at the apex of the cone and the telescope pupil at the base of the cone. If a Rayleigh beacon is used for a larger telescope, the cylindrical column of air above the telescope will not be well sampled. Because of this cone effect, Rayleigh beacons are suitable only for smaller telescopes of up to 2 m in diameter. Sodium beacons are formed from scattering light from a layer of ionic sodium that is centered at an altitude of 90 km above the ground. Because of their high altitude, sodium beacons sample a much larger cone of air when compared to Rayleigh beacons. So, they are better suited for use with large telescopes. Typical current laser beacon systems for astronomical applications do not compensate the outgoing laser beam to correct for atmospheric turbulence. As a result, the laser beacon can be large and extended, especially when compared to an unresolved point source, like a star. For most astronomical observatories, this is not a problem, because they are located in places with weak atmospheric turbulence. However, observatories for space situational awareness (SSA) are typically located in places with stronger atmospheric turbulence, so their laser beacons are typically larger than those at astronomical observatories. A larger laser beacon results in lower sensitivity of the laser-beacon wavefront sensor. To make matters worse for SSA observatories, when a ground-based telescope tracks a satellite in low-Earth orbit, it must slew quickly across the sky. This, in effect, creates a situation that is equivalent to a strong wind blowing across the aperture of the telescope. This means the adaptive optics system must operate at a higher frame rate and higher gain to compensate for atmospheric turbulence. The combination of these two factors means a laser beacon for SSA purposes must be much brighter and smaller than a laser beacon for astronomy. Thus, AFRL is seeking development of systems to generate smaller more spatially coherent laser beacons to help improve the performance of adaptive optics systems for ground-to-space imaging applications.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. "Phase I-type" deliverables include a report that thoroughly describes concepts, analyses, and simulations for laser beacon components that are suitable for SSA ground-to-space imaging applications. These analyses and simulations must show that the proposed components are effective and affordable. The report should describe the components at a level suitable for a conceptual design review. (See https://en.wikipedia.org/wiki/Engineering_design_process#Concept_Generation) The report shall include a plan for demonstrating the laser components on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. (Since this is a D2P2 topic, this section describes the content expected to substantiate that the proposer's technology is currently at an acceptable stage to award a D2P2.)

PHASE II: Phase II deliverables include a detailed design of laser beacon pre-compensation components that are suitable for SSA ground-to-space imaging applications. This design must illustrate that the proposed components are effective and affordable. The design documents should describe the components at a level suitable for preliminary and critical design reviews. (See https://en.wikipedia.org/wiki/Design_review_(U.S._government)#Preliminary_Design_Review_(PDR), and https://en.wikipedia.org/wiki/Design_review_(U.S._government)#Critical_Design_Review_(CDR)) After successful completion of the PDR and CDR, a prototype system will be built, tested in the lab environment. A detailed test plan shall also be developed for demonstrating the laser pre-compensation components on-sky, in conditions that are representative of typical sites for ground-based observations of earth-orbiting satellites. As cost and schedule constraints allow, the prototype pre-compensation system shall be demonstrated on-sky at a government, university, or civilian observatory. The proposer will not include the sodium beacon laser, launch telescope, gimbals, and safety systems in their proposal, as these components could be made available, depending on the location for the on-sky demonstration. Currently, the goal is to support on-sky testing on the island of La Palma in the Canary Islands, Spain

PHASE III DUAL USE APPLICATIONS: A Phase III effort would require identifying a suitable transition partner, which could be a government program office, a government contractor or other commercial entity, or a civilian astronomical observatory. Potential phase III applications include other defense SSA observatories in the US, Europe, and Australia; civilian astronomical observatories that wish to observe at visible wavelengths, which requires improved adaptive optics performance; and ground-to-space laser communications research facilities.

REFERENCES:

1. Laser beacons or laser guide stars, https://en.wikipedia.org/wiki/Laser_guide_star;
2. Drummond, Jack & Telle, John & Denman, Craig & Hillman, Paul & Spinhirne, Jim & Christou, Julian. (2004). Photometry of a Sodium Laser Guide Star from the Starfire Optical Range. II. Compensating the Pump Beam. Publications of the Astronomical Society of the Pacific. 116. 952-964. 10.1086/425595.

KEYWORDS: sodium beacons; laser beacons; laser beacon coherence; adaptive optics

AF233-D008 TITLE: AR for Equipment Maintenance

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces

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

OBJECTIVE: Implement AR and VR technology to improve efficiency and reduce error in equipment maintenance

DESCRIPTION: Preventative maintenance and corrective maintenance are two different approaches to equipment maintenance. Preventative maintenance involves regular upkeep and scheduled inspections to prevent equipment failure before it even happens. On the other hand, Corrective maintenance is reactive since it is done after a piece of equipment has broken down. Maintainers continue to rely on conventional maintenance resources, which communicate increasingly complex instructions and processes using images and text, even with increasingly complex machineries. Currently, technicians must duplicate the equipment's operation as it was prior to the problem developing. Each technician's effort is different and takes time. Advanced tools, machines, knowledge, and skills are needed to resolve maintenance issues in order to address and reduce equipment failures that eventually cause aircraft maintenance to be delayed. Additionally, training new technicians requires hands-on experience and depends on the workload that is available. AR can be used to diagnose equipment problems by overlaying diagnostic information on top of live video feed of the equipment. This can help technicians to quickly identify and troubleshoot issues. VR can provide simulated training environments that allow technicians to practice maintenance procedures on virtual equipment models. This can help to reduce the risk of damage to actual equipment during training, while also providing a more realistic training experience. By leveraging AR & VR technology, organizations can improve equipment uptime, reduce maintenance costs, increase the overall safety and reliability of their operation, enhance the efficiency and accuracy of equipment maintenance.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. To demonstrate the requisite feasibility 1 requirements, applicants should be able to demonstrate an understanding of the maintenance groups' needs and potential use cases for AR in equipment maintenance. This may be demontrated by citing prior work including feasibility studies or interviews with key stakeholders. Applicants should be able to evaluate available AR & VR technologies and develop a detailed plan for implementing AR in equipment maintenance.

PHASE II: Pilot Phase: This phase involves testing the AR technology in a small-scale pilot project to evaluate its effectiveness and identify any issues. This may involve training technicians on the use of AR technology, monitoring performance metrics, and gathering/analyzing feedback from stakeholders, evaluating the effectiveness of the AR technology and identifying areas where the technology can be optimized.

PHASE III DUAL USE APPLICATIONS: Implementation Phase: This phase involves rolling out the AR technology across the organization. This may involve scaling up the pilot project to a larger deployment, providing training to technicians, and ensuring that the technology is integrated with existing systems and processes.

REFERENCES:

1. https://www.ge.com/news/press-releases/ge-renewable-energy-debuts-high-speed-blade-inspection-system-advancing-performance ;
2. https://www.boeing.com/features/2018/01/augmented-reality-01-18.page ;
3. https://new.siemens.com/global/en/company/stories/industry/digitaltwin-virtualreality-augmentedreality-service-porsche.html

KEYWORDS: Augmented Reality for Equipment, AR for Equipment, Augmented Reality, Augmented Reality in factory maintenance, AR in MRO

AF233-D009 TITLE: Robotic Defastening

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Human-Machine Interfaces;Trusted AI and Autonomy

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

OBJECTIVE: Develop AI assisted defastening robot to improve process time and quality.

DESCRIPTION: Various Programmed Depot Maintenance (PDM) processes require removal of fasteners on the aircraft to access behind aircraft skins. The defastening process is currently conducted across all aircraft at Tinker AFB (E-3, E-6, B-52, KC-135, KC-46, and B-1B) by production personnel with hand drills. This amounts to hundreds of thousands of hours spent removing fasteners annually. With the B-1B FIF workload coming to Tinker AFB in FY25, over 10,000 fasteners will need to be removed from each jet. The defastening process is tedious and even the most skilled artisans are subject to fatigue, resulting in reduced quality over long periods of time, as well as increased risk of injury to personnel. Manual drilling is difficult and produces shavings and debris that prove challenging to collect, and drill bits tend to break quickly requiring frequent replacement. As the B-1B workload approaches, there is a concern that removing aircraft skins will become overwhelming to the production line and better methods need to be implemented before the workload arrives. Automating the defastening process will significantly improve personnel quality of life, reduce process time, and drive down risk of rework. Robotics have been implemented in industry to assist the defastening process, but no directly on an aircraft. Other technology, such as E-Drill, has proven successful in improving quality and speed, but still requires artisans to easily access the skins with heavy equipment. 76 AMXG is unique in that the aircraft requirements for this technology is much larger than other ALC's, requiring stricter parameters for space/motion.

PHASE I: To meet Phase 1 requirements, proposers should be able to demonstrate an understanding of requirements of fastener removal on aircraft and show feasibility of defastening on aircraft with 50% or more time reduction compaired to manual process and maintain 95% accuracy. Proposer should include a detailed plan for demonstrating this capability on military aircraft.

PHASE II: Provide mobile prototype capable of accomplishing Phase I requirements demonstrating ability to reduce flow days on various aircraft with various types of fasteners. Develop integration path to implementation across Maintenance Depots.

PHASE III DUAL USE APPLICATIONS: Integrate multiple mobile defastening robots into the PDM process, possibly across different aircraft, with data to prove efficiency/accuracy improvements.

REFERENCES:

1. https://ntrs.nasa.gov/citations/19940026069 ;
2. https://ppedm.com/e-drill/ ;
3. https://www.aflcmc.af.mil/NEWS/Article-Display/Article/3294689/rso-seeks-to-scale-innovation/

KEYWORDS: Robotic Defastening, Defastener, De-fastener, manual drill rivets, manual riveting, match drill, replacement skin, automated repair, structural repair, skin repair, fastening system, mobile robotic drilling, electrostatic discharge machining, E-Drill

AF233-D010 TITLE: Field-level Detection of Hydraulic Fluid Contamination in Jet Fuel

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

OBJECTIVE: Develop for field and depot maintenance applications, an integrated, palm size analytical type instrument with control software application utilizing an Artificial Intelligence Deep Learning Algorithm that is capable of detecting, identifying, and quantifying by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm)the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in a jet fuel sample within five minutes of analysis initiation from the scan of a 10mL or less sample of the suspected contaminated fuel. The instrument should have a targeted final cost of $2,500 or less not including any consumables or required calibrations.

DESCRIPTION: The US Air Force uses various grades/types of jet fuels, hydraulic fluids, and coolants in support of aircraft weapons system operations.
The primary grades of jet fuels used by the US Air Force are:
1) Jet A (ASTM D1655) with standard military additive package to include Fuel System Icing Inhibitor (FSII), Electrical Conductivity Improver (ECI) and Corrosion Inhibitor/Lubricity Improver (CI/LI).
2) JP-8 (MIL-DTL-83133)
3) Jet A-1 (DEF STAN 91-091) with standard military additive package to include FSII, ECI, and CI/LI.
4) JP-5 (MIL-DTL-5624) 5) JPTS (MIL-DTL-25524) There are different types of hydraulic fluids used by aircraft weapon systems, each with a unique chemical makeup. These include both petroleum and synthetic based products.
The primary hydraulic fluid specifications used by the US Air Force for aviation purposes are:
1) MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base
2) MIL-PRF-87257 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile
3) MIL-PRF-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
4) AS SAE 1241 Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
This product is clear and not distinctly visible during visual analysis of PAO contaminated fuel samples. The primary Polyalphaolefin (PAO) coolant specification used by the US Air Force for aviation purposes is MIL-PRF-87252 Coolant Fluid, Hydrolytically Stable, Dielectric. Hydraulic and/or PAO coolant fluid contamination of jet fuel poses both a real and existential threat to unit readiness. Jet fuel contaminated with hydraulic fluid has shown to impact engine operability and accelerated turbine blade and nozzle wear. PAO coolant fluids have been demonstrated as being able to dis-arm the water coaleser elements used in fuel water separators that provide a water/solid defense for aircraft from contaminated jet fuel. The problem begins when hydraulic fluid and/or coolant levels are found to be low when checked by aircraft maintenance personnel. Maintenance personnel must report the suspected contamination event and request removal of the fuel from the aircraft so that internal maintenance actions can be completed. The suspect fuel is generally defueled into a mobile refueling unit(s) or bowser. At this point a determination must be made on disposition of the defueled product i.e. return fuel to DLA Energy Capitalized bulk inventories, return to the aircraft, or dispose as hazardous waste. Currently, to obtain the data to support any of the above decisions the suspect fuel is sampled and sent overnight to the closest regional fuel laboratory with the ability to detect and quantify contamination levels. At some locations this is achieved quickly, however the process may take 2-10 days depending on lab and base location. This situation can escalate quickly because of further delays associated with country clearance or customs. While waiting for the sample results, the mobile refueling unit or bowser holding the suspect product is placed on a quality hold. This means it is unusable to the base or to DLA Energy to support other requirements. Additionally, most refueling locations have limited refueling assets to support aircraft operations and loss of an asset for even a couple of days can directly impact aircraft sortie generation and downed aircraft time due to maintenance. These incidents led to countless direct and

indirect costs associated with mobile refueling truck and/or aircraft downtime, mobile refueling truck remediation (tank cleaning, filter coalser replacement, etc.) and sample transportation. Aircraft engine original equipment manufacturers (OEM) have placed a 0.0 vol % or 0 ppm max allowable tolerance of both products. An analytical type instrument that is capable of detecting, identifying, and quantifying by either percent by volume (vol%) or parts per million (ppm) of the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in an aviation turbine fuel sample will save a significant amount of time and money sampling a product with no detectable contaminants. This capability will also be used to validate product quality following incidents and/or natural disasters. The instrument shall be capable of being stored and operated in conditions ranging from -25 degrees F to +135 degrees F and have the ability to operate on AC, rechargeable battery or a 12-DC volt sources. The instrument will minimize generation of any hazardous waste and require minimum consumables. The integrated system must be able to operate in a hazardous environment. Phase I: Develop a proof of concept for an integrated, palm size analytical type instrument utilizing an Artificial Intelligence Deep Learning Algorithm that is capable of detecting, identifying, and quantifying by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) contamination within five minutes of analysis initiation from the scan of a sample of the suspected contaminated aviation turbine fuel that consists of a targeted 10 mL or less size sample.
The proof of concept demonstration will be based on a demonstrated with a jet fuel (Jet A with FSII, ECI, CI/LI) contaminated with 1) a hydraulic fluid meeting any of the identified specifications, 2) a PAO coolant meeting the identified specification, and 3) a mixture of a hydraulic fluid and PAO coolant, with each meeting respective identified specifications.; at three concentrations defined by the Technical Point of Contact (TPOC). The concept must incorporate Air Force Human Systems Integration (HSI) Domains WRT requirements for operating the device in a field environment. Develop a plan to raise the technology to Technology Readiness Level (TRL) 8 by the end of Phase II. Provide a Rough Order of Magnitude (ROM) range of cost estimates for the purchase price of the Phase III product. Since most cost components in the cost estimate are unknown, the ROM should itemize known cost components and describe the rational for unknown cost components. The ROM should include a maximum expected cost and likely expected cost. Phase II: Develop and evaluate eight prototypes in a laboratory and field environment of an integrated analytical type instrument capable of detecting, identifying, and quantifying by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) of the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in a jet fuel sample. The prototypes by the end of Phase II must be able to demonstrate the ability to detect, identify, and quantify by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) of the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in an jet fuel (Jet A with FSII, ECI, CI/LI) contaminated with 1) each of the four identified hydraulic fluids meeting the identified specifications, 2) a PAO coolant meeting the identified specification, and 3) a mixture of each respective hydraulic fluid and PAO coolant, with each meeting respective identified specifications. For the neat hydraulic fluid and PAO samples, three concentrations for each sample will be defined by the Technical Point of Contact (TPOC) will be tested. For the hydraulic fluid/PAO mixture, three concentrations for each of the identified hydraulic fluid specifications, along with the identified PAO specification will be tested. Draft an ASTM test method based on the instrument technology and conduct an Inter-Laboratory Study IAW ASTM E691-22 Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method in support of data gathering to support a research report for submission of the draft ASTM test method for ballot by ASTM for adoption of the test method. Performance parameters to consider are: Performance in a field environment. Time required for analysis of the fluid, Cost to analyze the fluid, Accuracy of the analysis, Safety for the operator to conduct the analysis. Calibration, How? Who? Where? Repair ability, How? Who? Where Mean time between failures (MTBF): Transportability/drop ability: How does the devices handle transportation and accidental dropping? The prototype should be a TRL 8 or greater per Department of Defense Technology Readiness Assessment (TRA) Guide, April 2011. As TRL increase is each achieved, a revised cost estimate will be included in

the next required progress report. Note: this cost estimate is for budgeting planning purposes only; an authorized government-contracting officer will negotiate the purchase price of the final product.

PHASE I: For this Direct-to-Phase II topic, evaluators are expecting that the submittal firm demonstrate the ability to achieve the following: Develop a proof of concept for an integrated, palm size analytical type instrument utilizing an Artificial Intelligence Deep Learning Algorithm that is capable of detecting, identifying, and quantifying by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) contamination within five minutes of analysis initiation from the scan of a sample of the suspected contaminated aviation turbine fuel that consists of a targeted 10 mL or less size sample. The proof of concept demonstration will be based on a demonstrated with a jet fuel (Jet A with FSII, ECI, CI/LI) contaminated with 1) a hydraulic fluid meeting any of the identified specifications, 2) a PAO coolant meeting the identified specification, and 3) a mixture of a hydraulic fluid and PAO coolant, with each meeting respective identified specifications.; at three concentrations defined by the Technical Point of Contact (TPOC). The concept must incorporate Air Force Human Systems Integration (HSI) Domains WRT requirements for operating the device in a field environment. Develop a plan to raise the technology to Technology Readiness Level (TRL) 8 by the end of Phase II. Provide a Rough Order of Magnitude (ROM) range of cost estimates for the purchase price of the Phase III product. Since most cost components in the cost estimate are unknown, the ROM should itemize known cost components and describe the rational for unknown cost components. The ROM should include a maximum expected cost and likely expected cost.

PHASE II: Develop and evaluate eight prototypes in a laboratory and field environment of an integrated analytical type instrument capable of detecting, identifying, and quantifying by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) of the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in a jet fuel sample. The prototypes by the end of Phase II must be able to demonstrate the ability to detect, identify, and quantify by either percent by volume (vol%) ranging from 0.0 to 5.0 percent or parts per million (ppm) (ranging from 0 to 9,000 ppm) of the presence of a aviation grade hydraulic fluid and/or a Polyalphaolefin (PAO) coolant contamination in an jet fuel (Jet A with FSII, ECI, CI/LI) contaminated with 1) each of the four identified hydraulic fluids meeting the identified specifications, 2) a PAO coolant meeting the identified specification, and 3) a mixture of each respective hydraulic fluid and PAO coolant, with each meeting respective identified specifications. For the neat hydraulic fluid and PAO samples, three concentrations for each sample will be defined by the Technical Point of Contact (TPOC) will be tested. For the hydraulic fluid/PAO mixture, three concentrations for each of the identified hydraulic fluid specifications, along with the identified PAO specification will be tested. Draft an ASTM test method based on the instrument technology and conduct an Inter-Laboratory Study IAW ASTM E691-22 Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method in support of data gathering to support a research report for submission of the draft ASTM test method for ballot by ASTM for adoption of the test method. Performance parameters to consider are: Performance in a field environment. Time required for analysis of the fluid, Cost to analyze the fluid, Accuracy of the analysis, Safety for the operator to conduct the analysis.   Calibration, How? Who? Where?   Repair ability, How? Who? Where   Mean time between failures (MTBF): Transportability/drop ability: How does the devices handle transportation and accidental dropping? The prototype should be a TRL 8 or greater per Department of Defense Technology Readiness Assessment (TRA) Guide, April 2011.   As TRL increase is each achieved, a revised cost estimate will be included in the next required progress report. Note: this cost estimate is for budgeting planning purposes only; an authorized government-contracting officer will negotiate the purchase price of the final product.

PHASE III DUAL USE APPLICATIONS: Commercialize the integrated analytical type instrument for use by commercial and/or Government, overhaul entities, and DOD users/depot facilities. Develop and execute a transition plan to military and commercial customers based on requirements. Develop and document procedures for operation, calibration, and servicing.

REFERENCES:
1. Air Force Human Systems Integration Handbook, Directorate of Human Performance Integration Human Performance Optimization Division, 711 HPW/HPO, 2485 Gillingham Drive, Brooks City-Base, TX 78235-5105 www.acqnotes.com/Attachments/Air%20Force%20Human%20System%20Integration%20Handbook.pdf ;
2. Technology Readiness Assessment (TRA) Guide, January 2020 https://www.gao.gov/products/gao-20-48g;
3. Human Systems Integration Requirements pocket Guide, U.S. Air Force Human Systems Integration Office https://ww3.safaq.hq.af.mil/Portals/63/documents/organizations/ADA517632%20(5).pdf?ver=2016-07-28-120807-753
4. Operation of A T63 Turbine Engine Using F24 Contaminated Skydrol 5 Hydraulic Fluid, Air Force Research Laboratory, Aerospace Systems Directorate, Wright-Patterson Air Force Base, OH 45433-7541 https://apps.dtic.mil/dtic/tr/fulltext/u2/1021917.pdf ;
5. Comprehensive Electrical Evaluation of Polyalphaolefin (PAO) Dielectric Coolant https://apps.dtic.mil/dtic/tr/fulltext/u2/a363781.pdf ;
6. Technical Order 42B-1-1 Quality Control of Fuels, Air Force Petroleum Office, Petroleum Standards Division, Wright-Patterson Air Force Base, OH 45433 Available by request ;
7. Technical Order 42B2-1-3 Fluids for Hydraulic Equipment, Air Force Petroleum Office, Petroleum Standards Division, Wright-Patterson Air Force Base, OH 45433 Available by request
8. MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, https://quicksearch.dla.mil/qsSearch.aspx
9. MIL-PRF-87257 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile https://quicksearch.dla.mil/qsSearch.aspx
10. MIL-PRF-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance https://quicksearch.dla.mil/qsSearch.aspx ;
11. MIL-PRF-87252 Coolant Fluid, Hydrolytically Stable, Dielectric https://quicksearch.dla.mil/qsSearch.aspx ;
12. AS SAE 1241 Fire Resistant Phosphate Ester Hydraulic Fluid For Aircraft https://www.sae.org/standards/content/as1241d ;
13. MIL-DTL-83133 Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37) https://quicksearch.dla.mil/qsSearch.aspx ;
14. MIL-DTL-5624 Turbine Fuel, Aviation Grades JP-4 and JP-5 https://quicksearch.dla.mil/qsSearch.aspx ;
15. MIL-DTL-25524 Turbine Fuel, Aviation, Thermally Stable https://quicksearch.dla.mil/qsSearch.aspx ;
16. ASTM D1655 Standard Specification for Aviation Turbine Fuels https://www.astm.org ;
17. Defense Standard 91-091 Turbine Fuel, Kerosine Type, Jet A-1, https://www.dstan.mod.uk

KEYWORDS: Hydraulic Fluid, Jet Fuel, Aviation Turbine Fuel, Polyalphaolefin (PAO) Coolant

AF233-D011 TITLE: Functional Gradient Coatings for Landing Gear

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics;Microelectronics;Advanced 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 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 activate coatings that will allow for greater dimensional restoration of work surfaces on landing gear. As compared to the current process, this will reduce or eliminate Hexavelant Chrome on many aircraft part surfaces. The new process will reduce production time by a quicker deposition process and elimination of an 8 hour relief bake of production parts.

DESCRIPTION: Aircraft components wear down over time. To prolong the service life of parts, wear resistant coatings are applied to the working surface of the parts. Previously, this was done with Engineering Hard Chrome (also known as hexavalent chromium / hex-chrome). This coating is replaced by High Velocity Oxygen Fuel (HVOF) deposited Tungsten Carbide Cobalt, a metal/ceramic blend that has a very long functional life without the health hazards of hex-chrome   Tungsten Carbide Cobalt, as applied per AF DWG 200310641, has a maximum thickness before the coating develops stress cracks. Excessive build can lead to the coating removing itself from the part's surface. This exposes the underlying part to wear, and the shards of the coating can damage seals. A careful balance of proper coating thickness must be maintained for part functionality and preventing the part from rusting as well. A Functional Gradient Coating (FGC), consisting of a build layer, then an intermediary transition layer, then the wear coating layer, allows for much greater dimensional restoration while still applying a replaceable wear resistant layer on top. The coating's intermediary transition layer absorbs and dissipates much of the stresses that would normally cause a two-part coating system to fail under stress, eliminating or severely reducing the problem of stress cracks and coating separation.   This process will reduce our condemnation rate, which will help maintain functional supply of available assets reduce aircraft part replacement delivery times, allowing faster asset readiness to deploy or fight.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior "Phase I-type" effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement.   FEASABILITY DOCUMENTATION. For this Direct-to-Phase II topic, evaluators are expecting that the submittal firm demonstrate the ability to spraying of representative samples and candidate aircraft parts with the FGC and examining the cross-sectional properties, bend strength, adhesive strength, and fatigue characteristics.   Submittal Firm shall demonstrate on a representative sample, a functionally graded coating comprising of a thickness build/bond layer graded into a wear resistant layer. This functionally graded coating shall demonstrate a wear layer with FGM that satisfies performance criteria as identified in AF DWG 200310641.

PHASE II: Spraying the FGC on multiple candidate aircraft parts. Destructive testing would be done on the first item to confirm characteristics between representative samples and actual aircraft parts. Surface would then be ground to operational dimensions, then flight worthiness testing would commence. Addendums or supplements to AF DWG 200310641 would then be supplied to the 417 SCMS/GUEA for adaptation.

PHASE III DUAL USE APPLICATIONS: Once flight worthiness is established, upgrading Hill AFB machinery to be able to apply FGC's to aircraft parts. First article acceptance procedures would be carried out, then workload activation begins. Addendums or supplements to AF DWG 200310641 would then be supplied to the 417 SCMS/GUEA for adaptation. Coordination with 417 SCMS/GUEA to update applicable technical orders to use this process across the various assets as needed.

REFERENCES:

1. L. Prchlik, S. Sampath, J. Gutleber, G. Bancke, A.W. Ruff , Friction and wear properties of WC-Co and Mo-Mo2C based functionally graded materials, Wear 249 (2001) Elsevier, 3 May 2001
2. Giovanni Bolelli, Valeria Cannillo, Luca Lusvarghi, Roberto Rosa, Alfredo Valarezo, Wanhuk B. Choi, Ravi Dey, Christopher Weyant, Sanjay Sampath, Functionally graded WC–Co/NiAl HVOF coatings for damage tolerance, wear and corrosion protection, Surface & Coatings Technology 206 (2012) 2585-2601, 20 July 2021
3. M. Hasan, J. Stokes, L. Looney, M.S.J. Hashmi, Surf. Coat. Technol. 202 (2008) 4006.

KEYWORDS: Thermal Spray, High Velocity Oxygen Fuel, HVOF, Functional Gradient Coating, Wear Surface, Landing Gear, Dimensional Restoration

AF233-D012 TITLE: Materials for High-Temperature Performance Electronics: Memory and Packaging

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics;Space Technology;Advanced Materials

OBJECTIVE: The objective is to develop materials, devices/subcomponents, and integration processes that will enable a fully functional microprocessor capable of continuous operation at elevated temperatures. Here, elevated means anything above the current limitaiton of Silicon Complementary metal–oxide–semiconductor (Si CMOS) electronics of roughly 250 degrees Celsius. Ultimately, the goal is to develop materials and components capable of operation above 500 degrees Celsius to be used in Department of the Air Force platforms subject to extreme temperatures during operations.

DESCRIPTION: The realization of fully functional microprocessors operating at temperatures above 250 degrees Celsius will require advances in the materials and fabrication processes used for transistors/switches, memory elements, and passives, as well as new approaches to heterogenous integration of these various components. Current solutions to thermally protect electronics negatively effect the size, weight, and performance (SWAP) of the systems. Electronics capable of surviving and operating in the high-temperature realm will improve the SWAP of systems by the removal of insulating materials thus improving numerous system capabilities. The topic is expected to deliver at least two lab-scale testbeds of fully packaged electronics capable of operating at temperatures of at least 400 degrees Celsius (up to 500 degrees Celsius desired) without detrimental loss to functionality.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have; -Identified the prime potential Department of the Air Force end user(s) for the non-Defense commercial offering to solve the AF need, i.e., how it has been
modified;
-Described integration cost and feasibility with current mission-specific products;
-Described if/how the demonstration can be used by other DoD or Governmental customers.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The successful Phase 2 effort will build on emerging high temperature electronics technology such as Silicon Carbine (SiC) transistors, ferroelectric memory elements, correlated electron oxide memory elements, and laminate ceramic circuit boards to demonstrate integrated functionality towards a full high-temperature microprocessor. The contractor will establish a research and development strategy that addresses key technical hurdles in one or more of the following areas. Scalable memory fabrication and integration. There is currently no commercially available memory technology that is able to be manufactured in commercial microelectronics foundries, small enough to provide reasonable data densities, and capable of repeated read/write cycles at temperatures above 250 degrees Celsius. Candidate memory technologies must show the potential to satisfy these requirements. The associated read/write protocols should require voltage and current levels that can reasonably be achieved in an integrated microprocessor on a remote air or space platform. Transistor fabrication and integration. Transistors fabricated from wide band gap (WBG) semiconductor materials are the most promising candidates for high temperature logic, switches, and power amplifiers.The NASA SiC Junction Field Effect Transistor (JFET-R) process results in transistors capable of continuous operation at greater than 800 degrees Celsius. However, the speed, density, and voltage/power requirements of these devices must be improved to meet future Department of the Air Force system demands. Furthermore, integrating SiC transistors with emerging memory technology is uncharted ground, and will require novel device and circuit design approaches. Subcomponent integration. A key technology gap is the integration of high temperature logic with high temperature memory into a circuit architecture that can enable the development of digital algorithms for signal processing, data storage, and system control. This requires circuit design specific to these high temperature subcomponents, and the development of packaging processes that ensure the reliability of both the active and passive components of the circuit. The Phase 2 awardee will build on the current state of the art to advance the Technology Readiness Level in one or more of these technology areas by delivering designs and physical prototypes that demonstrate enhanced performance in one or more of the areas above. The awardee will coordinate with the Department of the Air Force technical point of contact (TPOC) via regular information exchange meetings and technical reports. The final deliverable will consist of one or more prototypes devices with demonstrated continuous operation at elevated temperature.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

REFERENCES:

1. https://doi.org/10.1007/s10854-015-3459-4; https://doi.org/10.1016/j.mseb.2010.10.003;
2. https://doi-org.wrs.idm.oclc.org/10.1109/TPEL.2014.2357836;
3. https://doi.org/10.3390/mi10060406;
4. https://doi-org.wrs.idm.oclc.org/10.1146/annurev-matsci-070317-124435;
5. https://doi-org.wrs.idm.oclc.org/10.1109/TPEL.2022.3148192;
6. https://doi-org.wrs.idm.oclc.org/10.1109/ECTC32862.2020.00051;
7. https://doi.org/10.4071/2380-4491.2021.HiTEC.000118

KEYWORDS: high-temperature electronics; high-temperature memory; nonvolatile memory; Silicon Carbide transistors

AF233-D013 TITLE: Development of New Oxidation Resistant Refractory Alloys for Additively Manufactured (AM) Components

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Space Technology;Advanced 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 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 program objective is to explore new oxidation resistant refracotry alloys that are amenable to additive manufacturing (AM). Developed alloy should be non-coating reliant to funciton at elevated temperatures. Alloy should have a depressed ductile to brittle transition temperature and exhibit some ductility at room temperature. This effort will assess the integration and performance of novel oxidation resistant refractory alloy, address the limitations of the alloy and consider (but not develop) possible protective coating solutions.

DESCRIPTION: Refractory alloys are being explored for advanced aerospace applications where material requirements exceed the capabilities of Nickel superalloys. In this realm, the emergence of Additive Manufactured (AM) refractory alloys has provided an innovative approach that enables complex geometries and/or graded microstructures for alloys that exhibit superior performance, but have been historically difficult to process and suseptible to oxidation. However, in all cases, refractory alloys require environmental coatings for protection to prevent chemical and structural degradation. The coating process for refractory alloys is very resource intensive and failure of this coating could cause failure of the part. Thus, an alloy that forms a passive or slowly progressing oxide layer is desired for structural material applications. The envisioned program will explore this application space. It is recommended that the selected small business will partner with relevant alloy/coating/component Original Equipment Manufacturers, as needed, to select and produce the required material stock. Overall, this Phase II effort will 1) investigate novel, oxidation, refractory alloys that can be produced via AM, 2) Consider which AM effort will best construct the material 3) Consider a quantifiable metric to assess any novel alloys 4) Consider what coating systems may be possible for the novel alloy.

PHASE I: This topic is intended for technology proven ready to move directly into Phase II. Therefore, a Phase I award is not required. The applicant is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including a feasibility study. The applicant should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. Phase I type efforts include determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the Air Force customer.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.   This program will require a team approach with several disciplines. [1] Material modelers that can use advance methods to assess candidate refractory coating and substrate combinations such they that will have the thermal, physical, mechanical and environmental properties needed to survive operations. [2] Process modelers to build property and life models using different refractory coating and substrate combinations with various architectures to minimize defects and provide uniform distribution of thermal protection. [3] Fabricators to build and deliver a cost effective refractory coating and substrate archetypes. These will have undergone screening methodologies (mechanical and environmental) to determine viability of component in an extreme high temperature environments. [4] The offeror will have to conduct microstructural characterization of refractory coating and substrate pre and post testing. The performance and microstructural data shall be used to validate and inform developed models.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

REFERENCES:

1. Mark D. Novak, Carlos G. Levi, "OXIDATION AND VOLATILIZATION OF SILICIDE COATINGS FOR REFRACTORY NIOBIUM ALLOYS", Proceedings of IMECE 2007 ASME International Mechanical Engineering Congress and Exposition, November 11-15, 2007, Seattle, Washington, USA, p 1-7;
2. Mark David Novak, "Microstructure Development and High-Temperature Oxidation of Silicide Coatings for Refractory Niobium Alloys", Ph.D. dissertation, University of California, Santa Barbara, 2010

KEYWORDS: refractory alloy; oxidation resistant materials; additive manufacturing

AF233-D014 TITLE: Advanced Nano-Composite Radiation Shielding Manufacturing

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

OBJECTIVE: This topic seeks to mature manufacturing processes for polymer based multi-layer radiation shielding. Ideal projects would improve shield quality and drive down shield cost through increased production, improvements to layer adhesion, efficient use of consumables, and development of a manufacturing process enhancement model capable of shield composition/architecture design, predictive manufacturing processes, and long-term tracking of manufacturing process data.

DESCRIPTION: The Department of the Air Force and the U.S. Space Force needs light weight and thinner radiation shields to protect our space assets from the dangers of radiation on orbit. Today, radiation shielding of electronics in space is primarily accomplished with aluminum slabs or metallic mesh. While inexpensive and easily attainable, this type of shielding adds unnecessary mass and bulk, reducing payload capacity and limiting the adoption of non-rad hardened commercial-off-the-shelf (COTS) electronics. This topic is expected to deliver space-ready, validated multi-layer radiation shields that are lighter weight and thinner than existing alternatives at an affordable cost. This effort should include manufacturing maturation techniques and software to reduce shield cost and improve yields for proliferated space. End of effort should also provide the Air Force with a trusted industrial partner for further development and procurement.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial and/or defense potential. The applicant must demonstrate that a prototype composite radiation shielding manufacturing capability already exists or provide a modeling capability to support design of composite radiation shields based upon environmental requirements. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have: identified the prime potential AF end user(s) for the non-Defense commercial offering to solve the AF need; describe if/how the demonstration can be used by other DoD or Governmental customers.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-type” effort predominantly separate from the SBIR/STTR Programs. Under the phase II effort, the offeror shall sufficiently develop the modeling capability for design of composite radiation shields, and modeling capability for predictive and data tracking of manufacturing processes, and/or the offeror must demonstrate new manufacturing processes and demonstrate increased production rates. Phase II efforts shall conduct analysis, further Modeling & Simulation optimization and experimentation on developed products to determine efficacy and address military requirements. Specific attention shall be paid to manufacturing readiness, preliminary costing, and Air Force logisitical considerations. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: Phase III or phase II enhancements shall include upgrades to the manufacturing process, further Modeling & Simulation test and evaluation results, and provide delivery of concepts. Phase IIE and Phase III shall provide a business and manufacturing plan including cost and further ruggedization if needed. Delivery of high-rate production is desired along with an improved manufacturing readiness.

REFERENCES:

1. More, C.V., Alsayed, Z., Badawi, M.S. et al. Polymeric composite materials for radiation shielding: a review. Environ Chem Lett 19, 2057–2090 (2021).
2. https://doi.org/10.1007/s10311-021-01189-9

KEYWORDS: nano-composite; radiation shielding; high-energy particles; electromagnetic; heavy-ions; manufacturing

AF233-D015 TITLE: Manufacturing of Nitrogen Vacant (NV) Diamond Substrates for Quantum Sensors

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

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

OBJECTIVE: The Manufacturing of Nitrogen Vacancy (NV) Diamond Substrates for Quantum Sensors program will scale-up growth manufacturing techniques that achieve the crystal properties required to enable the subsequent growth of high quality quantum defect containing epitaxial films. To enable various quantum technologies, the following properties must be achieved on a free-standing crystal. Specifically, the offeror will demonstrate a crystal with dimensions no less than 5x5x0.5 millimeters, with strain less than 0.5 parts per million at any point on the crystal measured with 10 micron spatial resolution, a nitrogen doping level less than 5 parts per billion, and a crystal warp less than 5 micron across the 5x5 millimeter surface. High yield and throughput approaches are desired, with an objective yield of 6 substrates per reactor per week, which will likely require parallelization due to anticipated growth times. As an example, high quality microwave plasma chemical vapor deposition (MPCVD) growth has been demonstrated to achieve low strain and low background doping density when grown on a high quality high pressure high temperature (HPHT) seed crystal [1]. Growth conditions were optimized to enable a free-standing film with crystal strain less than 0.1 parts per million, which is in line with the strain requirements. For proposed effort that require a seed crystal, it is essential to demonstrate vertical integration with a goal of 5% of grown substrates being of sufficient quality to use as a new master seed. Alternatively, high pressure-high temperature (HPHT) techniques have been used by foreign commercial suppliers to grow substrates with negligible stress and parts per billion-level unintentional dopants, domestic investments in mature HPHT techniques is a feasible and viable technique [2].

DESCRIPTION: There is a strong demand for the commercial supply of diamond with consistent and controllable properties for scientific applications. Diamond is an ultra-wide bandgap material that has the ability to host quantum defects, including nitrogen vacancies (NV), silicon vacancies (SiV) along with many other defects that enable quantum sensing and entanglement-based techniques. The majority of quantum systems depend on defect containing thin films that are epitaxially grown on single crystal diamond substrates, where the strain in the substrate crystal propagates into the epitaxial film containing the quantum emitters resulting in resonance broadening that degrades system performance. As a result it is essential that the supply of high quality, low strain, low background doping single crystal diamonds that can be reliably and consistently sourced. Currently the development of diamond based quantum materials is being limited by the inconsistent availability and quality of materials, this has limited both academic development as well as the commercialization of diamond quantum-defect related systems and sensors.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. Phase I type efforts would include demonstration of the capability to grow a crystal with dimensions no less than 5x5x0.5 millimeters, with strain less than 1.5 parts per million at any point on the crystal, nitrogen doping level less than 5 parts per billion.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. These efforts will include demonstration of nitrogen vacant (NV) diamond substrate growth with dimensions no less than 5x5x0.5 millimeters with the crystal properties required to enable the subsequent growth of high quality quantum defect containing epitaxial films. Under the phase II effort, the offeror shall sufficiently scale-up the aforementioned growth process to yield a minimum of six substrates per reactor per week, which will likely require parallelization due to anticpated growth times. The offeror shall also demsonstrate vertical integration and the regeneration of new master seed crystals. A minimum of 5% of grown substrates should be of sufficient quality to use as new master seed material. Specific attention shall be paid to manufacturing readiness levels (MRL), with an objective of MRL 6.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program. Focus should be on transitioning the nitrogen vacant (NV) diamond substrates for use in vector magnetometers.

REFERENCES:

1. Polyakov, S. N. et al. Large-Sized X-ray Optics Quality Chemical Vapor Deposition Diamond. physica status solidi (RRL) – Rapid Research Letters 16, 2200164 (2022).
2. Diggle, P. L. et al. Decoration of growth sector boundaries with nitrogen vacancy centers in as-grown single crystal high-pressure high-temperature synthetic diamond. Phys. Rev. Mater. 4, 093402 (2020).

KEYWORDS: Quantum; diamond; nitrogen-vacancy; microwave plasma chemical vapor deposition; high power high pressure; low strain; Optically Detected Magnetic Resonance

AF233-D016 TITLE: Technical Data Package (TDP) Modernization for As-Built Data

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

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

OBJECTIVE: The topic seeks to develop a software platform that facilitates the delivery of Technical Data Packages (TDPs) with the necessary Product Manufacturing Information (PMI), including inspection and machine controller data, using neutral data exchange standards to provide a complete as-built assembly model. The envisioned platform will provide traceability throughout the manufacturing process (from design through final inspection), while maintaining a linked single fit-for-purpose Authoritative Source of Truth (ASoT) geometric model. The underlying models are expected to be agnostic of commercial computer-aided engineering platforms; i.e., the models should leverage open data formats.

DESCRIPTION: The Department of Air Force (DAF) is exploring new capabilities for obtaining accurate digital representations of their acquired weapon systems. In the current DAF acquisition practice, idealized computer-aided design (CAD) models are shared as part of the required technical data package (TDP) delivery. However, as with the complexity of any DAF asset, an “as-designed” model of an aircraft will not match the delivered physical asset. In other words, sustainment depots, original equipment manufacturers (OEMs), and other stakeholders, cannot rely on geometry and topology values defined in as-designed models for operational and sustainment activities. In short, geometric deviations naturally occurring across a distributed production system significantly impact overall acquisition costs, including assembly challenges, component re-work, and significant human labor. This goal of this effort is to demonstrate the utility of emerging industrial data standards for (1) efficiently curating manufacturing data from machine controllers and inspection activities, (2) exporting native as-designed or CAD models into a neutral, open data representation will limited loss of information, and (3) spatially relating the aforementioned manufacturing data and other relevant Product Manufacturing Information (PMI) to the as-designed model. Outcome of this effort will produce an as-built model per aircraft tail number that could be used as a more indicative TDP for DAF stakeholders. The effort is expected to leverage existing DAF partnerships with OEMs that own the native CAD models. End of effort should also provide the Air Force with a “template” that could be used across other DAF acquisitions.

PHASE I: This topic is intended for technology proven ready to move directly into Phase II. Therefore, a Phase I award is not required. The applicant is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including a feasibility study. The applicant should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. Phase I type efforts include conceptualizing a data model that systematically links open data standards to realize an as-built model with PMI, such as dimensional data. Phase I type efforts would also include reporting on the readiness of the DAF partners, such as aircraft OEMs, in producing well-constructed neutral, open as-designed models.

PHASE II: Eligibility for a Direct to Phase Two (D2P2) is predicated on the applicant having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. Under the Phase II effort, the applicant shall sufficiently develop the technical approach via a demonstration in a small number of use cases and appropriate documentation. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: A Phase III or Phase II enhancement should include upgrades to the software platform, further test and evaluation results, and provide delivery of system concepts. Phase III could also include additional model healing and other related efforts on OEM-specific data. Delivery of a field ready system for deployment for testing purposes is desired, as well as a high technology readiness, enabling further procurement.

REFERENCES:

1. AFRL-2022-5873 [08 DEC 2022];
2. International Journal of Production Research: Defining requirements for integrating information between design, manufacturing, and inspection [2022, VOL. 60, NO. 11, 3339–3359]

KEYWORDS: Technical Data Package; As-Built Digital Twin; Quality Informaiton Framework; Neutral Engineering Data Exchange Standards

AF233-D017 TITLE: Next-Generation SAL Pulse Code

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

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

OBJECTIVE: Develop a new type of laser designation pulse code, or other technology, to significantly improve the countermeasure resiliency of laser guided weapons while providing benefits to performance and logistical employment.

DESCRIPTION: Semi-active laser guided weapons have been in use for decades. Commonly, these weapons lock-on to an encoded laser designator to allow deconfliction between multiple munitions and multiple designators, as well as to provide resiliency against countermeasures. Two type of pulse codes, existing in the open literature, include pulse repetition frequency (PRF) and pulse interval modulation (PIM). PRF codes have a consistent interval between each pulse. PIM codes have a varying interval between each pulse. Due to the sensitivity of this topic, details about the current employment of laser pulse codes, beyond a certain point, cannot be shared openly in this topic. However, some materials are available in the open domain covering these techniques. Countermeasures, especially from sophisticated adversaries, can significantly degrade the performance of semi-active laser seekers. As these codes are decades old, it is likely that there is significant risk in using these codes against near-peer adversaries. The Air Force is seeking new concepts that will provide robust defense against active laser countermeasures often referred to as “spoofing.” This topic is not intended to address destructive directed-energy countermeasures.

An ideal code will have the following attributes:
1) Despite being measured by an adversary in real-time, the munition will not lose track on the original code.
2) The code does not result in any performance loss (range, lock-on time, etc) compared to simple code options. Ideally results in performance benefits compared to baseline alternatives.
3) The code does not require cumbersome logistics for employment, such as robust communications between laser designator operator and weapon platform or regular updates in the field.
4) The code will be backwards compatible with other common codes and will not require munition or laser modifications to switch between codes.
5) The code will primarily require software modifications. Ideally involves zero hardware modifications, or limited/simple hardware modifications.
6) Mathematical efficiencies within the code generation and decode process such that the code generation is simple, yet the code decomposition is complex.

In addition to this understood need, the Air Force will also consider other approaches, which may not be well-understood, for laser designators or seekers that may provide high-value benefits in terms of performance or counter-measure resiliency for SAL seekers. These approaches should be limited to a single sub-system or component which can be upgraded (hardware or software) to provide a benefit when combined with the other existing sub-systems in inventory. Approaches requiring a complete overhaul of existing infrastructure will not be considered. Proposers should consider partnerships with manufacturers of SAL seekers, and clearly articulate a strategy for acquiring appropriate hardware and demonstration of algorithm improvements on that hardware (ideally in a shoot-out comparison with currently fielded hardware). Following successful laboratory demonstration, laser ranges will be available at Eglin AFB, FL for field testing.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. Prior work expected to be completed in a "Phase-I type" effort, in order to qualify for this D2P2, requires demonstrated feasibility which should include work and results in the following areas:
1) Complete analysis of multiple laser encoding scheme options, to including software modeling & simulation with objective mathematical metrics to access benefits and risks. Subjective benefits and risks, such as human factors which may affect user-adoption, will also be relevant.
2) Down-selection of theoretical laser encoding scheme, with objective mathematical and modeling results which demonstrate practical feasibility for future hardware development, to include laser repetition rate, pulse width, or any other factors that may affect compatibility with fielded or next-generation laser designators, such as duty cycle or other power limitations. Seeker processing limitations should also be considered and characterized, at least at a basic fundamental level.
3) While not required, an excellent proposal may include results from prior work which involves physical laboratory testing. Any data which objectively proves agreement between computer modeled and laboratory measured data would be the strongest form of established feasibility.

PHASE II: Develop a system design and produce a prototype capable of demonstrating functionality and benefits. Prototypes will be tested in both laboratory and field environments.

PHASE III DUAL USE APPLICATIONS: Successful demonstration will result in transition through hardware development partners to update fielded munitions. There are a wide variety of fielded munitions using SAL guidance that this technology will directly apply to.

REFERENCES:
1. Patent US 7,767,945, “Absolute time encoded semi-active laser designation,” Raytheon Company, Darin S. Williams, Aug. 3, 2010.;
2. Patent US 5,023,888, “Pulse code recognition method and system,” Martin Marietta Corporation, Thomas E. Bayston, Jun. 11, 1991.

KEYWORDS: semi-active laser seeker; laserr designator; infrared seeker; laser pulse code; missile guidance; laser countermeasure

AF233-D018 TITLE: Conformal Forward Looking Multi-Aperture Seeker for High Speed EO/IR Demonstrator

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

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

OBJECTIVE: Build a prototype EO/IR multi-aperture seeker that can actively mitigate thermal loading associated with Mach 5+ flight while viewing forward through a hot nose cone. Innovative solutions are desired that can target surface and airborne objects without blind spots in the field of view.

DESCRIPTION: Hypersonic vehicles generate excessive aerodynamic heating from friction and shear forces at the boundary layer between the nose cone and the free stream air. The resulting convective and radiative heat-flux into the nose cone and viewing windows can elevate the temperature of those components beyond 800C, making window survival and forward viewing a formidable challenge. Multi-aperture imagers based on biological principles can distribute the entrance aperture across an array of small windows for which thermal stresses and gradients can be reduced significantly using active cooling. Cooling not only improves window survival, it also reduces thermal background noise, thereby enhancing target detection sensitivity. Innovative concepts are sought that take advantage of the design features of biologically inspired, multi-aperture technologies to demonstrate operational capability in high-speed regimes. The desired concept will be conformal to the nose cone to minimize aerodynamic heating and will be capable of viewing forward without blind spots obscuring any portion of the field of view. The optical image is to be captured on a middle wavelength infrared (MWIR) focal plane array (FPA), which will be cryo-cooled to increase its detection sensitivity. The optical system must be designed to have its exit pupil positioned at the cold shield aperture of the cryo-cooled MWIR FPA.

PHASE I: UPDATE: The technical work that would need to have been completed prior to the proposal being submitted in order for the applicants to demonstrate the necessary feasibility to move directly into Phase II are:

- A complete optical design for a multi-aperture infrared sensor intended for high-speed forward looking seeker applications.
- A complete thermal management design of an actively cooled infrared window with components that can survive beyond 800 C.
- Benchtop testing of components or sub-systems to demonstrate the design as a proof-of-concept. Therefore, if an optical design and thermal management design have already been completed and components have been demonstrated at a benchtop level, then the Phase I requirements have been met; and Phase II shall build a complete prototype and test in a relevant environment.

As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior "Phase I-type" effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. Phase I shall consist of a vetted optical design for a MWIR multi-aperture sensor and thermal management design of an actively cooled MWIR window. These designs shall be intended for high-speed forward looking seeker applications with components that can survive beyond 800 C. Furthermore, benchtop testing of components or sub-systems shall be performed to demonstrate the design as a proof-of-concept. AFRL/RWTSE has verified that these milestones have been met and a Direct-to-Phase II is required to mature the technology.

PHASE II: Implement, integrate and demonstrate hardware. Execute an experimental program using the prototype hardware to demonstrate performance capabilities and limitations. Document the prototype experimental results in preparation for a demonstration flight experiment.

PHASE III DUAL USE APPLICATIONS: Possible teaming with Lockheed Martin, using matching funds through AFWERX STRATFI program.

REFERENCES:

1. W. Tropf, M. Thomas, T. Harris, S. Lutz, "Performance of Optical Sensors in Hypersonic Flight," Johns Hopkins APL Technical Digest, Volume 8, Number 4 (1987);
2. D. Kalin, S. Mullins, L. Couch, T. Blackwell, D. Saylor, "Experimental investigation of high velocity mixing/shear layer aero-optic effects," SPIE Vol. 1326 Window and Dome Technologies and Materials II (1990);
3. L. Brooks, D. Kalin, B. Peters, "Experimentally simulated aero-optic measurements through multi-aperture windows," SPIE Vol. 1760 Window and Dome Technologies and Materials III (1992);
4. D. Kalin, L. Brooks, C. Wojciechowski, G. Jones, "Performance characterization of an internally cooled window in a nonuniform high heat flux environment," SPIE Vol. 3060 Window and Dome Technologies and Materials V (1997);
5. D. Harris, "Materials for Infrared Windows and Domes – Properties and Performance," SPIE Press, 1999, ISBN 0-8194-3482-5;
6. F. Reininger, "Multihybrid artificial compound eye with varied ommatidia," U.S. Patent No. 8,576,489. 5 Nov. 2013;

KEYWORDS: MWIR Imaging; Multi-Aperture; Biologically Inspired; Hypersonic; Aero Thermal Response; Cooling

AF233-D019 TITLE: Hardened Scalar and Vector Magnetometer Development

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

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OBJECTIVE: Develop an environmentally hardened sensor package to provide magnetic navigation aiding on manned, unmanned, and weapon systems. Hardware should be appropriate for high vibration, low and high temperatures and altitudes while providing high-rate, accurate, and accurately timestamped magnetic measurements

DESCRIPTION: Navigation in contested environments is a critical capability for the Air Force and DoD. More flight systems are beginning to employ non-GPS navigation aiding to increase system robustness in contested environments [1]. This effort seeks to develop or modify magnetometer sensor payloads in support of modular, service-based GPS-denied navigation capabilities. Hardware should provide a highly accurate measurement of the magnitude of the magnetic field (i.e. a scalar measurement) at a rate of 100Hz or higher (ideally 1000Hz), regardless of the orientation of the magnetic field relative to the hardware. The standard deviation of the scalar magnetic measurement error should be below 5nT, with 1-2nT preferred and should not experience prolonged measurement drop-outs. This may require multiple sensor heads, or any other approach that delivers consistent, high-rate measurements. However, output of the measurements of each individual head is desired. The system should also provide a measurement of the magnetic field vector at a rate of 25Hz or higher. The standard deviation of the measurement error in each axis of the magnetic vector sensor should be less than 100nT, with better than 25nT preferred. If the vector sensor can meet the scalar sensor requirement, i.e., the three measurements combined to meet the scalar specifications, no scalar sensor would be required [2]. Sensitivity of the magnetic sensors to environmental factors (e.g. temperature, pressure, humidity) should be well understood (and possibly compensated), and additional sensors to measure any relevant quantities that could affect the magnetic measurements should be considered in the development of the hardware package, e.g., a system temperature sensor or multiple sensors in the case higher resolution is necessary. Hardware solutions should target a small size, weight, and power (SWaP). The sensor package and necessary drivers/processors should target 12 cubic inches. Sensor development may target larger SWaP values if needed, however proposals meeting SWaP goals will be prioritized and proposals with larger SWaP goals must include a clear path to a reduced footprint. The system should accept a 1 pulse per second (PPS) time source to drive timestamping. When an external 1PPS is not provided, the hardware package should still maintain accurate relative time stamping between each individual sensor. Sensor and drivers/processors can be collocated or packaged separately. Any necessary cabling should be highly flexible, appropriate for varied lengths, and provide shielding to the sensor data transmitted. All external messaging to and from the sensor package will be based on the All-Source Positioning and Navigation (ASPN) 3.1 or higher ICDs wherever feasible. Relevant ASPN ICD information will be provided upon request.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. A successful "Phase I-type" effort will constitute the development of a hardware system bread-board level prototype demonstrating real-time, time-stamped magnetic scalar (possibly x2), vector, and temperature measurements UPDATE: A successful phase I effort will constitute the design of a hardware system bread-board level prototype demonstrating real-time, time-stamped magnetic scalar (possibly x2), vector, and temperature measurements.

PHASE II: A successful phase II effort will constitute the development of a hardware system and testing of real-time, time-stamped magnetic scalar (possibly x2), vector, and temperature measurements. Hardware development efforts will produce prototype hardware systems appropriate for flight environments, lab vibration, temperature, and altitude testing, and demonstrate data acquisition on AFRL-lead flights.

PHASE III DUAL USE APPLICATIONS: Phase III will consist of a) transitioning prototype sensor hardware to an operationally approved ASPN compliant navigation system on an operational UAV or weapon system and/or b) scaling production beyond 1-5 units to show MRL/repeatability.

REFERENCES:

1. A. Canciani and J. Raquet, "Airborne Magnetic Anomaly Navigation," in IEEE Transactions on Aerospace and Electronic Systems, vol. 53, no. 1, pp. 67-80, Feb. 2017, doi: 10.1109/TAES.2017.2649238;
2. A. J. Canciani and C. J. Brennan, "An Analysis of the Benefits and Difficulties of Aerial Magnetic Vector Navigation," in IEEE Transactions on Aerospace and Electronic Systems, vol. 56, no. 6, pp. 4161-4176, Dec. 2020, doi: 10.1109/TAES.2020.2987475.

KEYWORDS: Magnetometer; Navigation; GPS-denied; GPS-Degraded; Open Architecture; ASPN, Modular

AF233-D020 TITLE: Real-time Sensor Fusion ATA in Golden Horde Colosseum

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

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

OBJECTIVE: The objective is to expand the current vanguard modeling, simulation, and analysis (MS&A) ecosystem (Golden Horde Colosseum [GHC]) to include the ability to simulate swarming-munition fusion-based automatic target acquisition (ATA) capabilities. This will support digital engineering approaches to solving long standoff and denial and deception ATA challenges. The proposed research should explore approaches for bringing physics-based sensing and sensor fusion into the M&S environment that uses AFSIM for exercising battlespace scenarios. It will also help to establish fusion architectures that support collaborative ATA. The Golden Horde Colosseum Capability is a Multi-Tier Digital Weapon Ecosystem, consisting of a high fidelity, government owned, open architected live, virtual and constructive (LVC) development pipeline for networked collaborative autonomy (NCA) technology and tactics. The Colosseum enables accelerated delivery, evaluation, and verification of NCA weapon technologies across numerous AFSIM-based scenarios. Expanding this environment to include the fusion of a diverse mix of sensors and data sources for ATA is critical to the development of future systems. The GHC ecosystem would be expanded to include target identification and tracking in real-time based on a myriad of inputs. The inputs would include sensor measurements assigned to the weapons, as well as inputs from prior intelligence, surveillance, and reconnaissance (ISR) and contextual inference of the local terrain. This effort will require advanced algorithmic R&D to bring the reality of the physical world to a high-level simulation environment. It must also develop a collaborative architecture that can maintain real-time or faster than real-time processing. These competing goals of increased fidelity and reduced computational load will require AI/ML hardware-aware algorithms, efficient protocols, and software development. There are two complementary scenarios – long distance standoff that requires evolving in-route ATA and closer distance target specific ATA that addresses denial, deception, and other challenges to developing exquisite target state estimates (TSEs). Thus, both the architecture and simulation tools must support the exploitation of multiple categories of information. This means that background databases – including terrain, structures, and roads – as well as live measurement simulations must be simultaneously simulated. A stretch objective would be to support contextual inference and a priori information into the process. For instance, fusion algorithms need to be able to leverage terrain-based insights such as when a possible detection of a wheeled vehicle occurs in a tree-filled ravine where it could not operate. Other examples include a priori information from ISR assets or human insights such as sightings of a convoy of tanks in a general area of regard (AoR). The proposed research must enable and even foster the future development of these sophisticated data fusion algorithms. Note that this proposed work is meant to enable, encourage, and evaluate sensor fusion R&D, but it does not include fusion R&D efforts. Relevant sensor and data fusion R&D is being executed under complementary programs.

DESCRIPTION: In order to support Global Precision Strike capabilities using Networked Collaborative Autonomous (NCA) systems, there is a great need for simulation of the highly complex battlespace and ATA challenges, as well as the need for orders of magnitude increases in synthetically generated physical sensor-based outputs for Fusion R&D. The GHC ecosystem and AFSIM provide a great way to simulate both battlefield level scenarios and target specific engagements. To date, this ecosystem has focused on fleet management, probability of kill assessments, and other swarm guidance and control factors. The proposed effort would expand GHC/AFSIM to include real-time target identification (i.e., ATA) along with other target engagement support. This is the natural next step in advancing the state-of-the-art in NCA weapon engagements. The effort would involve R&D aimed at ray-tracing or alternate methods that balance high-fidelity and reasonable compute loads to represent physical entities as part of scene generation simulation. It would also require the ability to represent emerging AI/ML methods for converting those physical entities into sensor outputs. Further, it would require completing the signal exploitation pipeline by introducing efficient methods for fusing context, data, features, and/or low confidence TSEs to produce actionable target engagements. Finally, it would need to include the data sharing architecture that supports precise time, precise location, and multi-tiered information fusion. The topic of Contextual Information overlaps both Information Fusion and Machine Learning and has received increasing amounts of attention in the past few years. There are multiple kinds of contextual information (hard, soft, low-level, high-level) and determining how much context to include in a given mission requires system knowledge such as local compute resources, and communication bandwidths. The proposed work should enable research in this area by providing data and analysis of alternatives, but the development of that research area would be funded separately. The result would be both the ability to generate the much-needed orders of magnitude increase in synthetically generated data and the ability to assess fusion-based ATA approaches in a rich ecosystem. It would utilize the Golden Horde Autonomy Architecture (GHAA) for data sharing between platforms. The inclusion of GHAA would help flesh out an emerging de facto standard for sharing TSE-related data in real time between cooperating munitions. Golden Horde Autonomy Architecture establishes a Government-owned autonomy architecture to provide vendors/users with a set weapon autonomy architecture to which they can develop specific algorithms/plays/behaviors. The autonomy architecture is open and Future Airborne Capability Environment (FACE) compliant and capable of running SWAP constrained weapon hardware. The architecture also provides the direct interface to simulated weapons to rapidly test the new algorithms, plays, and/or behaviors in the Colosseum.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. In order to demonstrate the feasibility of research completion, the applicant must have experience doing development inside of the AFSim environment. as well as experience working with live virtual and constructive Modeling and Simulation (M&S) environments such as Golden Horde Colosseum (GHC). Additionally, to better understand the communication and physical simulation requirements posed by physical simulation of ATR algorithms in AFSim, the selected vendor must have experience either with automatic target recognition/acquisition or similar research. Investigate approaches to enable near-real-time data and information fusion on limited SWAP platforms to support collaborative automated target acquisition (ATA) in multi-target, multi-agent environments. Conceptualize, develop, and model an algorithmic solution that provides near real-time collaborative ATA for heterogeneous sensors.

PHASE II: In this direct to Phase II SBIR, there would be a heavy combination of algorithm focused R&D and efficient coding practices, with the encouragement of utilizing model-based design (MBD) methods. First a significant effort would be undertaken to determine how best to represent physical targets in a large-scale MS&A ecosystem. Approaches such as raytracing are often too computational demanding, although some of these methods utilize GPU hardware to overcome this. Other representations include point clouds, statistical models, and even some AI-based methods. Early efforts would focus on determining the best approach for each phenomenology (EO, IR, or RF). Dovetailing with those efforts would be AI/ML and other approaches for transforming the physical representations into features that represent both canonical and specialized sensor technologies. Finally, a baseline fusion algorithm would be leveraged from other programs to complete the pipeline from the I/Q or pixel level data provided by scene generation tools into target state estimates. This completely integrated system would then enable future Sensor Fusion R&D competitors to supply their own fusion algorithms that drop in place in lieu of the placeholder fusion software object or container. In addition to establishing the ATA sensor processing pipeline within GHC, there is a complementary requirement to advance the fusion architecture (GHAA) alongside this research. The architecture will provide the necessary infrastructure for assessing future sensor exploitation and fusion algorithms in the MS&A environment. Specifically, protocols such as peer-to-peer networking, precision navigation and timing (PNT) support, and data coordination methods must be developed in order to support fusion R&D that is operationally relevant. The GHC assessments would need to score competing fusion ATA approaches based on the following metrics: 1) Accuracy of classification (Pid) 2) Time to classification (secs or epochs) 3) CPU utilization (flops) 4) Memory requirements (RAM) 5) Comms requirements (kbps)

PHASE III DUAL USE APPLICATIONS: Other potential PH III military and commercial applications of this technology include advances made towards fusing automatic targeting information across other distributed airborne platforms, such as ISR; and advances made towards fusing object classification and identification information across heterogeneous sensors onboard an autonomous or semi-autonomous automobile.

REFERENCES:

1. De Villiers, J.P., Pavlin, G., Jousselme, A.L., Maskell, S., de Waal, A., Laskey, K., Blasch, E. and Costa, P., 2018. Uncertainty representation and evaluation for modeling and decision-making in information fusion. Journal for Advances in Information Fusion, 13(2), pp.198-215;
2. Snidaro, L., Garcia-Herrera, J., Llinas, J. and Blasch, E., 2016. Context-enhanced information fusion. Boosting Real-World Performance with Domain Knowledge.;
3. Mahalanobis A, Van Nevel A. Integrated approach for automatic target recognition using a network of collaborative sensors. Appl Opt. 2006 Oct 1;45(28):7365-74. doi: 10.1364/ao.45.007365. PMID: 16983426;
4. Rao, Nageswara SV, David B. Reister, and Jacob Barhen. "Information fusion methods based on physical laws." IEEE transactions on pattern analysis and machine intelligence 27, no. 1 (2005): 66-77.;
5. M. Robinson, J. Henrich, C. Capraro and P. Zulch, "Dynamic sensor fusion using local topology," 2018 IEEE Aerospace Conference, 2018, pp. 1-7, doi: 10.1109/AERO.2018.8396546.

KEYWORDS: Sensor Fusion; Networked Collaborative Autonomy; Automated Target Acquisition; Scene Generation; Digital Engineering; Modeling Simulation and Analysis;

AF233-D021 TITLE: Subscription-Based, Real-Time UAS Detection, Tracking, and Identification

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces

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

OBJECTIVE: Design and develop an affordable and scalable subscription-based, real-time UAS tracking information system to provide authorized DoD end users with tailorable data feeds (UAS identity, location, and altitude) to meet DoD security and operational needs.

DESCRIPTION: The United States (U.S.) Department of Defense (DoD) is responsible for ensuring the safety, security, and protection of DoD personnel, facilities, and assets from various threats or hazards, including certain UAS operating in the National Airspace System (NAS). Given the increasing adoption of UAS for various legitimate purposes (recreation, commerce) and the potential for malicious actor use, DoD has a need to detect, track, and identify UAS operating in proximity to certain DoD facilities and assets in the U.S., pursuant to all applicable federal, state, and local laws and regulations. In the U.S., outside of certain DoD facilities, UAS tracking, unlike tracking of manned aircraft, is nearly non-existent, which introduces new risks to the safety, security, and protection of DoD personnel, facilities, and assets. As the Federal Aviation Administration (FAA) pushes out direction on how to integrate UAS into the NAS—including the remote identification of unmanned aircraft—there is an anticipated need for geographically scalable, filterable, and affordable commercial hardware and software solutions for UAS tracking, fusion, and data integration of existing and future DoD information systems. This approach would allow for widespread coverage and need-based service and cost levels to address DoD's dynamic current and future needs. Acceptable proposals may consider novel or efficient methods for detecting, tracking, and identifying UAS (compliant and/or non-compliant with applicable FAA rules and regulations); fusing, moving and storing data; and secure ways for providing data, in real-time, to authorized DoD entities with responsibility to ensure the safety, security, and protection of DoD personnel, facilities, and assets. In particular, proposals shall address how data feeds will be tailored or filtered to only include data (UAS location, altitude, identity) associated with certain UAS operations in the NAS (e.g., UAS operating in proximity to DoD covered facilities and assets pursuant to section 130i, Title 10, U.S. Code). Additionally, proposed solutions shall demonstrate compatibility with current and future FAA remote identification standards and rules, and the ability to integrate with existing and future DoD information systems.

PHASE I: This is a Direct to Phase 2 (D2P2) topic. Phase 1 like proposals will not be evaluated and will be rejected as nonresponsive. For this D2P2 topic, the Government expects that the small business would have accomplished the following in a Phase I-type effort via some other means (e.g. IRAD, or other funded work). It must have developed a concept for a workable prototype or design to address at a minimum the basic capabilities of the stated objective above. Proposal must show, as appropriate to the proposed effort, a demonstrated technical feasibility or nascent capability to meet the capabilities of the stated objective. Proposal may provide example cases of this new capability on a specific application. The documentation provided must substantiate that the proposer has developed a preliminary understanding of the technology to be applied in their Phase II proposal to meet the objectives of this topic. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.

PHASE II: Based on current performance and effectiveness data this effort would provide a new offering in industry to fill this warfighter need. Proposals must define expected final performance data and evidence to support it. The proposal must address design features in terms of at least: i. Employment strategy for UAS sensors providing coverage in proximity to DoD equities located throughout the U.S. (pursuant to all applicable federal, state, and local laws and regulations); ii. Hardware or software guardrails to ensure data feeds are tailored or filtered to only include authorized DoD user needs; iii. Scalability and affordability curves for notional adoption and subscriptions; iv. Sensor to Database and Database to User Security plans; v. User Data consumption technical approach; and vi. Open architecture approach to support adaptability and integration with other systems. vii. Integration with at least one DoD information system.

PHASE III DUAL USE APPLICATIONS: The Government has an interest in transition of the demonstrated concept to an operational capability in support of many MAJCOM and COCOMs across the DoD.

REFERENCES:

1. FAA, "Concept of Operations v2.0", https://www.faa.gov/researchdevelopment/trafficmanagement/utm-concept-operations-version-20-utm-conops-v20 2. FAA, https://www.faa.gov/uas

KEYWORDS: UAS activity, Drone, Remote ID, RF, Signal Detection, Radar Detection, Data Fusion, Data Management, Cloud data, AF233-D022 TITLE: Austere Cargo Offload and Onload System

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

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

OBJECTIVE: Develop a system capable of working with the 463L Pallet Cargo Handling System to offload and onload cargo pallets from aircraft in austere and standard environments.

DESCRIPTION: Numerous government and private industry groups have experienced the challenges of material handling in an austere environment where normal methods, supported by local infrastructure, are sparse or non-existent. Current technology designed to be supported by local infrastructure does not translate well to austere environments for a multitude of reasons. Austere environments can be expected to include non-paved surfaces, rolling terrain, poor access to local material handling equipment, poor access to local energy sources including suitable fuel, and tight access to airfields and aprons. Furthermore, existing onload/offload equipment is large and heavy, prohibiting transport with the cargo. In a future fight, it is expected cargo aircraft like C-130s and C-17s will have to increasingly rely on austere bases that are smaller and lack modern aerial port amenities. In order to align with operational imperative 5 (see Reference 1), resilient basing, a system needs to be developed that allows for easy offload and onload of cargo in the 463L Pallet Cargo Handling System (see Reference 2) on C-130s and C-17s. Current systems like modern forklifts are too large and heavy to bring in with the cargo, and too expensive and vulnerable to stage ahead of time or leave behind at these remote, unserviced airfields. In addition, the system to be developed needs be transported with the incoming cargo aircraft. The maximum allowable physical size of the system should be limited to the capabilities of a single standard 463L pallet position.

PHASE I: This is a Direct to Phase 2 (D2P2) topic. Phase 1 like proposals will not be evaluated and will be rejected as nonresponsive. For this D2P2 topic, the Government expects that the small business would have accomplished the following in a "Phase I-type" effort via some other means (e.g. IRAD, or other funded work). It must have developed a concept for a workable prototype or design to address at a minimum the basic capabilities of the stated objective above. Proposal must show, as appropriate to the proposed effort, a demonstrated technical feasibility or nascent capability to meet the capabilities of the stated objective. Proposal may provide example cases of this new capability on a specific application. The documentation provided must substantiate that the proposer has developed a preliminary understanding of the technology to be applied in their Phase II proposal to meet the objectives of this topic. Documentation should include all relevant information including, but not limited to technical reports, test data, prototype designs/models, and performance goals/results.

PHASE II: Develop a new method or system to offload and onload cargo from aircraft that utilize the 463L Pallet Cargo Handling System that will work in austere locations. i. Develop and demonstrate a method or system, compromised of one or more pieces of equipment, that is capable of handling a 10,000 lbs ISU 90 standard container ii. Develop and demonstrate a method or system that can transport a 10,000 lbs ISU 90 standard container from the cargo bay of the aircraft 500 ft away from the flightline iii. The method or system should be designed to function in an austere environment that could include, but is not limited to salt fog, packed dirt runways and aprons, lack of other common support equipment, and sparse fuel and electrical power availability iv. Develop matrix of operational tradeoffs relating to employing the new system v. Generate Interface Control Document (ICD) and overview descriptions in parallel with the system development. vi. System needs to be deployable with the inbound cargo aircraft, weigh less than 10,000 pounds and fit, in the transport configuration, onto a 463L pallet position or smaller. vii. System needs to be rapid deployable and ready to offload or onload cargo with 10 minutes of the plane coming to a stop and lowering the ramp. Complete the design of the system, demonstrate performance of a prototype system through field testing, and deliver the prototype for subsequent evaluation by the government.

PHASE III DUAL USE APPLICATIONS: The Government has an interest in transition of the demonstrated concept to airfield operations and cargo delivery, but offer options for weapons loading and other aerial port operations in both austere and well-supported locations. Solutions may have application to commercial air cargo operations, warehouse material handling operations, and construction.

REFERENCES:

1. Department of the Air Force Operational Imperatives, https://www.af.mil/Portals/1/documents/2023SAF/OPERATIONAL_IMPARITIVES_INFOGRAPHIC.pdf
2. J. Schroeder, C. Martinez, G. Galloway; USAF Pallet and Dunnage System Evaluation, 1997 https://apps.dtic.mil/sti/pdfs/ADA356785.pdf
3. Management and control of Intermodal Containers and System 463L Equipment, Defense Transportation Regulation – Part VI https://www.ustranscom.mil/dtr/part-vi/dtr_part_vi_608.pdf

KEYWORDS: Contested Logistics, austere operations, austere environment, aerial port, logistics, cargo handling, forklifts, material handling equipment (MHE), onload, offload, combat offload

AF233-D023 TITLE: TAK Mobile Machine Learning (MML) Model Development

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

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

OBJECTIVE: The objective of this topic is to develop and train cutting-edge machine learning models for edge deployment via TAK using the Model Integration Software Toolkit (MISTK) format.

DESCRIPTION: Training can be accomplished server-side, but inference must be done on device. TAK-ML, a client and server-side framework for ML development, and NodeDrop, a technology to reduce the size of neural networks without affecting efficacy, are provided to performers. Sample models/algorithms developed in and integrated with TAK-ML are provided (e.g., biometrics, edible plants). Example use cases may include, but are not limited to geolocation, command and control, search and rescue, surveillance, communications, IOT, cloud or intelligence (including open-source intelligence). Use of digital engineering tools to at a minimum define the APIs and where applicable build reference implementations is preferred. Leveraging TAK-ML and StreamlinedML to integrate into the TAK ecosystem is strongly preferred.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a "Phase I-like" effort, in this instance demonstrating familiarity and proficiency with applied machine learning, preferably at the tactical edge.

PHASE II: As an applied ML topic, Phase II objectives mirror standard machine learning lifecycle steps to include data collection, model architecting and design, implementation either standlone or via registration/integration with provided AFRL toolkits, training, testing, and evaluation at the tactical edge.

PHASE III DUAL USE APPLICATIONS: Successful Phase II technology development will be eligable for additional Phase III work, with specific transition paths depending on the domain and problem set selected by the proposer. AFRL will work with the Tactical Assault Kit (TAK) Product Center (TPC) and domain-relevant end-user communities to promote transition of machine learning models that reach sufficient TRL (5-7) and interface well with mobile end-user devices in use by operators in the field.

REFERENCES:

1. https://mistkml.github.io/;https://github.com/raytheonbbn/tak-ml;https://dl.acm.org/doi/abs/10.1109/MILCOM52596.2021.9652909;
2. https://tak.gov;https://civtak.org

KEYWORDS: mobile machine learning; end-user devices; edge computing; machine learning/artificial intelligence; resource constraints

AF233-D024 TITLE: Integration of Machine Learning (ML) Platforms with a Mobile Device Manager (MDM) for the TAK Ecosystem

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced 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 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 integrate a Mobile Device Manager (MDM) with a machine learning (ML) management infrastructure (StreamlinedML, WingmanAI) to allow the ability to define, compare, evaluate, train, deploy, and update ML Models for use in Mobile Machine Learning (MML) applications which support the TAK ecosystem in a secure, reliable environment for both cloud-based and disconnected environments.

DESCRIPTION: The Tactical Assault Kit (TAK) ecosystem currently has no end-to-end means to evaluate, compare, fine tune, and deploy MML to end user devices at scale. The environment should enable the comparison of models (e.g., Model Cards) with onboard inferencing. Provide the ability to scan ML models to check functionality, security, and reliability. Provide enterprise management of a “Marketplace” for ML models within the MDM’s “App Store”. Support both connected and disconnected environments. Provide the ability to review and version control, models and apps/plugins before analytics are pushed back to the developers on how the models are used. StreamlinedML, a government ML management and TAK-ML, a TAK-oriented ML development framework, are provided to performers. Use of digital engineering tools to at a minimum define the APIs and where applicable build reference implementations is preferred.

PHASE I: This topic aims at D2P2 awards with a "Phase I-type" minimum feasibility study that demonstrates experience developing, deploying, orchestrating, integrating and managing the likes of a Tactical Assault Kit (TAK) with a Mobile Device Manager in conjunction with a machine learning (ML) management infrastructure framework that supports the evaluation, comparison, fine tuning and deployment of Mobile Machine Learning to end user devices at scale.

PHASE II: The phase II objective of this topic seeks to integrate a Mobile Device Manager (MDM) with a machine learning (ML) management infrastructure (StreamlinedML, WingmanAI) to allow the ability to define, compare, evaluate, train, deploy, and update ML Models for use in Mobile Machine Learning (MML) applications which support the TAK ecosystem in a secure, reliable environment for both cloud-based and disconnected environments. StreamlinedML, a government ML management and TAK-ML, a TAK-oriented ML development framework will be provided to performers. Use of digital engineering tools to at a minimum to define the APIs and where applicable build reference implementations is preferred.

PHASE III DUAL USE APPLICATIONS: Successful Phase II technology effort reaching suitable TRL (6-7) will be candidates for additional Phase III development, including potential for transition to the Tactical Assault Kit (TAK) ecosystem in partnership with the TAK Product Center (TPC). In addition, Phase III efforts will focus on delivering the TAK mobile device manager technology with a machine learning (ML) management infrastructure to potentially a broader speactrum or series of diversed customers for operational use in a relevant commercial/civilian, or government/military working environment.

REFERENCES:

1. https://tak.gov;https://civtak.org;
2. https://dl.acm.org/doi/abs/10.1109/MILCOM52596.2021.9652909;
3. https://github.com/raytheonbbn/tak-ml;https://github.com/mistkml/mistk

KEYWORDS: mobile machine learning; machine learning model verification; mobile device management; machine-learning marketplace; machine-learning model cards

AF233-D025 TITLE: Improved Data Collection and Knowledge Graphing in the TAK Ecosystem

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

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

OBJECTIVE: The objective of this topic is to demonstrate a capability to define, capture, organize, label, and reason over the data that is generated by end-user devices and servers in the Tactical Assault Kit (TAK) ecosystem for use by machine learning model development, re-training, fine tuning, and federated learning of existing models, or consumption by AFRL ML tools.

DESCRIPTION: The TAK ecosystem currently has a wealth of sensor data, usage data, and analytics that is under-utilized for artificial intelligence/machine learning (AI/ML). Leverage general-purpose machine learning (ML) tools (StreamlinedML/MISTK, WingmanAI), Android sensor hubs (TAK-ML sensor framework, Foresight and Sensor Manager), and semantic network/knowledge graphing tools (KnowML, FuelAI) to extend the TAK-ML framework. Accept analytics back from any frameworks, models, or plugins developed for further refinement. Use of digital engineering tools to at a minimum define open application programming interfaces (APIs) and where applicable build reference implementations is preferred.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including experience with extension, modification, or creation of enterprise machine learning life cycle management toolkits for knowledge graphic, data curation, and related machine learning tasks.

PHASE II: Phase II objectives include the development of technologies to collect, reason over, and harness data from the TAK ecosystem for use in machine learning tasks, demonstrating integrations with (and extensions of) AFRL toolkits such as TAK-ML, StreamlinedML/MISTK, and KnowML to apply broader Air Force machine learning development to the tactical edge.

PHASE III DUAL USE APPLICATIONS: Successful Phase II technology effort reaching suitable TRL (6-7) will be candidates for additional Phase III development, including potential for transition to the Tactical Assault Kit (TAK) ecosystem in partnership with the TAK Product Center (TPC) or to other AFRL programs developing next generation AI/ML capabilities.

REFERENCES:

1. https://github.com/raytheonbbn/tak-ml;
2. https://dl.acm.org/doi/abs/10.1109/MILCOM52596.2021.9652909;
3. https://mistkml.github.io/;
4. https://tak.gov;
5. https://civtak.org;

KEYWORDS: semantic web; knowledge graphing; mobile machine learning; end-user devices; data analytics; ATAK

AF233-D026 TITLE: OptiFrame-- Topology Optimized Load-Bearing Airframe with Additive Manufacturing

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

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

OBJECTIVE: This topic seeks to develop a new design and manufacturing paradigm capable of rapidly producing a low-cost, lightweight, full-scale airframe structure for a next-generation aircraft system by combining topology optimization (TO) and additive manufacturing (AM) technologies. The new design tool and printed structure will be evaluated by ground testing, during which the new and baseline structures will be compared based on weight, stiffness, strength, cost, fatigue life, and manufacturing time.

DESCRIPTION: The Department of the Air Force is exploring the concept of design for manufacturing to enable agile development and delivery of full-scale airframe structures for next-generation air vehicles. Air Force Research Laboratory (AFRL) is assessing emerging airframe design tools and 3D printing technologies to address rapidly changing warfighter needs more efficiently during airframe design and manufacture. The emergence of new design and manufacturing technologies, such as TO and AM, provides possible solutions to improve the development and delivery of capable airframe structures. First, TO offers design freedom, allowing structures to be designed around load paths rather than constrained to orthogonal rib and spar layouts. Second, AM offers manufacturing freedom, using truly toolless fabrication to manufacture complex geometries without the need for extensive machining. The combination of TO and AM opens the door to new possibilities in the design and manufacture of airframe structures. Current developments in TO and AM technologies have shown the power of TO and AM in addressing design and manufacture at the component scale, but further work is needed to prove the power of TO and AM at the structural scale. For example, TO is widely used to design optimal geometries at the component scale, but the design of a large-scale structure system with TO has yet to be proven. Similarly, AM technologies are available to manufacture parts at the component scale, but the inherent link between the printing footprint of AM machines and maximum producible part size precludes the complete manufacture of full-scale structures. This effort aims to explore a new hybrid way of designing and manufacturing a full-scale, load-bearing airframe structure at a fraction of the time and cost without sacrificing structural capabilities such as weight, stiffness, strength, and fatigue life. The hybrid approach will harness the complementary capabilities of TO and AM in creating an approach that can adapt to fast-changing mission needs. TO will be used to design an airframe structure that is divided into the minimum number of segments, considering the maximum AM print part size. Toolless fabrication capability, enabled by AM, is essential to produce the resulting TO structures efficiently. The entire system should be printed, including the wing skin, and each segment will be printed with novel joint concepts to minimize assembly efforts and the number of parts. The material is not limited to polymer, chopped/continuous fiber, metal, or any combination thereof to build the most weight-efficient structure, but the load-bearing airframe structure should satisfy the stiffness and strength requirements of over a 10,000 lb vehicle. A baseline structure will be provided upon selection of the award. The main deliverable for this topic is a redesigned, full-size, printed airframe structure matching AF’s provided baseline structure. The contractor should analyze, design, build, and test to validate the new printed structure and demonstrate that the fabricated structure will be equivalent to or outperform the baseline structure.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior "Phase I-type" effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. The proposer should have already demonstrated a technology to prove the concept at a scaled or component level, including a feasibility study prior to submitting a proposal. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The applicant should have defined a clear, immediately actionable plan with the proposed solution. Relevant areas of demonstrated experience and success include designing and modeling prototype concepts, concept development, concept demonstration, concept evaluation, and field testing. Phase I-type efforts include the assessment of the structural concept and the potential for 3D printing.

PHASE II: This effort shall conduct analysis, tool development, experimentation, and fabrication of representative full-size prototype systems to address unique requirements that may not be otherwise met by a scaled conventional airframe design and fabrication.

PHASE III DUAL USE APPLICATIONS: Phase III shall include the fabrication of more complex prototypes, such as a full vehicle.

REFERENCES:
1. Taylor, Robert & Niakin, Bijan & Lira, Nicholas & Sabine, Gavin & Lee, Joakim & Conklin, Craig & Advirkar, Sangram. (2020). Design Optimization, Fabrication, and Testing of a 3D Printed Aircraft Structure Using Fused Deposition Modeling. 10.2514/6.2020-1924. ;
2. https://www.ga.com/ga-asi-partners-with-divergent-technologies-inc;
3. https://www.forbes.com/sites/erictegler/2023/04/27/uas-startup-firestorms-ambition-to-crank-out-combat-drones-fast-cheap-and-en-masse-is-a-lesson-for-dod/?sh=168b9f871409;
4. https://aviationweek.com/aerospace/advanced-air-mobility/firestorm-flies-modular-3d-printed-small-uas;

KEYWORDS: topology optimization; additive manufacturing; low-cost UAV; design for manufacturing; ACP; lightweight structure;

AF233-D027 TITLE: GPU Accelerated Large Eddy Simulation for Low Pressure Turbine Design

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

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

OBJECTIVE: To increase the fidelity of turbine aerodynamic predictions performed during the design cycle via the adoption of Large Eddy Simulation techniques that are enabled by Graphical Processing Unit (GPU) architectures to achieve unprecedented turnaround times for the completion of calculations

DESCRIPTION: Large Eddy Simulation (LES) represents a substantial increase in the fidelity of viscous modeling used in turbomachinery design. LES is an essential capability for the accurate prediction of flows over Low Pressure Turbine (LPT) airfoils at conditions that are consistent with high-altitude Unmanned Air Systems (UAS). Successful application of LES in the design cycle of an LPT is expected to yield geometries that have unprecedented levels of lift, work, and resistance to flow separation at high altitude conditions. This would lead to substantial reductions in engine weight, length, and cost while at the same time enabling increased engine fuel-efficiency as well as increased range, endurance, and ceiling for an UAS. However, the grid topologies required to obtain accurate LES simulations of LPT flowfields make it impossible to complete such calculations in a timely manner for design purposes. Typically, LES simulation is a research tool used to increase the understanding of turbomachinery flow physics, and it is not currently used in the turbine design cycle at any Original Equipment Manufacturer for jet engines due to the large calculation times required by state-of-the-art, commercially available flow solvers. Fortunately, the application of advanced computer architectures incorporating Graphical Processing Units (GPUs) to flow solvers for turbomachinery holds the promise of reducing the turnaround time required for such flow simulations to a level consistent with design iterations. Accordingly, an SBIR project is proposed to apply GPU architectures to an available flow solver (or flow solvers) and to demonstrate the efficacy of that capability for design purposes. Long range, high endurance Unmanned Air Systems are an essential component of an effective Tactical Air Dominance, NGAD Family of Systems capability. This effort is in keeping with the Air Superiority 2030 Flight Plan which states that “development efforts for … persistent ISR capabilities will focus on multi-domain alternatives for placing the right sensor in the right place at the right time.” Increases in turbine aero-performance at high altitude lead directly to increased range and endurance for Unmanned Air Systems, and operationally this leads to increased time on station. Finally, this effort is an excellent illustration of the intent of the S&T 2030 document which states that “the Air Force will increase focus on and strengthen relationships with … industry” and that “partnerships will expand and strengthen to draw technology out of government, university, and industry laboratories and mature it into transformational operational capabilities.”

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. Accordingly, to qualify for consideration under this D2P2 topic, applicants must have accomplished the following in a prior "Phase I-type" of effort: Perform initial Large

Eddy Simulation code development along with proof-of-concept calculations and a demonstration of potential improvements in turnaround time through use of GPU architectures on a Low Pressure Turbine airfoil of interest to the USAF. An example airfoil of interest is the well known Pack B airfoil that is widely distributed throughout industry, government, and academia and is readily found in the open literature.

PHASE II: Perform code development and demonstration of net improvements in turnaround time through use of GPU architectures for Large Eddy Simulations of Low Pressure Turbine stages. Perform code validation studies against datasets defined by both the USAF and an Original Equipment Manufacturer of turbine engines.

PHASE III DUAL USE APPLICATIONS: Commercialize and transition GPU-enabled LES code to tier 1, tier 2, and tier 3 OEMs for turbine engines and additional government agencies.

REFERENCES:

1. Kerestes, J., Marks, C., Clark, J., Wolff, J., Ni, R-H., and Fletcher, N., 2023, "LES Modeling of High-Lift High-Work LPT Blades, Part II: Validation and Application," ASME Paper No. GT2023-101950.

KEYWORDS: Low pressure turbine; GPU computing; Large eddy simulation; Turbine design

AF233-D028 TITLE: Video Imaging for Patrol and Emergency Management

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

OBJECTIVE: The objective of this project is to develop a mobile camera system that meets the Air Force Security Forces Center's specifications. The system should be lightweight, compact, durable, and equipped with 360° thermal vision. It should also be capable of live streaming the video feed to a separate video source that is carried by the officer and is also available to controllers at the Defense Operations Center.

DESCRIPTION: The proposed mobile camera system for law enforcement and military use would feature a tetherable, compact and lightweight design, allowing for easy integration with an officer's standard duty gear. The camera would be engineered to be highly durable and capable of withstanding harsh conditions and aggressive impacts, such as being thrown into a room or down a flight of stairs. The camera's casing and lens would be made from high-quality materials to ensure optimal functionality in any environment. The tether would allow for system retrieval from areas where situational awareness is required but physical entry to the area would be catastrophic for its operator. The camera's casing and lens would be made from high-quality materials to ensure optimal functionality in any environment. To provide enhanced situational awareness and threat detection capabilities, the camera would be equipped with 360° thermal vision. This feature would allow officers to view a complete picture of the room or area under surveillance, eliminating the need for them to enter and potentially endanger themselves or others. The camera would also be equipped with night vision and zoom capabilities, providing additional surveillance options in low-light and longrange scenarios. The camera system would also be designed to allow for live streaming of the video feed to a separate video source that is carried by the officer and is also available to controllers at the Defense Operations Center. This would enable real-time analysis of the video feed, providing critical information to officers and command centers in emergency situations. The camera system would be designed to be easily deployable, with the officer able to throw the camera into a room before entering, allowing them to quickly and accurately vet the room for potential threats. The camera's compact size and lightweight design would make it easy to carry and maneuver, ensuring rapid deployment and efficient use in high-pressure situations. To meet the Air Force Security Forces Center's requirements, the camera system would need to be highly durable, compact, lightweight, and equipped with 360° thermal vision. The camera system would also need to be easily deployable and retreivable utilzing a tether to or something similar to retrieve. Capable of live streaming the video feed to a separate video source

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. The development plan would involve concept design, component selection, prototype development, testing and evaluation, and deployment. The estimated costs for the development of the mobile camera system would depend on various factors, such as the cost of components, research and development, and testing and evaluation.

PHASE II: System Development, Testing, Deployment Testing and Evaluation: The camera system would undergo rigorous testing and evaluation to ensure its safety, effectiveness, and compatibility with other equipment and technology. Testing scenarios would assess the camera's performance in different environments and against various targets, evaluating its ability to withstand impact, accuracy, and provide a complete view of the room without the need for the officer to enter. Deployment; The camera system would be integrated into existing operational procedures, including training and education for security forces. Logistical and operational considerations would also need to be addressed, including distribution and handling of any malfunctions

PHASE III DUAL USE APPLICATIONS: Expand the capability of a camera system by conducting further research and development to identify additional features or improvements that could be made to enhance its effectiveness and versatility. Additionally, expanding the system's capability would require ongoing testing and evaluation to ensure that any new features or improvements do not compromise the safety of security forces or the system's effectiveness. This testing and evaluation process could involve simulated scenarios and real-world testing under controlled conditions. Finally, expanding the capability of the system would also require ongoing training and education for security forces to ensure that they are equipped with the knowledge and skills necessary to use the system in various situations effectively. This could involve regular training exercises and simulations, as well as incorporating the system into the standard training curriculum for security forces

REFERENCES: 1. AFI 31-101

KEYWORDS: Active shooter; Law enforcement; Security forces; Mobile camera system; Room vetting; Moving target engagement; Lightweight; Compact; Durable; Hi-impact; 360° thermal vision; Live streaming; Testing and evaluation; Deployment; Safety; Effectiveness; Commercial development; Situational awareness; Emergency response; Versatility

AF233-D029 TITLE: Low-Loss Magnetless Optical Isolators for Quantum Integrated Photonics Applications

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

OBJECTIVE: This topic seeks to develop wafer scale processes to produce compact and robust low loss, magnetless, magneto-optic isolators. This technology should show a path towards compatibility with commercial silicon photonics foundries (preferably AIM Photonics), either through homogeneous, hybrid, or heterogeneous integration. These isolators should target isolation of 780 nm optical wavelength for quantum applications, and have an optical loss of < 3 dB, and an isolation ratio of > 20 dB. Due to the 780 nm wavelength, it is anticipated that integration with the semiconductor photonics platform may be through an intermediate dielectric waveguide layer such as silicon nitride. However, other approaches may be proposed, provided the optical loss specification can be met. Optical loss is of critical importance in single photon quantum systems. Judicious selection of the magneto-optic material or device structure, low scatter loss waveguides, design of mode matching device structures will be an important aspect of the isolator integration development process.

DESCRIPTION: Optical isolators are a key element in preventing the deleterious effects of back reflections and standing waves in integrated photonic circuits. Quantum technologies are especially susceptible to these effects since they are inherently highly coherent systems operating at extremely small photon counts, with a high integration density on a single compact chip. The most common type of optical isolator is based on the Faraday magneto-optic effect, of which bulk isolators are currently available that are based on externally applied magnetic fields. Fiber-connectorized isolator components are available, but are still based on discrete free space coupled bulk elements within the component package. Demonstrations of quantum key distribution and sensing have been done at the benchtop level using such discrete parts. The challenge now is to implement these circuits in a chip-scale integrated photonic form-factor such that they are robust and compact enough to place on airborne and space platforms. While integrated magneto-optic isolators have been realized, they typically rely on external magnets, either from a permanent magnet or from an electromagnet. An important requirement for quantum technologies is that the isolator element be magnetless since the presence of a magnetic field in a high density photonic circuit can disrupt single photon quantum entanglement processes. Additionally, it is also anticipated that such magnetless integration will reduce the size and cost of these circuits through wafer scale production and economies of scale. Significant strides have been made in developing magnetless integrated isolators that operate at telecommunications wavelengths, and other efforts have scaled the technology to operate at the 780nm wavelength targeting quantum applications. These works have typically relied on the use of latched magneto-optic films or through resonant acousto-optic effects.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-type” effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. Device designs demonstrating the ability for magnetless optical isolation must be provided either through simulation, or preferably, previously-fabricated and tested devices. While operation at 780nm and integration within a commercial foundry-like platform are not required for the proposal, a realistic plan to take the previously designed device to this point must be provided.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the device design and fabrication process for the 780nanometer isolator structure. This device will then be fabricated and characterized, with the intended performance meeting the required specifications. This device structure must then be adapted to a platform compatible with commercial integrated photonics foundries (preferably AIM Photonics). Ideally, work with the commercial foundry will begin and proposer will demonstrate preliminary integration of the device design with the foundry itself (for example, successful integration and characterization of a magneto-optic material bonded to the AIM Photonics interposer platform). At the end of the effort, reports and characterization results will be provided to AFRL, as well as a fabricated device for independent test verification in AFRL's laboratories. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the device design developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications through a commercial integrated photonics foundry. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program. This work should meet at least Technology Readiness Level 4 before entry into Phase III, and a specific foundry for which the technology will be inserted must be identified. The foundry must be accessible by the DAF for DoD applications (this will place limitations on overseas foundries), and will be preferably domestic.

REFERENCES: 1. E. Kesto, V. Stenger, A. Pollick, S. Nelson, M. Levy. (2022) Bias-Magnet-Free Optical Isolating Ridge Waveguide Operating at 780 nm. Journal of Lightwave Technology 40:18, 6207-6212, (2022);

2. Sohn, D.B., Örsel, O.E. & Bahl, G. Electrically driven optical isolation through phonon-mediated photonic Autler–Townes splitting. Nat. Photon. 15, 822–827 (2021);

3. M. Serrano, Y. Shoji, T. Mizumoto, "Small magnetless integrated optical isolator using a magnetized cobalt ferrite film. IEICE Electronics Express. 19. 10.1587/elex.18.20210500. 2021;

4. G. Portela, M. Levy, H.E. Hernandez "Magnetless Optical Circulator Based on an Iron Garnet with Reduced Magnetization Saturation," Molecules (Basel, Switzerland) vol. 26, 15 4692, (2021);

KEYWORDS: isolator; magneto-optic; integrated photonics; quantum

AF233-D030 TITLE: Autonomous Airfield Repair Robotics Swarm Platform

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

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OBJECTIVE:

To demonstrate the ability for a robotic swarm platform to autonomously accomplish airfield repair tasks currently performed by personnel. This includes damage assessment, UXO identification and removal, spall and crater repair, paint striping, and airfield lighting.

DESCRIPTION:

Currently, repairing an airfield after attack is a manually intensive and time-consuming task, with numerous interrelated and sequential tasks needing to be done by dozens of personnel. Even in the most ideal circumstances, this requires substantial training, large amounts of equipment, and an airfield free from the possibility of being attacked before repairs are complete. This is a set of assumptions that is increasingly difficult to make in today's contested environments. Rather, adapting robots to the various tasks needed to repair an airfield and having a swarm accomplish these interrelated tasks removes several of the assumptions and has the potential to get the overall effort done faster and with less errors.

PHASE I:

As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior "Phase I-type" effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. The applicant must be able to demonstrate its technical solution can accomplish the following to show the feasibility of adapting the technical solution into a prototype: 1) a software platform capable of monitoring and reporting on the status, location, and current operation of dozens of individual robots as well as commanding them to do a set of tasks in a given area, 2) a base robotic platform capable of being fitted with various attachments to accomplish different tasks, 3) the ability for an individual robot to sense its environment and adapt what it is doing to the situation (e.g., noticing a 5 foot deep crater and navigating around it, avoiding other robots or large debris), 4) a drivetrain or similar locomotion that is able to navigate extremely uneven terrain and self-right in the event of tip-over or similar, 5) the ability to do operations completely autonomous within the swarm with no outside communication.

PHASE II: The Government will seek awardees to adapt their existing technology to the specific requirements of airfield damage repair and recovery. This will include: 1) determining the technical requirements for each task and the ones best suited for demonstrating the potential of further development and scaling, 2) adding various attachments appropriate to needed tasks, 3) adapting the existing software platform to monitor and control the new tasks, 4) iterating through various approaches to operations flow as the interrelated tasks start and complete over time, 5) demonstrating the use case from objective 1 in a live setting.

PHASE III DUAL USE APPLICATIONS: From a military standpoint, extending the functionality of the robot swarm beyond this use case will be comparatively simple with the basic framework already in place and demonstrated. Adapting the technology to further simple tasks in different environments will create a force multiplier effect on the technology itself, benefiting the military far beyond this first use case. From a commercial standpoint, autonomous robots that can perform interrelated but simple tasks from either centralized control or as a networked swarm has application in numerous fields beyond airfield damage repair. Natural disaster recovery could have robots removing debris, locating survivors in hard-to-reach places, delivering supplies, etc. Performing maintenance in remote areas could be simplified by having robots stationed there instead.

REFERENCES:

1. Department of the Air Force, “Introduction to Rapid Airfield Damage Recovery (RADR)”, AFTTP 3-32.10, 15 Oct 2019;
2. Bell, Haley P., Cox, Benjamin C., Edwards, Lulu, Garcia, Lyan I., et al, “Rapid Airfield Damage Recovery Technology Integration Experiment”, US Army Corps of Engineers Engineer Research and Development Center, June 2019;

KEYWORDS: Airfield repair; robotics; autonomous; swarm; crater; UXO; multi-purpose; robot

AF233-D031 TITLE: Rapid Fly Mobile UAS

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

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OBJECTIVE: Develop a customizable Unmanned Aerial System (UAS) suite that will conduct 360-degree detection of air-based threats from a safe stand-off distance that enables targeting of air-based threats to include: Rockets, Artillery, Mortars and Small Unmanned Aerial Systems (sUAS). Demonstrate the extensibility for future payloads and missions.

DESCRIPTION: The Air Force Security Forces Center is seeking an autonomous, economical UAS. The UAS must be an economical solution meant to be deployed and retrieved multiple times, however, should be inexpensive to maintain, use, and replace. The operator must be able to carry the UAS on their person with the ability to retrieve and deploy within five minutes over a distance of at least 2 miles. The UAS must demonstrate autonomous abilities and awareness of its surroundings. Autonomy must include collision avoidance, course and restricted sites (no fly zones) avoidance, autonomous take off, autonomous recovery, and autonomous flight to its destination and back, with the ability of command signal change while in flight. The UAS must be lightweight. Lightweight is specified in being 4lbs or lighter including payload. The UAS must not require a special license to operate. The UAS must be able to go from out of the box to flight with little to no training for the average 18–24-year-old, high school educated Airman. The UAS must have the ability to be used both indoor and outdoor during the same mission set.

PHASE I: As this is a Direct-to-Phase-II (D2P2) topic, no Phase I awards will be made as a result of this topic. To qualify for this D2P2 topic, the Government expects the applicant to demonstrate feasibility by means of a prior “Phase I-type” effort that does not constitute work undertaken as part of a prior SBIR/STTR funding agreement. Evaluate vendor solutions to proposed requirements and ensure key requirements are met: autonomous software, TAK integration, and customizable platform(s)/payload mounting system. Capabilities/issues identified but not address in previous phase can be resolved, added or remove as needed.

PHASE II: Develop and test autonomous Blue UAS suite for emergency response. Capabilities/issues identified but not address in previous phase can be resolved, added or remove as needed.

PHASE III DUAL USE APPLICATIONS: Expand capability to additional mission sets and tie into base network. Fully operational capability requires seamless integration onto the Air Force Information Networks (AFIN) for network transport and Air Forces Network (AFNET) for software utilization. The system will utilize these networks for software application usage (both for on premises and remote access), security practices and procedures, and data transport requirements. Prior to inclusion on Air Force Installation Base Enclaves, all hardware components must comply with DoD Unified Capabilities Requirements (UCR), and be listed on the Department of Defense Information Network (DoDIN) Approved Products List (APL). All software components must adhere to UCR and be certified per the Air Force Evaluated Products List (EPL). In the event components are not currently authorized, authorization will be completed with support of government sponsorship prior to capability delivery to enable immediate operational usage. Request solution use current common criteria certified components when/where possible.

REFERENCES:
1. DoD C-sUAS Strategy 2021;
2. AFMAN 11-502;
3. DAFMAN 17-1301

KEYWORDS: UAS; Autonomous; sUAS, Defense