ARMY 23.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

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

Proposers responding to a topic in this BAA must follow all general instructions provided in the Department of Defense (DoD) SBIR Program BAA. Army requirements in addition to or deviating from the DoD Program BAA are provided in the instructions below.

Specific questions pertaining to the Army SBIR Program should be submitted to:

Monroe Harden
Fundamental Portfolio Manager, Army SBIR
usarmy.apg.ccdc.mbx.sbir-program-managers-helpdesk@mail.mil
U.S. Army Combat Capabilities Development
Command6662 Gunner Circle
Aberdeen Proving Ground, MD
21005-1322TEL: 866-570-7247

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

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.

PHASE I PROPOSAL SUBMISSION

The Defense SBIR/STTR Innovation Portal (DSIP) is the official portal for DoD SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Detailed instructions regarding registration and proposal submission via DSIP are provided in the DoD Program BAA.

The Technical Volume (Volume 2) .pdf document has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments.DSIP contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Cost Volume, and how to upload the Technical Volume. For questions regarding proposal electronic submission, contact DSIP Support at DoDSBIRSupport@reisystems.com.

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

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

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

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

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

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

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

PHASE I COST VOLUME

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

The Army will occasionally accept deviations from the POW requirements with written approval from the Funding Agreement officer.

PHASE II PROPOSAL SUBMISSION

Only Small Businesses that have been awarded a Phase I contract for a specific topic can submit a Phase

II proposal for that topic. Small businesses submitting a Phase II Proposal must use the DOD SBIR electronic proposal submission system (https://www.dodsbirsttr.mil/submissions/)This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, theCost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DOD Help Desk at DoDSBIRSupport@reisystems.com.

For projects awarded in cycle 23.2, there will be **ONE window for submission** of Phase II proposals. A single Phase II proposal can be submitted by a Phase I awardee within one, and only one, Phase II submission window. The submission window opens at 0001hrs (12:01 AM) eastern time on the first day and closes at 2359 hrs (11:59 PM) eastern time on the last day. Any subsequent or Sequential Phase II proposal (i.e., a second Phase II subsequent to the initial Phase II effort) shall be initiated by the Government Technical Point of Contact for the initial Phase II effort and must be approved by Army SBIR PM in advance.

The 2025(a) Phase II proposal submission window for Phase I contracts awarded under the 23.2 cycle opens for submission on 15 October 2024 and closes on 14 November 2024.

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

Only the electronically generated Cover Sheet and Cost Volume are excluded from the 38-pageTechnical Volume.

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

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

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

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

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

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

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

OZONE CHEMICALS

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

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

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

The Army has a Technical Assistance Advocate (TAA) to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

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

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

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

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

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

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

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

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

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

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

COMMERCIALIZATION READINESS PROGRAM (CRP)

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

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The

CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

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

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

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

ARMY SBIR PROGRAM COORDINATORS (PCs) for Army SBIR PHASE 23.2

Participating Organizations	Program Coordinator	Phone
Armaments Center (AC)	Ben Call Peter Susberich	973-724-6275 973-724-5783
Aviation and Missile Center (AvMC-A)	Dawn Gratz	256-842-8769
Aviation and Missile Center (AvMC-M)	Dawn Gratz	256-842-8769
Army Research Laboratory (ARL)	Zeke Topolosky	301-394-2070
Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR)	Tamarisk Gillespie	703-704-0124
Chemical Biological Center (CBC)	Martha Weeks	410-436-5391
Engineer Research and Development Center (ERDC)	Melonise Wills	703-428-6281
Soldier Center (SC)	Cathryn Polito	508-206-3497

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall

(a) Submit two copies of the approved scientific or technical report delivered under the contract to the Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy ofthe report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

PROTEST PROCEDURES

Refer to the DoD SBIR Program Announcement for procedures to protest the Announcement.

As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Monroe Harden, Army Fundamental SBIR Portfolio Director, at Monroe.b.harden2.civ@army.mil .

NOTIFICATION OF SELECTION OR NON-SELECTION

Proposing firms will be notified of selection or non- selection status for a Phase I award within 90 days of the closing date of the BAA. The individual named as the Corporate Official on the Proposal Cover Sheet will receive an email for each proposal submitted from the Army SBIR portal with their official notification of proposal selection or non-selection.

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

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

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

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

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

4. The Technical Volume .pdf document has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments).

   Offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposalsubmission as THESE WILL COUNT AGAINST THE 20-PAGE LIMIT. Any information that details work involved that should be in the technical volume but is inserted into other sections of the proposal will count against the page count. ONLY the electronically generated Cover Sheet and Cost Volume are excluded from the Technical Volume .pdf 20-page limit. Army Phase I proposals submitted with a Technical Volume .pdf document of over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

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

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

7. If applicable, plan for research involving animal or human subjects, or requiring access togovernment resources of any kind.

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

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

Army SBIR 23.2 Topic Index

A23-001 TITLE: Lightweight, Robust, Ruggedized North Finding Technology

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: The purpose of this topic is to demonstrate a rugged, lightweight, compact north-finding technology that can provide a precise measurement of heading relative to true north in GPS-denied environments and in the presence of interference, such as magnetic fields or overcast skies.

DESCRIPTION: Recent advances in MEMS-based technology offer the promise of rapidly measuring azimuth with high accuracy and in a small, ruggedized form factor. The desired application for this technology is the orientation of weapons platforms (e.g., mortar systems), radar system configuration. The technology should also be suitable as a and-alone navigation aid for soldiers in austere environments,. The technology should offer the capability to provide the measured heading to the user or to a host system in which the technology is embedded.

PHASE I: Design a proof-of-concept for a lightweight, compact north-finding system capable of either standalone or platform-integrated operation. The design should include hardware and software integration and a detailed description of how a user or system integrator would interact with the system. The final deliverables will be a breadboard demonstration of the proposed technology and a concept design presentation featuring anticipated performance, size, weight, power and cost estimates for the system.

PHASE II: Develop and deliver a TRL 7 prototype low-cost north-finding device that can be utilized as a standalone system or as a component of a larger system. Demonstrate the sensor in a relevant representative environment. The prototype must have a modular open system architecture that can be integrated into existing and future Army systems for demonstration, testing and evaluation across a range of training and operational environments. The prototype should be able to measure heading relative to True North to within Threshold [T] 1, objective [O] 0.2 degree(s). The prototype should include a detailed interface design that would allow a systems integrator to easily incorporate the north-finding technology into its system. The prototype should feature a user manual describing how a user can perform a heading measurement in a standalone use case.

PHASE III DUAL USE APPLICATIONS: A low-cost, lightweight north-finding technology can be utilized in systems that otherwise do not have an easy and accurate way to determine heading to north due to interference, such as counter-UAS or counter-fire radar systems. The north-finding capability would enhance products like the Army’s Weaponized Universal Lightweight Fire Control (WULF) system, enabling it to more accurately calculate mortar firing solutions for users. For Soldiers navigating unfamiliar terrain, the system could be set down and allowed to perform a measurement to provide the soldier with a heading for orienteering in place of the M2 Compass. In the commercial market, north-finding would be useful for surveyors to obtain accurate measurements of landmark positions or on ships as an alternative to larger navigation tools currently in use.

REFERENCES:

1. Gade, Kenneth. The Seven Ways to Find Heading. Journal of Navigation, 955-970. 2016.
2. FIELD MANUAL 23-90. Mortars. March 2000.
3. Lechner, Wolfgang. AZIMUTH DETERMINATION WITH INERTIAL SYSTEMS, International Federation of Surveyors – FIG Proceedings
4. Hovde, Stian. Compact Sensor System for Target Localization, 2017.
5. The road to providing a faster, more accurate mortar firing system | Article | The United States Army
6. Kaplan, George H. Determining the Position and Motion of a Vessel from Celestial Observations.
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8. FIELD MANUAL 3-25.26. Map Reading and Land Navigation. 2001

KEYWORDS: Navigation; north-finding; MEMS; orientation.

A23-002 TITLE: Development of polarimetric SWIR camera system with AI/ML capabilities to counter swarming UAVs

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 polarimetric SWIR camera system with incorporated artificial intelligence and machine learning (AI&ML) capability for enhanced target detection/identification, and tracking of swarming UAVs.

DESCRIPTION: To overcome limitations inherent in conventional image-based targeting systems, (e.g., visible and conventional thermal vision systems) a polarimetrically filtered SWIR camera system based on new high resolution FPA technology is to be developed. [1-3] New SWIR FPAs cost a fraction of the cost (compared to cooled thermal FPAs) and exhibit nearly twice the spatial resolution of their thermal counterparts. similarly, new SWIR FPA readout technology is capable of producing very large dynamic range resulting in exceptionally low light sensitivity.
To address the highly asymmetric nature of a UAV swarming event, the polarimetric image stream would be analyzed in real-time by an AI&ML algorithm to produce maximum situational awareness. By introducing a polarimetric capability, target imagery is expected to display enhanced information content which can be further exploited by AI/ML analysis. [4-6] AI&ML algorithm developers should consider recent advances in deep neural networks (DNN) and the maturation of graphical processing unit (GPU) technology optimized for intensive matrix computations. Such AI&ML algorithms are expected to be trained relatively quickly on low-cost GPUs to perform inference on GPUs in real-time. [7-8] Finalized system should be capable of providing appropriate targeting parameters for gimble mounted offensive system to be determined (TBD).

PHASE I: During the initial solicitation candidates must identify 1) the optical design proposed for the SWIR polarimetric camera system, and 2) hardware, architecture, and algorithm(s) for the AI&ML operation of the system. As a result, during the Phase I candidates will be expected to conduct a feasibility study which will consist of predictive analysis and/or preliminary prototype development in support of their proposed polarimetric/AI&ML design. This should include identifying and assessing (with costs) all critical components necessary to develop the proposed system. Specifically, the candidate should define and identify particular focal-plane-array (FPA) architecture, readout circuitry, minimum integration time, optical design, spectral responsivity, and control/analysis hardware and software required for high resolution, high frame-rate operation. To provide the enhanced spatial and textural detail required for robust targeting, the polarimetric camera system must be capable of producing in real-time a minimum of the following Stokes imagery, i.e., S0, S1, S2, and a degree-of-linear-polarization (DoLP) image.[9-10] Analysis should include optical design modeling and optimization in which both radiometric and polarimetric response characteristics are predicted, e.g., noise-equivalent-delta-polarization-state (NEDP). Candidates should strive to achieve a minimum acceptable NEDP of ±1%.

PHASE II: Based on the design criteria established during the Phase I, the candidate will procure all necessary components to assemble, test, and demonstrate a fully functional prototype device. Testing will also include evaluation of AI&ML algorithms based on specific test objectives, e.g., percentage of UAVs accurately located/targeted per swarming event and the ability to discern avian clutter from a true threat. Prototype testing and evaluation will be conducted at a government facility in which optimum functionality will be determined based on range, atmospheric conditions, and tactical scenario. To be conducted concurrent with the prototype development, the contractor will begin identifying all possible commercialization opportunities and partnerships necessary to successfully bring their developed intellectual property (IP) to market.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of Phase II, the contractor may be asked to demonstrate developed AI&ML polarimetric imaging target and tracking system vera the interfacing with identified C-UAV offensive device. Such evaluation will take place at an appropriate U.S. Army field-test facility. This will also include further maturation of the system in which reduction in size, weight, and power (SWaP) will be examined. The candidate is expected to pursue civilian applications and additional commercialization opportunities, e.g., remote sensing of geological formations, enhanced surveillance for homeland/boarder security, detection of buried landmines and IEDs, identification of camouflaged/hidden targets, and night-time facial recognition. [11-14]

REFERENCES:

1. Tyo J, Goldstein D, Chenault D, Shaw J. Review of passive imaging polarimetry for remote sensing. Appl Opt. 2006;45(22).
2. B. Preece, R. Thompson, V. Hodgkin, K. Gurton, D. Tomkinson, H. Choi, K. Krapels, “Performance Comparison of Conventional IRST (Infrared Search and Track) Sensor versus Polarimetric IRST for the Detection of UAS”, 2014 Military Sensing Symposia (MSS) National Symposium on Sensor & Data Fusion, Springfield, VA. Oct. 28-31, (2014).
3. Gurton K.P. Calibrated long-wave infrared (LWIR) thermal and polarimetric imagery of small unmanned aerial vehicles (UAVs) and birds. Army Research Laboratory (US); 2018 Aug. Report No.: ARL-TR-8475.
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8. K. He, X. Zhang, S. Ren, and J. Sun, “Spatial pyramid pooling in deep convolutional neural networks for visual recognition”, IEEE Trans. On Pattern Analysis and Machine Intelligence, 37(9), pp. 1904-1916, (2015).
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10. Duncan L. Hickman, Moira I. Smith, Kyung Su Kim, Hyun-Jin Choi, "Polarimetric imaging: system architectures and trade-offs," Proc. SPIE 10795, Electro-Optical and Infrared Systems: Technology and Applications XV, 107950B (9 October 2018); doi: 10.1117/12.2325320
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KEYWORDS: Vision systems, artificial intelligence (AI), machine learning (ML), polarimetric imaging, anomaly detection, SWIR, drone detection, counter-UAV

A23-003 TITLE: Electromagnetic Skins and Smart RF Radomes for Spectrum Camouflage

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

OBJECTIVE: Design and build an electrically thin electromagnetic (EM) skin to absorb, scatter, and change the polarization of undesirable radio frequency (RF) radiation providing spectrum camouflage for Army antennae and radar systems. The objective of this SBIR is to utilize novel EM skins by adding RF functionality to create a Smart Radome surface to apply to airborne platforms or Smart Munitions.

DESCRIPTION: We define an Electromagnetic (EM) skin as a thin layer of radio frequency (RF) components and/or periodic structures conformed to an Army platform that manipulate radiation or scattering parameters. Thin EM skins will occupy areas designed and shaped primarily for mechanical and environmental functions. One example is an antenna radome which is a protective enclosure surrounding an antenna. The radome is made of a material that minimally attenuates transmit and receive signals from the enclosed antenna. Many applications, such as airborne platforms or Smart Munitions, use curved radomes and must maintain performance under extremely harsh environments (i.e., high velocity and high acceleration conditions). Application requirements will impact the size and geometrical shape of the radome, and these requirements may cause a noticeable radar cross section (RCS) signature. An EM Skin can exist on the surface of such a radome as a frequency selective surface that allows desirable frequencies to penetrate the radome while absorbing undesirable bands to greatly reduce undesirable RF scattering. Additional functions these EM skins may perform include beamforming, transceiver operation, deception through signal polarization conversion, transmit signal coding, and anti-jamming operations. The added functionality creates a SMART Radome which performs important RF functions in addition to its original purpose of protecting the enclosed antenna. This can't be done with conventional materials while maintaining the mechanical and aerodynamic properties of Army platforms. This SBIR will address two important topics to produce a functional Smart Radome utilizing an EM skin. First is the design of electronic RF components and subsystems that produce the EM skin's required RF functionality. These RF components must fit within the thin bounds of the skin which will be on the order of 5 mm or less. The second topic of study is the mechanical, thermal, and environmental aspects of integrating the EM skin onto selected Army platforms. A major concern is the stability of EM performance on conformal platforms, airborne drag effects, and the extreme thermal and high-G conditions of munitions. Both topics must be addressed before considering the integration of SMART Radomes onto airborne platforms or munitions.

PHASE I: In Phase I, the investigation shall explore the underlying technologies used to enable an EM skin within the frequency range of 2-18 GHz. The EM skin should enhance EM radiation while mitigating internal reflections for desirable frequency bands, and act as a scatterer or absorber of undesirable frequencies. The end of Phase I should produce several outcomes in the range of TRL 2-3. (1) Simulation study of the interactions and coupling between different RF components/subsystems in both planar and conformal aspects of an EM skin. (2) Determine how the chosen RF components affect the conformal, mechanical, thermal and environmental aspects of integrating the EM skin onto an airborne radome. (3) Full system simulation of the EM skin design on a representative Smart Radome surface including S-parameter performance and transmit/receive radiation performance of the EM skin. (4) A proof-of-concept prototype of a single unit cell of the EM skin with measured S-parameter and radiation performance. (5) The performer will provide a final report detailing the technology developed and its performance based on simulation and measured results.

PHASE II: The end of Phase II should produce several outcomes in the range of TRL 4. (1) Prototype a flat EM skin prototype based on the unit cell demonstrated in Phase I. The performer should measure the S-parameter and radiation performance of the EM skin. (2) Integrate a conformal EM skin prototype onto a representative curved Smart Radome surface. The performer should measure the S-parameter and radiation performance of the EM skin. (3) Determine the feasibility of integrating multiple layers of EM skins on top of one another either to enable two separate RF functionalities or to extend the bandwidth of the original EM skin design. Provide simulation results demonstrating the increased functionality of a multi-layer EM skin. (4) Prototype a flat EM skin unit cell incorporating the multi-layer configuration. The performer should measure the S-parameter and radiation performance of the EM skin. (5) The performer will provide a final report detailing the technology developed and its performance based on simulation and measured results.

PHASE III DUAL USE APPLICATIONS: At the end of the SBIR, the performer should be well positioned to transfer their EM skin and Smart Radome technology to both military and commercial applications. An electrically thin surface with built-in RF functionality would be of great interest to both military and commercial airborne applications. Replacing large radiating structures on the surface of an airborne platform has mitigating effects on drag reducing fuel consumption and lowering the overall cost of air flight. For military applications there is also the possibility to control out of band RF absorption. For SMART Munitions, the EM skin design would be easy to alter to provide geolocation and or RF sensing.

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KEYWORDS: Electromagnetic (EM) skins, Smart Radome, metamaterials/metasurfaces, RF scattering

A23-004 TITLE: UAS Continuous Time Spectrum Situational Awareness

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): 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: "UAS Continuous Time Spectrum Situational Awareness," research topic is to apply the advantages of continuous time signal processing over traditional DSP for advanced Spectrum Situational Awareness. Shannon's sampling theorem [1] limits current spectrum situational awareness systems. Continuous time signal processing [2]-[5] is not limited by Shannon's sampling theorem and provides significant advantages [2]-[6] and [9]-[14] over conventional digital signal processing.

DESCRIPTION: Advanced Spectrum Situational Awareness is required for improved threat detection and Future Tactical UAS applications. UAS swarms require accurate timing and position information for navigation and information fusion. A recent example showing the capabilities for swarm navigation and control was the opening display at the Tokyo 2020 Olympic Games [15]. A drone swarm created a rotating globe over Olympic stadium.

Advanced UAS sensor networks will provide data and sensor fusion for the future transparent battlefield [16]-[20]. Transparent Battlefield requires advanced spectrum situational awareness to enable first identification of threats and prevent adversaries from gaining an advantage. Warfighter Network needs to operate in a contested environment using advanced spectrum situational awareness and spectrum management. For commanders, spectrum situational awareness, transparent battlefield and warfighter networks provide a decisive decision and time advantage over peer adversaries.
"Continuous Time Spectrum Situational Awareness" research topic seeks to bring the advantages of continuous time systems over conventional digital systems to Spectrum Situational Awareness and swarm sensor and fusion networks.

Continuous time (CT) digital signal processing (DSP) is an emerging subfield of signal processing [2]-[6]. CT is asynchronous (no clock) like analog signal processing [2]-[6]. Continuous time [2]-[6] has the time domain properties of analog signal processing with the benefits of digital signal processing without discrete time limitations, quantization error, and Shannon sampling limitations [2]-[4]. Another benefit of CT systems is adaptive sampling. For a 2.5 second electrocardiogram (ECG) data set, a continuous-time, 32-level, level crossing ADC only requires 225 samples compared to 1250 samples for conventional digital signal processing. Fewer samples result in less data processing and lower energy. The medical community has recognized the benefits of improved accuracy and energy savings for processing ECG signals with CT systems [13]-[15].
Continuous time systems were first developed in the 1950's for control system applications. In 1962, Inose, et al. [7] developed the asynchronous delta-sigma ($\Delta\Sigma$) analog-to-digital converter. A much more accurate $\Delta\Sigma$ demodulator technique was developed by Lazar and Tóth [8] in 2004. In 2003, Tsividis published his research work on the benefits of continuous time systems: no quantization error, no discrete time lag, and no frequency aliasing [2]-[3]. In a continuous time system, "quantization" occurs when the input signal exactly equals a threshold level, resulting in no inherent quantization error. Schell and Tsividis developed a 16-level (4-bit equivalent), continuous-time ADC with better than 100 dB signal-to-

noise-and distortion ratio (SNDR) using offline reconstruction [9]-[10]. Kurchuk et al. develop a GHz speed continuous time analog-to-digital converter in 2012 [11]. Jungwirth and Crowe [12] developed a continuous time pipeline analog-to-digital converter and continuous time software reconfigurable radio architecture.

Machine learning/artificial intelligence concepts can be applied to continuous time systems for signal analysis and signal processing. Neural networks based on analog signal processing concepts can be directly mapped into continuous time systems. Spiking neural networks are similar to continuous time systems. The continuous time properties (1) sample frequency is proportional to the slope of the input signal (compressive sensing) and (2) vector outputs (time stamp, and amplitude level) may be very beneficial for deep neural networks and signal processing.

This SBIR is a multidiscipline research effort, and researchers from several fields are required. Research team should include at a minimum researchers with significant experience in continuous time systems, spectrum estimation, signal processing, UAV swarms, sensor fusion, and machine learning/artificial intelligence. "Continuous Time Spectrum Situational Awareness," research topic is to apply the advantages of continuous time signal processing over traditional DSP for advanced Spectrum Situational Awareness. This effort is to support spectrum situational awareness for PEO Aviation, Long Range Precision Fires and Air and Missile Defense Army Modernization Priorities, the Microelectronics Technology Focus Area and long-term development areas of Transparent Battlefield, Warfighter Network, and Gaining Decision Advantage.

PHASE I: Conventional DSP systems are based on quantized, discrete time (digital). For the Phase I proposal, research team shall describe the feasibility (1)-(6) of developing a continuous time spectrum situational awareness system for UAS applications.
(1) multidiscipline research team
(2) advantages of continuous time spectrum situational awareness over conventional DSP.
(3) benefits of adaptive sampling and sample rate is proportional to the slope of the input signal
(4) conversion between continuous time and DSP.
(5) how machine learning/artificial intelligence, convolutional neural networks, etc. can be applied and take advantage of continuous time systems.
(6) propose a Future Tactical UAS application for continuous time spectrum situational awareness.
For the phase I effort, the offeror shall demonstrate the feasibility and performance benefits of continuous time systems for spectrum situational awareness. Offeror shall develop models, simulations, prototypes, etc. to determine technical feasibility (1)-(6) of developing continuous time spectrum situational awareness. Offer shall develop test cases for comparing CT-DSP to DSP.

PHASE II: Research team shall develop a Continuous Time Spectrum Situational Awareness System for Future Tactical UAS. Research team shall deliver a year 1 report and a year 2 report describing system architecture and test results. Offeror shall deliver to the government point of contact for test and evaluation: 1 prototype continuous time situational awareness system including all codes, software, etc. and licenses for all development tools to build and use the system. Research team shall provide 3 days of on-site training for the system.

PHASE III DUAL USE APPLICATIONS: Offer shall commercialize CTDSP technology for both government and commercial application spaces. The development of continuous-time digital signal processing will enable significant leap-ahead technology for signal processing to support communications, remote sensing, and control. These technologies offer potential benefits across several fields including communications, telecom and sensor networks for both military and civilian applications.

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KEYWORDS: Continuous time systems, Spectrum Situational Awareness, UAS

A23-005 TITLE: Open Source, High Assurance Hardware and Software Co-Design

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software, 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: Open source hardware and software offer new opportunities for creating high assurance computing. Currently, seL 4 microkernel uses blocks of assembly language instructions for security primitives. Hardware primitives and software instructions can be added to the extensible RISC-V architecture to support seL 4 and other high assurance microkernels. Offer shall proposed a FPGA softcore RISC-V architecture to support and simplify the seL 4 high assurance microkernel.

DESCRIPTION: Current generation aviation systems were not developed with strong computer security requirements. Past cyber threats, [1]-[2], Spectre [3], Meltdown [4], current cyber treats, and future cyber treats need to be countered. Embedded system designs are typically based on commodity hardware optimized exclusively for speed – leading to critical cyber vulnerabilities that can have devastating effects on safety and mission effectiveness. This has also led to the unsustainable "Perimeter, Patch, Pray" Information Assurance strategy [5] that is simply impractical for fielded aviation and missile systems. De Clercq and Verbauwhede [6] have recommended more hardware based security over software. Hardware based operating systems concepts began in the 1970's [7]-[9]. The Intel iAPX 432 [10] pioneered protected objects in 1983. Nakano [11] developed the first practical hardware based operating system in 1995. Renesas released a commercial microcontroller [12] with a simple hardware based operating system in 2014. The RISC-V family of instruction set architectures was published open source in 2010 [13]. RISC-V was designed to be extendable. The high assurance microkernel, seL 4, was developed in 2009 [14]-[15].
We are interested in hardware/software co-design based on open source RISC-V and seL4 microkernel. The seL4 microkernel has blocks of assembly code that are not as rigorously proven as the C code for seL4. By extending RISC-V using hardware based operating system principles, a more streamlined and secure version of seL4 is possible. The offeror is asked to develop a RISC-V and seL4 high assurance FPGA softcore processor.

PHASE I: For the Phase I proposal, research team shall describe the feasibility (1)-(6) of developing a RISC-V softcore processor with hardware security primitives to simplify, and create a more secure seL4 microcontroller.
(1) describe multidiscipline research team
(2) advantages of developing a seL4 microkernel with fewer blocks of assembly code
(3) advantages seL4 microkernel with fewer blocks of assembly code for formal proof of correctness
(4) describe the design features of RISC-V that allow for implementing hardware security primitives to support high assurance microkernel's like seL4.
(5) describe how (2)-(4) can simplify machine proof-of-correctness.
(6) propose a Future of Vertical Lift application for RISC-V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design."
For the phase I effort, the offeror shall demonstrate the feasibility and performance benefits of RISC-

V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design." Offeror shall develop models, simulations, prototypes, etc. to determine technical feasibility (1)-(6) of RISC-V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design."

PHASE II: Research team shall develop a RISC-V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design" for Future of Vertical Lift application. Research team shall deliver a year 1 report and a year 2 report describing system architecture and test results. Offeror shall deliver to the government point of contact for test and evaluation: 2 prototype RISC-V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design" systems including all codes, software, etc. and licenses for all development tools to build and use the system. Research team shall provide 3 days of on-site training for the system.

PHASE III DUAL USE APPLICATIONS: Offer shall commercialize RISC-V/seL4 co-design for "Open Source, High Assurance Hardware and Software Co-Design" for both government and commercial application spaces. Offeror will develop and market high assurance system based on phase II development work and marketing plans from phase I and II. Offeror will integrate high assurance system into an Army Aviation or Missile subsystem currently under development or via technology refresh.

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KEYWORDS: RISC-V, seL 4, high assurance, softcore procressor, FPGA, computer architecture

A23-006 TITLE: Advanced III-V avalanche photodiode structures in the infrared

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: Design and implement III-V based linear-mode infrared avalanche photodiodes suitable for ranging imagery.

DESCRIPTION: Active imaging systems all require the detection of reflected light, usually through an active source such as a laser. Additionally, commonly fielded single-point range finding technologies lack the capability to ensure that the range for the object of interest is being interrogated rather than an adjacent object in the scene. In this effort, we seek to develop III-V linear mode avalanche photodiodes which are capable of linear gain and short response times to enable detection and ranging of man-sized objects. Approaches compatible with leveraging large substrates and existing mature commercial foundry services are highly preferred.

PHASE I: Design and model III-V APD detector structures compatible with GaSb or GaAs substrates and capable of linear gains with short response times in the infrared. Determine growth process that includes any experimental parametric variations for fabrication. Proposers intending to grow initial test structures and perform preliminary characterization in Phase I will be rated favorably. Develop experimental plan for achieving anticipate Phase II program goals.

PHASE II: Execute growth, characterization, and fabrication plans developed during the Phase I program. Deliver growth recipe to commercial growth foundry and determine efficacy of growth via wafer level characterization as necessary. Fabricate test chips or large area devices suitable for cryogenic testing and measure sensor dark current, spectral characteristics, and quantum efficiency. Characterize gain of device as function of applied bias and show gain-normalized dark current levels. Characterize minimum detectable pulse energy using test structures or mini-arrays. By the conclusion of the Phase II program, deliver a test report and test structures to the Army for characterization of pulse detection.

PHASE III DUAL USE APPLICATIONS: Continue to mature the technologies developed in Phase II for potential dual-use applications that require ranging. Continue incremental improvement of detector structures and increase array format to sizes suitable for imaging. Investigate options for ROIC integration.

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KEYWORDS: avalanche photodiode (APD), pulse detection, infrared, III-V material

A23-007 TITLE: Multi-Modal Synthetic Data Corpus to Support Machine Intelligence Development

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

OBJECTIVE:
1. Synthetically create a multi-modal data corpus that can be used to train Artificial Intelligence/Machine Learning (AI/ML) Algorithms to support multi-Intelligence (multi-INT) data fusion and machine intelligence.
2. Develop a scenario-based tool that enables the Army to create an environment that can develop and test future multi-modal AI/ML capabilities

DESCRIPTION: Multi-Modal data includes text, images, sounds, etc. Having a corpus of synthetic multi-modal data allows the Army to fuse this data together and rapidly generate higher preforming AI/ML algorithms. Creating an Army owned environment that can develop and test future AI/ML capabilities with a focus on multi-INT data fusion and machine intelligence. This environment should be able use the synthetic data to simulate different scenarios for AL/ML training and validation. Some scenarios may include situations where we need to distribute AI to edge deceives.

PHASE I: Conduct research and complete the initial design of the scenario-based tool for testing and developing AI/ML capabilities with a baseline dataset for the multi-modal synthetic data corpus.

PHASE II: Creation of the scenario-based prototype tool for testing and developing AI/ML capabilities along with the multi-modal synthetic data corpus that can train high fidelity AI/ML algorithms.

PHASE III DUAL USE APPLICATIONS: Maturing the prototype into a planned operational system which can be demonstrated in the operational environment.

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KEYWORDS: Data Fusion, Multi-Modal Data, Multi-INT Data, Machine Intelligence, Artificial Intelligence/ Machine Learning (AI/ML), Testing and Validation

A23-008 TITLE: Wideband RF Sensing Algorithms for Detection of Priority Ground RF-Enabled Threats

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

OBJECTIVE: Leveraging emergent combinations of commercially available high-rate Analog-to-Digital Converters (ADCs) and advanced Field Programmable Gate Arrays (FPGAs) to detect a broad spectrum of priority Radio Frequency (RF)-enabled threats.

DESCRIPTION: This effort explores novel applications of new, state of the art Commercial Off the Shelf (COTS) ADCs tightly integrated with advanced FPGAs providing revolutionary increases in wideband direct digital Radio Frequency (RF) sampling. Rapidly changing threat environment with a multitude of signals, both threat and non-threat, in close proximity and covering an ever-increasing swath of spectrum, is an ever-present challenge. This presents the difficult task of assessing and identifying a wide variety of signal types accurately and quickly across an extremely wide range of frequencies. Additionally, as systems are forced to address an increased number of threats concurrently, false detections can compromise protection, requiring identification algorithms to be more precise. With the increase in spectrum data that RF systems now need to ingest as a result of advances in state-of-the-art ADC coupled RF FPGAs, systems are further in danger of wasting these gains through inefficient detection and identification techniques.

These emerging COTS ADCs will enable new algorithms for wideband threat detection that has the potential to increase the efficiency and efficacy of future next gen systems. This is extremely important for ground platforms face a complex cluttered environment and are increasingly hindered by platform space and power constraints. Systems in the future will also need to identify and characterize unknown threats, these enhanced algorithms will provide rapid detection and better effectiveness at the tactical edge. Decreasing false detections and misclassifications reduce unnecessary RF emissions and reduce output power and increase systems interoperability. All these factors require an innovative set of detection and identification algorithms capable of leveraging advanced RF components to provide accurate and efficient threat characterization across an extremely wideband of RF frequencies.

PHASE I: Identify novel algorithms and techniques for threat/signal identification enabled by wideband COTS hardware to detect representative Radio Frequency (RF) enabled threats targeting ground platforms. Use representative class of threats to define an extendable proof of concept, algorithm (or suite of algorithms) for wideband threat identification on identified COTS hardware. Define requirements for algorithm and validate method/framework for identifying and characterizing threats. Measure performance of algorithm against such metrics as speed, accuracy, and rate of false characterization, as well as proficiency in successfully characterizing out of library threats.

PHASE II: Implement prototype algorithm developed in Phase I and an extended to include additional classes of threats. Demonstrate generalized identification algorithms for all types of RF-threats to ground platforms within a digital M&S environment provide report documenting findings. Additional class(es) of threats will be assessed based on how well it demonstrates an extension of the base algorithms, as well as how different the class(es) of threat(s) is(are) from the original class used in Phase I. Algorithms will be assessed based on effectiveness criteria mentioned above, as well as ease and speed of algorithm retraining. Identify exemplar threat and demonstrate and test algorithms in a Hardware in the Loop (HITL) environment.

PHASE III DUAL USE APPLICATIONS: Implement and test algorithms from Phase II on wideband representative hardware and demonstrate in relevant open-air environment. Demonstrate performance gains that superior detection and identification algorithms can provide on hardware.

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KEYWORDS: Machine Learning, Ground Platforms, Threat Identification, Survivability

A23-009 TITLE: Zero Trust Identity

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

OBJECTIVE: Determine the level of risk when a person uses a personal device to access Army resources (i.e., Bring Your Own Device (BYOD)) in accordance with Zero Trust principles

DESCRIPTION: As per NIST 800-207, one of the basic tenets of Zero Trust is "Access to resources is determined by dynamic policy—including the observable state of client identity, application/service, and the requesting asset—and may include other behavioral and environmental attributes". When the requesting asset is an approved managed device, the security and trustworthiness of the device can be determined using the one of the many agents that are already installed on the asset and are used to control the asset configuration. In a Bring Your Own Device (BYOD) scenario the device is not managed by the Army and the state and trustworthiness of the asset is unknown. Additionally, people are highly reluctant to install monitoring software (e.g., agents) on their personal device to allow the Army to determine the state of the device. Without an understanding of the state of the device, the device is considered untrustworthy and it is prevented from accessing Army resources. This results in the Army having to purchase, provide, manage and maintain equipment (e.g., laptops, mobile phones etc.) for people to access Army resources. This cost grows very large when considering the large quantity and variety of users, such as active-duty military, guard, reserves, civilians and contractors that utilize Army resources. The purpose of this SBIR is to research and develop innovative ways to determine the trustworthiness of a personal device, without requiring software to be installed on the device. A solution to this problem would enable any user to utilize personal devices, such as mobile devices and personal computers, to access Army resources, while still providing the Army with a dynamic risk analysis that help protect Army resources from being accessed from untrustworthy devices.

PHASE I: Determine the feasibility of the proposed solution. The solution should describe in detail the approach to be used for determining the trustworthiness of the device without installing software on the device. The solution should also describe the technical challenges, the risks and how they will be mitigated and any dependencies that are required for the solution to work. The approach should be designed with open architecture and industry standards and protocols in mind.

PHASE II: Develop the solution outlined in Phase I. A demonstration of the solution determining the trustworthiness of a BYOD (specific device information will be provided after award). The demonstration should include the ability for the observers to determine how the level of trustworthiness for a given device was measured (e.g., what specific device factors were used to determine the level of trustworthiness of the device, any configuration data used in the decision and how that data was mapped to a level of trustworthiness etc.).

PHASE III DUAL USE APPLICATIONS: Expand the solution to enable determining trust on additional devices (examples information will be provided after award). The demonstration in Phase II is expected to utilize a small number of trust factors, so in Phase III the solution should be enhanced to include additional trust factors for the types of devices supported in Phase II.

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KEYWORDS: ZERO TRUST, DEVICE, RISK, TRUST, BYOD, CYBERSECURITY

A23-010 TITLE: Open Multi-Sensor Counter Unmanned Aerial Systems (C-UAS) Software System

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

OBJECTIVE: Develop a solution that addresses the design of a multi-sensor counter unmanned aerial system (cUAS) capability utilizing an open software platform.

DESCRIPTION: A counter unmanned aerial system (C-UAS) that utilizes multiple sensors would have the ability to detect and track unmanned aerial vehicles (UAVs) using a variety of methods while minimizing nuisance detections to near zero. This may include radar, infrared, electro-optical, acoustic, or other sensors. The system would then use this information to identify and classify the UAV, and ultimately neutralize or redirect it if necessary. The use of multiple sensors would also help to reduce the likelihood of false alarms and improve the overall accuracy of the system.
Additionally, utilizing an open platform for counter unmanned aerial systems (C-UAS) is important for several reasons.

First, an open platform allows for the integration of multiple sensors and technologies.
Second, an open platform enables third-party developers to create and integrate new capabilities, which can help to keep the system up to date with the latest technologies and threats.
Third, an open platform can also lower the system's cost and increase its flexibility.
Finally, an open platform can foster innovation and collaboration within the C-UAS industry, which can lead to new technologies and capabilities that can benefit everyone.

PHASE I: The purpose of this Phase I SBIR is to provide a white paper that addresses the design of an open platform multi-sensor counter unmanned aerial system (C-UAS) capabilities system. The white paper should contain the following key elements:
1. An overview of the C-UAS problem: The white paper should provide an overview of the current C-UAS threat landscape and the challenges that organizations face in detecting and neutralizing UAVs.
2. A description of the multi-sensor approach: The white paper should describe the advantages of using multiple sensors to detect and track UAVs, including how this approach can improve the system's overall performance and effectiveness.
3. An explanation of the different sensors and technologies used: The white paper should provide a detailed description of the different passive sensors and technologies that should be used and integrated into the system, including passive radar, infrared, electro-optical, acoustic, or other sensors and effectors. It should also explain how these sensors and technologies work together while minimizing false positives and performing all operations prior to defeating a UAS without user input in a variety of environments, ranging from urban cities and dense forest to remote desert environments, etc. Additional details will be provided to firm once selected.
4. An analysis of system performance: The white paper should provide an analysis of the system's anticipated performance in different and varying environments utilizing a variety of sensors and effectors. Additional details will be provided to firm once selected.
5. A description of the system's capabilities: The white paper should describe the system's capabilities, including its ability to detect and track UAVs, its ability to neutralize or redirect UAVs, and its ability to integrate with other existing systems. Additional details will be provided to firm once selected.
6. A discussion of future developments: The white paper should discuss future developments and enhancements that can be made to the system by third-party developers, including adding new sensors, algorithms, and software updates, etc.

PHASE II: Develop and demonstrate the solution to achieve the capabilities outlined in Phase I by developing the software for an open multi sensor c-UAS system that achieves the capabilities outlined in

the whitepaper. Host the software in a government owned full DEVSECOPS environment that allows for the benefits of Open Systems development to be utilized. Integrate and fuse many disparate sensors and effectors of varying quality and types - Additional details will be provided to firm once selected.
Integrate the outputs of the open system into existing systems. Additional details will be provided to firm once selected.
Ensure third party developers can build upon the work from this open system with other associated source code repositories they may develop.

PHASE III DUAL USE APPLICATIONS: Expand the capabilities of the solution to allow for integration of additional sensors into the open architecture. Implement enhanced SWAP capabilities and add additional algorithms that optimize usage of the c-UAS system to operate without user input. Additional details will be provided to firm once selected.

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KEYWORDS: Counter-Unmanned Aircraft System (CUAS), Multi-Sensor Fusion, DEVSECOPS

A23-011 TITLE: Operations in Degraded Visual Environments using Millimeter Wave Imagery

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

OBJECTIVE: Develop a millimeter wave imaging system capable of seeing through Degraded Visual Environments (DVE) to address current needs for DVE mitigation within the Defense community.

DESCRIPTION: Degraded Visual Environments (DVE) present significant challenges to tactical operations due to lack of situational awareness, which can lead to mission failure and loss of life. Such environments include low light, fog, dust, rain, snow, and other visual obscurants. Imaging in the millimeter wave region of the spectrum has demonstrated great utility for the ability to see through such obscurants with low attenuation, thereby providing navigational and operational cues and consequently a unilateral tactical advantage. [1] Millimeter wave imaging technology has furthermore found application in screening for contraband including person-borne weapons and improvised explosives hidden under clothing. [2] Nonetheless, current millimeter wave imaging technology remains complex, expensive, and high size, weight and power (SWaP); significant reductions in these parameters are required to facilitate greater deployment opportunities and open new applications and markets. To this end, increased leverage of commercial off-the-shelf (COTS) components is needed. The recent proliferation of collision avoidance radar systems within the automotive industry has created a huge market for millimeter wave components, bringing production to scale and driving down prices. Such radar systems are generally able to warn that objects are within a certain detection range, but do not currently identify these objects nor provide intuitive imagery of them. A system consisting of small arrays of these automotive radars in conjunction with rapidly developing artificial intelligence and machine learning technologies creates great potential for low SWaP imaging solutions to DVE with unprecedented capabilities and price points. [3] Leveraging of these recently developed low-cost systems could address current needs for DVE mitigation within the Defense community.

PHASE I: Define a system concept and perform a feasibility study. The system should be able to visualize through common degraded visual environments such as low light, fog, dust, rain, snow, and other visual obscurants The system should run at video rate (24 frames/sec or better). The system should have sufficient resolutions to be able to detect and resolve a human shape from a distance of 30 meters or greater.

PHASE II: Build a hardware prototype and demonstrate DVE mitigation capability. Construct and demonstrate a working prototype imaging system using the design developed in Phase I. Demonstrate video rate imaging of threats from a distance of 30 meters or greater. Develop artificial intelligence and machine learning technologies to support rapid and robust detection of threats in environment with significantly visual degradation. Deliver the working prototype to the government for further testing.

PHASE III DUAL USE APPLICATIONS: Further research and development during Phase III efforts will be directed toward refining the final deployable equipment and procedures. Design modifications based on results from tests conducted during Phase III will be incorporated into the system. Manufacturability specific to Army Concept of Operations (CONOPS) and end-user requirements will be examined. The development of a low-cost solution to imaging in the millimeter wave region has the potential to provide significant benefits to numerous programs within the DOD and will also have application in commercial markets.

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KEYWORDS: Degraded Visual Environment, DVE, Millimeter Wave, Automotive Radar, Computer Vision, Machine Learning.

A23-012 TITLE: Adapting commercial technologies to deliver the Modular Attributable Sensor System (MASS), an array of AI-enabled sensor nodes interoperable with the Unified Network

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

OBJECTIVE: Develop and validate a software tool compatible with various hardware systems that will allow military end users to analyze, store, and share photo and video data. The system will allow military customers to tap real-time data sources from IP-based CCTV, mobile ISR systems and unattended sensors (e.g. camera traps, small tactical grids) in a unified interface. Sample use cases include physical security, fire/smoke surveillance, firearm detection, and wildlife surveys on training lands. The goal of the project is to develop a specific use case, contributing to the Army Network modernization priority.

DESCRIPTION: Today, large Army installations rely on sparse, labor-intensive patrols for security, training operations, compliance, and other routine operational tasks. As a result, these areas suffer from high operational costs, slow response times, and frequent disruptions to training activities, directly impacting military readiness.

Persistent, AI-based surveillance can modernize many of these routine tasks when deployed at scale across these areas to free Army personnel to focus on the mission, reduce operational costs, and improve response times for critical security, compliance, and operational events (e.g. unknown vehicle intrusion in restricted areas, vandalism of government property, disease spreading among a population of a federally listed species).

Successful solutions should provide Army Network compatibility, have scalability for large quantities of data, offer web-based command and control interface, and allow forward and backward integration of various sensor systems through zero-trust APIs. The solution should be adaptable across various use cases in line with Army installation of the future priorities. Sensor pods that incorporate renewable technology (e.g. solar power) have the potential to contribute to the Energy Independence and Security Act of 2007 priorities, while offering improved installation resiliency.

PHASE I: Perform lab testing and customer discovery of a system that will allow military end users to analyze video and photo data. The system should be compatible with the Army Network and provide operational benefits (e.g., time savings) in a specific use case. Quantify the accuracy of detection for different events. Determine how artificial intelligence algorithms can be incorporated into DoD and commercial operations. The false positive rate and false negative rate should reach < 90%.

PHASE II: Develop a new system or adapt a commercial product that will allow military end users to use AI approaches to categorize imagery and other related data. Test the system in real-world use with a partner installation identified by the TPOC. The false positive rate and false negative rate should reach < 95%. Reduce the time for photo categorization by 50+% and improve data availability.

PHASE III DUAL USE APPLICATIONS: The project has broad applicability across all military branches/installations and private sector. The outcome of the project will be a state of art system reflecting learnings from military, commercial and open-source communities. The benefits of the project will include (1) Time savings through the use of automation and collaboration tools, (2) Faster detection speed for operational trends and adaptive

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KEYWORDS: artificial intelligence, unified network, security surveillance, sensor agnostic, persistent power management, renewable energy, climate resilience, natural and cultural resource management

A23-013 TITLE: Real-Time Analytics for Engineer Reconnaissance

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

OBJECTIVE: To develop a software solution to translate ground-based full-motion video (FMV) data collected by Engineer reconnaissance assets into a digital product that can be manipulated and analyzed to answer intelligence requirements and inform command decisions. This tool will assist Engineers in exploiting the previously underutilized resource of ground-based FMV data, providing engineers and decision-makers with a visualization of obstacles and mobility corridors.

DESCRIPTION: This topic focuses the development of analytical tools for processing tactical sensor data to automate engineer reconnaissance functions. Army engineers possess capabilities to acquire reconnaissance data from a suite of sensors housed in the Instrument Set, Reconnaissance and Surveying Toolkit (ENFIRE). A Microsoft LifeCam video camera and Ricoh G800SE digital camera capture imagery and focal length augmented by laser range finder distance measurements. Currently, Soldiers capture video imagery as reconnaissance teams traverse areas of interest and then transport and offload data for post-processing. Our effort will decrease collection and exploitation times thereby collaterally benefitting delivery of intelligence necessary for command decisions.

PHASE I: Determine the technical feasibility of ingesting, processing, and displaying imagery from multiple ground sensors focusing on a single geographic objective, i.e. roads, bridges, tunnels. During Phase 1, formats and resolution of data provided by current sensors within the ENFIRE system should be reviewed and assessed. Some field testing is anticipated to verify that the technical approach is achievable for further development in Phase 2. Deliver a report documenting the initial research activities under Phase 1 to document the initial concept.

PHASE II: Implement the Phase I architecture on ENFIRE edge computing devices. Demonstrate the prototype capability to generate digital products of specific portions of routes, such as bridges and tunnels. Demonstrate in-app essential analytical tools, including dimensions of obstacles. Demonstrate capabilities potential for integration into existing ENFIRE hardware and workflows. Army Engineers shall conduct the final demonstration in a field environment with a relevant tactical scenario, such as a route reconnaissance mission.

PHASE III DUAL USE APPLICATIONS: The work has a broad range of applications for military reconnaissance and mission planning. The studies conducted under Phase 1 and 2 will be novel and useful in establishing a framework for expediting the process of analyzing engineer reconnaissance data. This work would validate and integrate outcomes of the research into the ENFIRE system. Additional applications of this work would exist for any agency performing disaster recovery missions or other functions requiring actionable information on infrastructure.

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KEYWORDS: reconnaissance, artificial intelligence, survey, infrastructure, imagery

A23-014 TITLE: Persistent Intelligence, Surveillance, and Reconnaissance via Perching Unmanned Air Vehicles

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): 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: Perform preliminary design of autonomous, robust, and versatile perching capabilities with an unmanned air vehicle to enable persistent intelligence, surveillance, and reconnaissance (ISR).

DESCRIPTION: Small unmanned air vehicles (UAVs) have demonstrated the ability to autonomously plan trajectories that allow them to maneuver through tight spaces [1], precisely land on moving platforms [2], and even perch onto various targets in the environment (poles, rods, cables, walls, tree branches, etc.) [3]. Perching has been accomplished through grippers [4], magnets [5], adhesives [6, 7], modular/actuated landing gears [8], and metamorphic frames [9]. UAVs have demonstrated perching on targets with horizontal [10], vertical [11], inclined [12], and even inverted [13] orientations. Perching capabilities have been largely demonstrated in laboratory settings with the assistance of indoor cameras systems that provide accurate UAV state information to assist in perching on the desired target. The limited outdoor demonstrations of perching capabilities could be combined with recent advances in vision-based navigation algorithms to enable autonomous perching solely using onboard sensors [14]. Perching can offer significantly reduced energy usage compared to the power required for hovering, but energy expenditure may not be zero. Novel methods to recharge UAVs through powerlines [15] and photovoltaic cells [16] could be used to extend perching endurance for persistent ISR.

The goal of this SBIR is to review the state-of-the-art and the capabilities of existing systems and then perform a thorough preliminary design of a system that would be capable of performing the persistent intelligence, surveillance, and reconnaissance mission. The preliminary design should include, at a minimum, coverage of the platform, perching method/mechanism/algorithms, sensor payload(s), and recharging capability with respect to anticipated energy demand. The design should be able to identify a target perch location using onboard sensors and then autonomously navigate towards and robustly perch onto the target in an orientation that allows it to direct onboard sensors at a desired target location to provide persistent ISR.

PHASE I: Detailed design and data package fully describing the candidate platform, perching method/mechanism/algorithms, sensor payload(s), and recharging capability will be submitted. The data package should include detailed description of modeling, analysis, and simulation activity used to determine that the system will be capable of satisfying mission requirements.

PHASE II: Required Phase II deliverables include a demonstration with a prototype UAV autonomously perching onto realistic environments and providing ISR on a target location using multispectral sensors. The UAV shall be able to robustly perch onto the target and remain perched in wind conditions gusting up to 10 knots. The UAV must be able to remain perched without the use of propulsion and increase the charge on the vehicle's battery by extracting energy from the environment. A report detailing the UAV's dynamic response, flight control system, autonomy, perching mechanism and maneuver, and test results will be submitted.

PHASE III DUAL USE APPLICATIONS: This capability could be used in military applications to deploy UAVs into contested areas for ISR while perching for concealment and endurance.

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KEYWORDS: UAV, multirotor, perching, autonomy, recharge, intelligence, surveillance, reconnaissance