

**Defense Advanced Research Projects Agency (DARPA)
DoD 22.4 Small Business Innovation Research (SBIR) Annual BAA
Proposal Submission Instructions Release 3**

INTRODUCTION

DARPA’s mission is to make strategic, early investments in science and technology that will have long-term positive impact on our national security. As part of this mission, DARPA makes high-risk, high-reward investments in science and technology that have the potential to disrupt current understanding and/or approaches. The pace of discovery in both science and technology is accelerating worldwide, resulting in new fields of study and the identification of scientific areas ripe for small business utilization through the SBIR and STTR programs. Small businesses are critical for developing technology to support national security. Proposers are encouraged to consider whether the R/R&D being proposed to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. The topics below focus on technical domains important to DARPA’s mission pursuing innovative research concepts that fall within one of its technology offices. More information about DARPA’s technical domains and research topics of interest may be found at: <http://www.darpa.mil/about-us/offices>.

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

Specific questions pertaining to the administration of the DARPA Program and these proposal preparation instructions should be directed to: DARPA Small Business Programs Office at SBIR_BAA@darpa.mil. DSIP Topic Q&A will NOT be available for these DARPA topics. Technical questions related to improving the understanding of a topic’s requirements must be submitted to SBIR_BAA@darpa.mil by the deadline listed below.

The following dates apply to this DARPA Topic release:

- April 26, 2022:** Topics issued for pre-release
- May 11, 2022:** Topics open; DARPA begins accepting proposals via DSIP
- June 07, 2022:** Deadline for technical question submission
- June 14, 2022:** Deadline for receipt of proposals no later than **12:00 pm ET**

PHASE I PROPOSAL GUIDELINES

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

Current Release Award Structure by Topic

Topic Number	Phase I		
	Technical Volume	Award Amount	Period of Performance (PoP)
HR0011SB20224-04	25 pages	\$225,000	10 months

Technical Volume (Volume 2)

The technical volume is not to exceed 20 pages and must follow the formatting requirements provided in the DoD SBIR Program BAA. Phase I commercialization strategy shall not exceed 5 pages. This should be the last section of the Technical Volume and will not count against the 20-page limit.

Content of the Technical Volume

Proposers should refer to the DARPA Phase I Proposal Instructions, provided on the DARPA Small Business site (<https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>).

Cost Volume (Volume 3)

Please see the chart above for award amounts listed by topic. Proposers are required to use the Phase I – Volume 3: Cost Proposal Template (Excel Spreadsheet) provided on the DARPA Small Business site (<https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>).

Company Commercialization Report (CCR) (Volume 4)

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

Supporting Documents (Volume 5)

In addition to the documents required by DoD, small businesses may also submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5.

DIRECT TO PHASE II PROPOSAL GUIDELINES

Proposers should refer to the DARPA Direct to Phase II Proposal Instructions, provided on the DSIP Submission site.

Current Release Award Structure by Topic

Topic Number	Direct to Phase II				
	Tech Volume	Award Amount	Period of Performance (PoP)	Option Amount	Option PoP
HR0011SB20224-04	65 pages	\$1,000,000	18 months	\$500,000	6 months
HR0011SB20224-05	65 pages	\$1,700,000	18 months	N/A	N/A
HR0011SB20224-06	65 pages	\$2,750,000	24 months	\$1,225,000*	12 months

***HR0011SB20224-06:** for this topic DARPA will accept DP2 proposals with a total maximum cost/price of \$4,000,000. This maximum cost/price includes a 24-month base period not to exceed \$2,750,000 and a 12-month Option minimum of \$225,000. The base period and the minimum funding for the Option (if exercised) are funded entirely by DARPA. Additionally, if the Option is exercised, DARPA is encouraging the performer to arrange additional program funding with a commercial or government (non-DARPA) partner of up to \$500,000. Any proposed non-DARPA

funding agreement must be written, signed, and received by DARPA 60 calendar days before the last day of the period of performance of the base period to permit DARPA sufficient time to access as part of the determination to award the Option effort. DARPA will match up to \$500,000 of non-DARPA funds under a written, signed, and timely submitted agreement. Securing a non-DARPA funding agreement does not obligate DARPA to exercise the Option effort, nor will the lack of a written funding agreement prevent the performer from receiving an Option. DARPA will make option award decisions based on performance and funding availability.

Technical Volume (Volume 2)

If a proposer can provide adequate documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications, the Direct to Phase II (DP2) authority allows the Department of Defense (DoD) to make an award to a small business concern under Phase II of the SBIR program without regard to whether the small business concern was provided an award under Phase I of an SBIR program. This SBO is accepting DP2 proposal submissions.

DP2 Feasibility Documentation shall not exceed 20 pages. DP2 Technical Proposal shall not exceed 40 pages. Phase I commercialization strategy shall not exceed 5 pages. This should be the last section of the Technical Volume and will not count against the 40-page limit.

Content of the Technical Volume

Proposers should refer to the DARPA Phase I Proposal Instructions, provided on the DARPA Small Business site (<https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>).

Cost Volume (Volume 3)

Please see the chart above for award amounts listed by topic. Proposers are required to use the Phase I – Volume 3: Cost Proposal Template (Excel Spreadsheet) provided on the DARPA Small Business site (<https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>).

Company Commercialization Report (CCR) (Volume 4)

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

Supporting Documents (Volume 5)

In addition to the documents required by DoD, small businesses may also submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5.

PHASE II PROPOSAL GUIDELINES

Phase II proposals may only be submitted by Phase I awardees. Should DARPA have funding available and decide to proceed with a Phase II, proposers awarded a Phase I contract will be eligible to submit a proposal for Phase II and will be contacted to do so by the DARPA Small Business Programs Office at the appropriate time during their Phase I period of performance. Phase II proposals will be evaluated in accordance with the applicable DoD or DARPA SBIR BAA. Phase II selection(s) are at the sole discretion of the government and are subject to funding availability and Phase I performance.

Current Release Award Structure by Topic

Topic Number	Phase II				
	Tech Volume	Award Amount	Period of Performance (PoP)	Option Amount	Option PoP
HR0011S210002-04	45 pages	\$1,000,000	24 months	\$500,000	12 mos

Technical Proposal shall not exceed 40 pages. Phase II commercialization strategy shall not exceed 5 pages. It should be the last section of the Technical Volume and will not count against the 40-page limit.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

DARPA does not offer TABA funding.

EVALUATION AND SELECTION

All proposals will be evaluated in accordance with the evaluation criteria listed in the DoD SBIR 2022.4 BAA. DARPA will conduct an evaluation of each conforming proposal. Proposals that do not comply with the requirements detailed in this BAA and the research objective(s) of the corresponding topic are considered non-conforming and therefore are not evaluated nor considered for award.

Using the evaluation criteria, the Government will evaluate each proposal in its entirety, documenting the strengths and weaknesses relative to each evaluation criterion, and, based on these identified strengths and weaknesses, determine the proposal's overall selectability. Proposals will not be evaluated against each other during the evaluation process, but rather evaluated on their own individual merit to determine how well the proposal meets the criteria stated in this BAA and the corresponding DARPA topic.

Awards will be made to proposers whose proposals are determined to be the most advantageous to the Government, consistent with instructions and evaluation criteria specified in the DoD SBIR 2022.4 BAA and availability of funding. Given the limited funding available for each topic released, not all proposals considered selectable will be selected for funding.

For the purposes of this proposal evaluation process, a selectable proposal is defined as follows:

Selectable: A selectable proposal is a proposal that has been evaluated by the Government against the evaluation criteria listed in the DoD SBIR 2022.4 BAA and DARPA topic, and the strengths of the overall proposal outweighs its weaknesses. Additionally, there are no accumulated weaknesses that would require extensive negotiations and/or a resubmitted proposal.

For the purposes of this proposal evaluation process, a non-selectable proposal is defined as follows:

Non-Selectable: A proposal is considered non-selectable when the proposal has been evaluated by the Government against the evaluation criteria listed in the DoD SBIR 2022.4 BAA and DARPA topic, and the strengths of the overall proposal do not outweigh its weaknesses.

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 DoD SBIR 2022.4 BAA. It is the policy of DARPA to treat all proposals as source selection information and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate

nondisclosure agreements. Input on technical aspects of the proposals may be solicited by DARPA from other Government and/or non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements. No submissions will be returned. Upon completion of the evaluation and selection process, an electronic copy of each proposal received will be retained at DARPA.

Proposal titles, abstracts, anticipated benefits, and keywords of proposals that are selected for contract award will undergo a DARPA Policy and Security Review. Proposal titles, abstracts, anticipated benefits, and keywords are subject to revision and/or redaction by DARPA. Final approved versions of proposal titles, abstracts, anticipated benefits, and keywords may appear on the DoD SBIR/STTR awards website and/or the SBA's SBIR/STTR award website (<https://www.sbir.gov/sbirsearch/award/all>).

Refer to the DoD SBIR 2022.4 Program BAA for procedures to protest the Announcement. As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests regarding the selection decision should be submitted to:

DARPA
Contracts Management Office (CMO)
675 N. Randolph Street
Arlington, VA 22203
E-mail: scott.ulrey@darpa.mil and sbir@darpa.mil

AWARD AND CONTRACT INFORMATION

1. General Award Information

Multiple awards are anticipated. DARPA may award FAR-based government contracts (Firm-Fixed Price or Cost-Plus Reimbursement) or Other Transactions for Prototypes agreement (under the authority of 10 U.S.C. § 2371b) subject to approval of the Contracting Officer. The amount of resources made available for each topic issued under this BAA will depend on the quality of the proposals received and the availability of funds.

Small businesses that are owned in majority part by multiple venture capital operating companies (VCOs), hedge funds, or private equity funds are eligible to submit applications or receive awards.

The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this announcement and to make awards with or without communications with proposers. Additionally, the Government reserves the right to award all, some, one, or none of the options on the contract(s)/agreement(s) of the performers based on available funding and technical performance. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work, as applicable.

The Government reserves the right to request any additional, necessary documentation once it makes the award instrument determination. The Government reserves the right to remove a proposal from award consideration should the parties fail to reach agreement on award terms, conditions, and price within a reasonable time, and/or the proposer fails to provide requested additional information within three business days.

In all cases, the Government Contracting Officer reserves the right to select award instrument type, regardless of instrument type proposed, and to negotiate all instrument terms and conditions with selectees. DARPA will apply publication or other restrictions, as necessary, if it determines that the

research resulting from the proposed effort will present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Any award resulting from such a determination will include a requirement for DARPA permission before publishing any information or results on the program. For more information on publication restrictions, see the DoD SBIR 2022.4 BAA.

Because of the desire to streamline the award negotiation and program execution process, proposals identified for negotiation will result in negotiating a type of instrument for award that is in the best interest of the Government. In the case of an OT for Prototype agreement under DARPA's authority to award OTs for prototype projects, 10 U.S.C. § 2371b, use of an OT provides significant opportunities for flexible execution to assist in meeting DARPA's aggressive SBIR/STTR program goals.

All proposers that wish to consider an OT award should carefully read the following:

The flexibility of the OT award instrument is beneficial to the program because the Performer will be able to apply its best practices as required to carry out the research project that may be outside of the Federal Acquisition Regulation (FAR) process-driven requirements. Streamlined practices will be used, such as milestone-driven performance, intended to reduce time and effort on award administration tasks and permit performers to focus on the research effort and rapid prototyping. Because of this ability, OTs provide the Agreements Officer the flexibility to create an award instrument that contains terms and conditions that promote commercial transition, reduce some administratively burdensome acquisition regulations, and meet SBIR/STTR program goals.

Proposers must only propose an OT agreement with fixed payable milestones. Fixed payable milestones are fixed payments based on successful completion of the milestone accomplishments agreed to in the milestone plan. Refer to the Other Transactions for Prototypes Fact Sheet and Other Transaction for Prototype Agreement, available at <https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>. Specific milestones will be based upon the research objectives detailed in the SBO.

Please see <https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program> for more information on OTs.

2. Transition and Commercialization Support Program (TCSP)

DARPA will provide services to Phase II or DP2 awardees upon contract execution through the Transition and Commercialization Support Program (TCSP) at no cost to awardees. The TCSP goal is to maximize the potential for SBIR/STTR companies to move their technology beyond Phase II, and into other research and development programs for further maturity, or into solutions or products for DoD acquisition programs, other Federal programs, and/or the commercial market. Please visit <https://www.darpa.mil/work-with-us/for-small-businesses/commercialization-continued> for more information on DARPA TCSP.

3. Embedded Entrepreneurship Initiative

Awardees of SBIR funding pursuant to this BAA may be eligible to participate in the DARPA Embedded Entrepreneurship Initiative (EEI) during the Period of Performance. Invitation to participate in EEI is at the sole discretion of the Government based on evaluation of technical and commercial factors and subject to program balance and the availability of funding. EEI is a limited scope program offered by DARPA, at DARPA's discretion, to a small subset of awardees. The goal of DARPA's EEI is to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense. EEI supports DARPA's mission "to make pivotal investments in breakthrough technologies and capabilities for national security" by accelerating the transition of innovations out of the lab and into new capabilities for the Department of Defense (DoD). EEI investment supports development

of a robust and deliberate Go-to-Market strategy for selling technology product to the government and commercial markets and positions DARPA awardees to attract U.S. investment. The following is for informational and planning purposes only and does not constitute solicitation of proposals to the EEI.

There are three elements to DARPA's EEI: (1) A Senior Commercialization Advisor (SCA) from DARPA who works with the Program Manager (PM) to examine the business case for the awardee's technology and uses commercial methodologies to identify steps toward achieving a successful transition of technology to the government and commercial markets; (2) Connections to potential industry and investor partners via EEI's Investor Working Groups; and (3) Additional funding on an awardee's contract for the awardee to hire an embedded entrepreneur to achieve specific milestones in a Go-to-Market strategy for transitioning the technology to products that serve both defense and commercial markets. This embedded entrepreneur's qualifications should include business experience within the target industries of interest, experience in commercializing early stage technology, and the ability to communicate and interact with technical and non-technical stakeholders. Funding for EEI is typically no more than \$250,000 per awardee over the duration of the award. An awardee may apportion EEI funding to hire more than one embedded entrepreneur, if achieving the milestones requires different expertise that can be obtained without exceeding the awardee's total EEI funding. The EEI effort is intended to be conducted concurrent with the research program without extending the period of performance.

EEI Application Process:

After receiving an award under the solicitation, awardees interested in being considered for EEI should notify their DARPA Program Manager (PM) during the period of performance. Timing of such notification should ideally allow sufficient time for DARPA and the awardee to review the awardee's initial transition plan, identify milestones to achieve under EEI, modify the award, and conduct the work required to achieve such milestones within the original award period of performance. These steps may take 9-18 months to complete, depending on the technology. If the DARPA PM determines that EEI could be of benefit to transition the technology to product(s) the Government needs, the PM will refer the performer to DARPA Commercial Strategy.

DARPA Commercial Strategy will then contact the performer, assess fitness for EEI, and in consultation with the DARPA technical office, determine whether to invite the performer to participate in the EEI. Factors that are considered in determining fitness for EEI include DoD/Government need for the technology; competitive approaches to enable a similar capability or product; risks and impact of the Government's being unable to access the technology from a sustainable source; Government and commercial markets for the technology; cost and affordability; manufacturability and scalability; supply chain requirements and barriers; regulatory requirements and timelines; Intellectual Property and Government Use Rights, and available funding.

Invitation to participate in EEI is at the sole discretion of DARPA and subject to program balance and the availability of funding. EEI participants' awards may be subsequently modified bilaterally to amend the Statement of Work to add negotiated EEI tasks, provide funding, and specify a milestone schedule which will include measurable steps necessary to build, refine, and execute a Go-to-Market technology transition plan aimed at delivering new capabilities for national defense. Milestone examples are available at: <https://www.darpa.mil/work-with-us/contract-management>.

Awardees under this solicitation are eligible to be considered for participation in EEI, but selection for award under this solicitation does not imply or guarantee participation in EEI.

For more information please refer to the EEI website <https://eei.darpa.mil/>.

ADDITIONAL INFORMATION

DARPA intends to use electronic mail for all correspondence regarding these topics. Questions related to the technical aspect of the research objectives and awards specifically related to a topic should be emailed to SBIR_BAA@darpa.mil. Please reference the topic number in the subject line. All questions must be in English and must include the name, email address, and the telephone number of a point of contact.

DARPA will attempt to answer questions in a timely manner; however, questions submitted within seven (7) calendar days of the proposal due date listed herein may not be answered. DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting please visit: <http://www.darpa.mil/work-with-us/opportunities>. Under the topic number summary, there will be a link to the FAQ. The FAQ will be updated on an ongoing basis until one week prior to the proposal due date.

Technical support for the Defense SBIR/STTR Innovation Portal (DSIP) is available Monday through Friday, 9:00 a.m. – 5:00 p.m. ET. Requests for technical support must be emailed to DoDSBIRSupport@reisystems.com with a copy to SBIR_BAA@darpa.mil.

Appendix A: DARPA PHASE I PROPOSAL INSTRUCTIONS

I. Introduction

A complete proposal submission consists of:

- Volume 1: Proposal Cover Sheet
- Volume 2: Technical Volume
- Volume 3: Cost Volume
- Volume 4: Company Commercialization Report
- Volume 5: Supporting Documents
- Volume 6: Fraud, Waste and Abuse Training

The Defense SBIR/STTR Innovation Portal (DSIP) provides a structure for building the proposal volumes and submitting a consolidated proposal package. If this is your first time submitting an SBIR or STTR proposal using DSIP, please review detailed training guides at <https://www.dodsbirsttr.mil/submissions/learning-support/training-materials>. It is the responsibility of the proposing firm to ensure that a complete proposal package is certified and submitted by the close date listed in the TOPIC to which they are responding.

To assist in proposal development, templates for Volume 2: Technical Volume and Volume 3: Cost Volume have been provided as attachments to the announcement posted at <https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>. Use of these templates is mandatory.

II. Proprietary Information

Proposers that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall follow instructions in the DoD SBIR 2022.4/STTR 2022.D BAA regarding marking propriety proposal information.

III. Phase I Proposal Instructions

a. Proposal Cover Sheet (Volume 1)

The Cover Sheet must include a brief technical abstract of no more than 3000 characters that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. **Do not include proprietary or classified information in the Proposal Cover Sheet.** If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released.

b. Format of Technical Volume (Volume 2)

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

topic. The Government will not consider pages in excess of the page count limitations.

3. **Layout:** Number all pages of your proposal consecutively. Font size should not be smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by DSIP when the Cover Sheet was created. The header may be included in the one-inch margin. Please refer to the attachment titled Phase I Template – Volume 2: Technical Volume at <https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program> for additional details.

c. Content of the Technical Volume (Volume 2)

The Technical Volume should cover the following items in the order given below:

1. **Identification and Significance of the Problem or Opportunity.** Define the specific technical problem or opportunity addressed and its importance.
2. **Phase I Technical Objectives.** Enumerate the specific objectives of the Phase I work, including the questions the research and development effort will try to answer to determine the feasibility of the proposed approach.
3. **Phase I Statement of Work (including Subcontractors' Efforts)**
 - a) Provide an explicit, detailed description of the Phase I approach. The Statement of Work should indicate what tasks are planned, how and where the work will be conducted, a schedule of major events, and the final product(s) to be delivered. The Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the Technical Volume section.
 - b) The topic may have been identified by the Program Manager as research or activities involving Human/Animal Subjects and/or Recombinant DNA. In the event that Phase I performance includes performance of these kinds of research or activities, please identify the applicable protocols and how those protocols will be followed during Phase I. Please note that funds cannot be released or used on any portion of the project involving human/animal subjects or recombinant DNA research or activities until all of the proper approvals have been obtained (see DoD SBIR 2022.4/STTR 2022.D BAA).
4. **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the PI, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The technical volume must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

5. **Relationship with Future Research or Research and Development**

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

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

7. **Foreign Citizens.** Identify any foreign citizens or individuals holding dual citizenship expected to be involved on this project as a direct employee, subcontractor, or consultant. For these individuals, please specify their country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Refer to DoD SBIR 2022.4/STTR 2022.D BAA for more information.

Supplemental information provided in response to this paragraph will be protected in accordance with the Privacy Act (5 U.S.C. 552a), if applicable, and the Freedom of Information Act (5 U.S.C. 552(b)(6)).

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

9. **Subcontractors/Consultants.** Subcontractor means any supplier, distributor, vendor, firm, academic institution, research center, or other person or entity that furnishes supplies or services pursuant to a subcontract, at any tier. Involvement of a university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be identified and described according to the Cost Breakdown Structure at <https://www.dodsbirsttr.mil/submissions/learning-support/firm-templates>. Please refer to DoD SBIR 2022.4/STTR 2022.D BAA for detailed eligibility requirements as it pertains to the use of subcontractors/consultants.

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

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

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

11. **Transition and Commercialization Strategy.** DARPA is equally interested in dual use commercialization of SBIR/STTR project results to the U.S. military, the private sector market, or both, and expects explicit discussion of key activities to achieve this result in the transition and commercialization strategy part of the proposal. Phase I is the time to plan for and begin transition and commercialization activities. The small business must convey an understanding of the market, competitive landscape, potential stakeholders and end-users, and preliminary transition path or paths to be established during the Phase I project. The Phase I transition and commercialization strategy shall not exceed 5 pages. It should be the last section of the technical volume and include the following elements:

- a) **A summary of transition and commercialization activities conducted during prior SBIR/STTR efforts if applicable, and the Technology Readiness Level (TRL) achieved.**
- b) **Problem or Need Statement.** Briefly describe the problem, need, or requirement, and its significance relevant to a Department of Defense application and/or a private sector application that the SBIR/STTR project results would address. Is there a broader societal need you are trying to address? Please describe.
- c) **Description of Product(s) and/or System Application(s).** Identify the commercial product(s) and/or DoD system(s), or system(s) under development, or potential new system(s). Identify the potential DoD end- users, Federal customers, and/or private sector customers who would likely use the technology.
- d) **Business Model(s)/Procurement Mechanism(s).** Discuss your current business model hypothesis for bringing the technology to market. Describe plans to license, partner, or self-produce your product. How do you plan to generate revenue? Describe the resources you expect will be needed to implement your business models. Discuss your plan and expected timeline to secure these resources. Understanding DARPA's goal of creating and sustaining a U.S. military advantage, describe how you intend to develop your product and supply chains to enable this differentiation.
- e) **Target Market.** Describe the market and addressable market for the innovation. Describe the customer sets you propose to target, their size, their growth rate, and their key reasons they would consider procuring the

technology. Discuss the business economics and market drivers in the target industry. Describe competing technologies existent today on the market as well as those being developed in the lab. How has the market opportunity been validated? Describe the competition. How do you expect the competitive landscape may change by the time your product/service enters the market?

- f) **Funding Requirements.** Describe your company's funding history. How much external financing have you raised? Describe your plans for future funding sources (internal, loan, angel, venture capital, etc.).
- g) **Transition and Commercialization Risks.** Describe the major technology, market and team risks associated with achieving successful transition and commercialization of the DARPA funded technology. DARPA is not afraid to take risks but we want to ensure that our awardees clearly understand the risks in front of them. What are the key risks in bringing your innovation to market? What are actions you plan to undertake to mitigate these risks?
- h) **Expertise/Qualifications of Team/Company Readiness.** Describe the expertise and qualifications of your management, marketing/business development and technical team that will support the transition of the technology from the prototype to the commercial market and into government operational environments. Has this team previously taken similar products/services to market? If the present team does not have this needed expertise, how do you intend to obtain it? What is the financial history and health of your company (e.g., availability of cash, profitability, revenue growth, etc.)?
- i) **Anticipated Transition and Commercialization Results.** Include a schedule showing the anticipated quantitative transition and commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its Company Commercialization Report at least annually.

Advocacy Letters (OPTIONAL)* Feedback received from potential Commercial and/or DoD customers and other end-users regarding their interest in the technology to support their capability gaps. Advocacy letters that are faxed or e-mailed separately will NOT be accepted.

Letters of Intent/Commitment (OPTIONAL)* Relationships established, feedback received, support and commitment for the technology with one or more of the following: Commercial customer, DoD PM/PEO, a Defense Prime, or vendor/supplier to the Primes and/or other vendors/suppliers identified as having a potential role in the integration of the technology into fielded systems/products or those under development. Letters of Intent/Commitment that are faxed or e-mailed separately will NOT be accepted.

*Advocacy Letters and Letters of Intent/Commitment are optional, and should ONLY be submitted to substantiate any transition or commercialization claims made in the commercialization strategy. Please DO NOT submit these letters just for the sake of including them in your proposal. These letters DO NOT count against any page limit.

In accordance with section 3-209 of DOD 5500.7-R, Joint Ethics Regulation, letters from government personnel will NOT be considered during the evaluation process.

d. Format of Cost Volume (Volume 3)

Proposers are required to use the Phase I – Volume 3: Cost Proposal Template (Excel Spreadsheet) provided at <https://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program>.

e. Content of the Cost Volume (Volume 3)

Some items in the Cost Breakdown Guidance below may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item.

ALL proposed costs should be accompanied by documentation to substantiate how the cost was derived. For example, if you proposed travel cost to attend a project-related meeting or conference, and used a travel website to compare flight costs, include a screen shot of the comparison. Similarly, if you proposed to purchase materials or equipment, and used the internet to search for the best source, include your market research for those items. You do not necessarily have to propose the cheapest item or supplier, but you should explain your decision to choose one item or supplier over another. It's important to provide enough information to allow contracting personnel to understand how the proposer plans to use the requested funds.

If selected for award, failure to include the documentation with your proposal will delay contract negotiation, and the proposer will be asked to submit the necessary documentation to the Contracting Officer to substantiate costs (e.g., cost estimates for equipment, materials, and consultants or subcontractors). It is important to respond as quickly as possible to the Contracting Officer's request for documentation.

Cost Breakdown Guidance:

- List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
- Special tooling and test equipment and material cost may be included. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with DARPA; unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DARPA.
- Cost for travel funds must be justified and related to the needs of the project.
- Cost sharing is permitted for proposals under this announcement; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.
- All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal. Enter this information in the Explanatory Material section of the on-line cost proposal form. The Supporting Documents Volume (Volume 5) may be used if additional space is needed.

For more information about cost proposals and accounting standards associated with contract

awards, see the DCAA publication titled “Audit Process Overview – Information for Contractors” available at <http://www.dcaa.mil>.

f. Company Commercialization Report (Volume 4)

The Company Commercialization Report (CCR) allows companies to report funding outcomes resulting from prior SBIR and STTR awards. The Company Commercialization Report (CCR) is required for Phase I and Direct to Phase II proposals. Please refer to the DoD STTR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by DARPA during proposal evaluations.

g. Supporting Documents (Volume 5)

In addition to required DoD documentation and certifications, small businesses may also submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5.

h. Fraud Waste and Abuse (Volume 6)

The Fraud, Waste and Abuse (FWA) training is required for Phase I and Direct to Phase II proposals. FWA training provides information on what represents FWA in the SBIR/STTR program, the most common mistakes that lead to FWA, as well as the penalties and ways to prevent FWA in your firm. This training material must be thoroughly reviewed once per year. Plan ahead and leave ample time to complete this training based on the proposal submission deadline. Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to \$10,000, up to five years in prison, or both. Understanding the indicators and types of fraud, waste, and abuse that can occur is critical for the SBIR/STTR awardees’ role in preventing the loss of research dollars.

APPENDIX B: DARPA DIRECT TO PHASE II (DP2) PROPOSAL INSTRUCTIONS

I. Introduction

A complete proposal submission consists of:

Volume 1: Proposal Cover Sheet

Volume 2: Technical Volume (feasibility documentation and technical proposal) Volume 3: Cost Volume

Volume 4: Company Commercialization Report

Volume 5: Supporting Documents

Volume 6: Fraud, Waste and Abuse Training

The Defense SBIR/STTR Innovation Portal (DSIP) provides a structure for building the proposal volumes and submitting a consolidated proposal package. If this is your first time submitting an SBIR or STTR proposal using DSIP, please review detailed training guides at <https://www.dodsbirsttr.mil/submissions/learning-support/training-materials>. It is the responsibility of the proposing firm to ensure that a complete proposal package is certified and submitted by the close date listed in the TOPIC to which they are responding.

To assist in proposal development, templates for Volume 2: Technical Volume and Volume 3: Cost Volume have been provided as attachments to the announcement posted at <https://www.dodsbirsttr.mil/submissions/login>. Use of these templates is mandatory.

NOTE: Beginning with the DARPA FY21 SBIR and STTR BAA, all proposers are required to submit Volume 4: Company Commercialization Report (CCR).

II. Proprietary Information

Proposers that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall follow instructions in section 4.5 regarding marking propriety proposal information.

III. DP2 Proposal Instructions

a. Proposal Cover Sheet (Volume 1)

The Cover Sheet must include a brief technical abstract of no more than 3000 characters that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. Do not include proprietary or classified information in the Proposal Cover Sheet. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released.

b. Format of Technical Volume (Volume 2)

1. The Technical Volume must include two parts, PART ONE: Feasibility Documentation and PART TWO: Technical Proposal.
2. Type of file: The Technical Volume must be a single Portable Document Format (PDF) file, including graphics. Perform a virus check before uploading the Technical Volume file. If a virus is detected, it may cause rejection of the proposal. Do not lock or encrypt the uploaded file. Do not include or embed active graphics such as videos, moving pictures, or other similar media in the document.

3. Length: The length of each part of the technical volume (Feasibility Documentation and Technical Proposal) will be specified by the corresponding TOPIC. The Government will not consider pages in excess of the page count limitations.
4. Layout: Number all pages of your proposal consecutively. Font size should not be smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by DSIP when the Cover Sheet was created. The header may be included in the one-inch margin.

c. Content of the Technical Volume (Volume 2)

PART ONE: Feasibility Documentation

1. Provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the TOPIC has been met and describe the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.
2. Maximum page length for feasibility documentation will be specified by the TOPIC. If you have references, include a reference list or works cited list as the last page of the feasibility documentation. This will count towards the page limit.
3. Work submitted within the feasibility documentation must have been substantially performed by the proposer and/or the PI.
4. If technology in the feasibility documentation is subject to Intellectual Property (IP), the proposer must either own the IP, or must have obtained license rights to such technology prior to proposal submission, to enable it and its subcontractors to legally carry out the proposed work. Documentation of IP ownership or license rights shall be included in the Technical Volume of the proposal.
5. Include a one-page summary on Commercialization Potential addressing the following:
 - i. Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
 - ii. Describe the potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated.

PART TWO: Technical Proposal

1. Significance of the Problem. Define the specific technical problem or opportunity addressed and its importance.
2. Phase II Technical Objectives. Enumerate the specific objectives of the Phase II work, and describe the technical approach and methods to be used in meeting these objectives.
3. Phase II Statement of Work. The statement of work should provide an explicit, detailed description of the Phase II approach, indicate what is planned, how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.
 - a. Human/Animal Use: Proposers proposing research involving human and/or animal use are encouraged to separate these tasks in the technical proposal and cost proposal in order to avoid potential delay of contract award.
 - b. Phase II Option Statement of Work (if applicable, specified in the corresponding TOPIC). The statement of work should provide an explicit, detailed description of the activities planned during the Phase II Option, if exercised. Include how and where the work will be

carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail.

4. **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the PI, the proposer, consultants or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state of the art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number) and (3) date of completion.
5. **Relationship with Future Research or Research and Development.**
 - i. State the anticipated results of the proposed approach if the project is successful.
 - ii. Discuss the significance of the Phase II effort in providing a foundation for Phase III research and development or commercialization effort.
6. **Key Personnel.** Identify key personnel who will be involved in the Phase II effort including information on directly related education and experience. A concise resume of the PI, including a list of relevant publications (if any), must be included. All resumes count toward the page limitation. Identify any foreign nationals you expect to be involved on this project.
7. **Foreign Citizens.** Identify any foreign citizens or individuals holding dual citizenship expected to be involved on this project as a direct employee, subcontractor, or consultant. For these individuals, please specify their country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Refer to section 3.2 of this BAA for more information. Supplemental information provided in response to this paragraph will be protected in accordance with the Privacy Act (5 U.S.C. 552a), if applicable, and the Freedom of Information Act (5 U.S.C. 552(b)(6)).
8. **Facilities/Equipment.** Describe available instrumentation and physical facilities necessary to carry out the Phase II effort. Items of equipment to be purchased (as detailed in the cost proposal) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices and handling and storage of toxic and hazardous materials.
9. **Subcontractors/Consultants.** Involvement of a university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be identified and described according to the Cost Breakdown Guidance. Please refer to section 3 of this BAA for detailed eligibility requirements as it pertains to the use of subcontractors/consultants.
10. **Prior, Current or Pending Support of Similar Proposals or Awards.** If a proposal submitted in response to this topic is substantially the same as another proposal that was funded, is now being funded, or is pending with another Federal Agency, or another or the same DoD Component, you must reveal this on the Proposal Cover Sheet and provide the following information:
 - a. Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
 - b. Date of proposal submission or date of award.
 - c. Title of proposal.
 - d. Name and title of the PI for each proposal submitted or award received.

- e. Title, number, and date of BAA(s) or solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
- f. If award was received, state contract number.
- g. Specify the applicable topics for each proposal submitted or award received.

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

11. Transition and Commercialization Strategy. DARPA is equally interested in dual use commercialization of SBIR/STTR projects that result in products sold to the U.S. military, the private sector market, or both. DARPA expects explicit discussion of key activities to achieve this result in the transition and commercialization strategy part of the proposal. The Technical Volume of each Direct to Phase II proposal must include a transition and commercialization strategy section. The Phase II transition and commercialization strategy shall not exceed 5 pages, and will NOT count against the proposal page limit.

Information contained in the commercialization strategy section will be used to determine suitability for participation in EEI. Selection for participation in EEI will be made independently following selection for SBIR/STTR award. Please refer to section 2.6 of this BAA for more information on the DARPA EEI and additional proposal requirements.

The transition and commercialization strategy should include the following elements:

- a. A summary of transition and commercialization activities conducted during Phase I, and the Technology Readiness Level (TRL) achieved. Discuss the market, competitive landscape, potential stakeholders and end-users, and how the preliminary transition and commercialization path or paths may evolve during the Phase II project. Describe key proposed technical milestones during Phase II that will advance the technology towards product such as: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.
- b. Problem or Need Statement. Briefly describe what you know of the problem, need, or requirement, and its significance relevant to a Department of Defense application and/or a private sector application that the SBIR/STTR project results would address. Is there a broader societal need you are trying to address? Please describe.
- c. Description of Product(s) and/or System Application(s). Identify the commercial product(s) and/or DoD system(s), or system(s) under development, or potential new system(s). Identify the potential DoD end- users, Federal customers, and/or private sector customers who would likely use the technology.
- d. Business Model(s)/Procurement Mechanism(s). Discuss your current business model hypothesis for bringing the technology to market. Describe plans to license, partner, or self-produce your product. How do you plan to generate revenue? Describe the resources you expect will be needed to implement your business models. Discuss your plan and expected timeline to secure these resources. Understanding DARPA's goal of creating and sustaining a U.S. military advantage, describe how you intend to develop your product and supply chains to enable this differentiation.
- e. Target Market. Describe the market and addressable market for the innovation. Describe the customer sets you propose to target, their size, their growth rate, and the key reasons they would consider procuring the technology. Discuss the business economics and market drivers in the target industry. Describe competing technologies existent today on the market as well as those being developed in the lab. How has the market opportunity been validated? Describe the competition. How do you expect the competitive landscape may change by the time your product/service enters the market?

- f. **Funding Requirements.** Describe your company's funding history. How much external financing have you raised? Describe your plans for future funding sources (internal, loan, angel, venture capital, etc.).
- g. **Transition and Commercialization Risks.** Describe the major technology, market and team risks associated with achieving successful transition of the DARPA funded technology. DARPA is not afraid to take risks but we want to ensure that our awardees clearly understand the risks in front of them. What are the key risks in bringing your innovation to market? What are actions you plan to undertake to mitigate these risks?
- h. **Expertise/Qualifications of Team/Company Readiness.** Describe the expertise and qualifications of your management, marketing/business development and technical team that will support the transition of the technology from the prototype to the commercial market and into government operational environments. Has this team previously taken similar products/services to market? If the present team does not have this needed expertise, how do you intend to obtain it? What is the financial history and health of your company (e.g., availability of cash, profitability, revenue growth, etc.)?
- i. **Anticipated Transition and Commercialization Results.** Include a schedule showing the anticipated quantitative transition and commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its Company Commercialization Report at least annually.

Advocacy Letters (OPTIONAL)* Feedback received from potential Commercial and/or DoD customers and other end-users regarding their interest in the technology to support their capability gaps. Advocacy letters that are faxed or e-mailed separately will NOT be accepted.

Letters of Intent/Commitment (OPTIONAL)* Relationships established, feedback received, support and commitment for the technology with one or more of the following: Commercial customer, DoD PM/PEO, a Defense Prime, or vendor/supplier to the Primes and/or other vendors/suppliers identified as having a potential role in the integration of the technology into fielded systems/products or those under development. Letters of Intent/Commitment that are faxed or e- mailed separately will NOT be accepted.

*Advocacy Letters and Letters of Intent/Commitment are optional, and should ONLY be submitted to substantiate any transition or commercialization claims made in the commercialization strategy. Please DO NOT submit these letters just for the sake of including them in your proposal. These letters DO NOT count against any page limit.

In accordance with section 3-209 of DOD 5500.7-R, Joint Ethics Regulation, letters from government personnel will NOT be considered during the evaluation process.

d. Format of Cost Volume (Volume 3)

Proposers are required to use the Direct to Phase II – Volume 3: Cost Proposal Template (Excel Spreadsheet) provided as an attachment to this announcement. The Cost Volume (and supporting documentation) DOES NOT count toward the page limit of the Technical Volume.

e. Content of the Cost Volume (Volume 3)

Some items in the Cost Breakdown Guidance below may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item.

ALL proposed costs should be accompanied by documentation to substantiate how the cost was derived. For example, if you proposed travel cost to attend a project-related meeting or conference, and used a travel website to compare flight costs, include a screen shot of the comparison. Similarly, if you proposed to purchase materials or equipment, and used the internet to search for the best source, include your market research for those items. You do not necessarily have to propose the cheapest item or supplier, but you should explain your decision to choose one item or supplier over another. It's important to provide enough information to allow contracting personnel to understand how the proposer plans to use the requested funds. If selected for award, failure to include the documentation with your proposal will delay contract negotiation, and the proposer will be asked to submit the necessary documentation to the Contracting Officer to substantiate costs (e.g., cost estimates for equipment, materials, and consultants or subcontractors). It is important to respond as quickly as possible to the Contracting Officer's request for documentation.

Cost Breakdown Guidance:

1. List all key personnel by name as well as by number of hours dedicated to the project as direct labor. Special tooling and test equipment and material cost may be included. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with DARPA; unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DARPA.
2. Cost for travel funds must be justified and related to the needs of the project.
3. Cost sharing is permitted for proposals under this announcement; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.
4. All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal. Enter this information in the Explanatory Material section of the on-line cost proposal form. The Supporting Documents Volume (Volume 5) may be used if additional space is needed.

For more information about cost proposals and accounting standards, see the DCAA publication titled "Audit Process Overview – Information for Contractors" available at: <http://www.dcaa.mil>.

f. Company Commercialization Report (Volume 4)

The Company Commercialization Report (CCR) allows companies to report funding outcomes resulting from prior SBIR and STTR awards. The Company Commercialization Report (CCR) is required for Phase I and Direct to Phase II proposals. Please refer to the DoD STTR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by DARPA during proposal evaluations.

g. Supporting Documents (Volume 5)

In addition to required DoD documentation and certifications, small businesses may also submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5.

h. Fraud Waste and Abuse (Volume 6)

The Fraud, Waste and Abuse (FWA) training is required for Phase I and Direct to Phase II proposals. FWA training provides information on what represents FWA in the SBIR/STTR program, the most common mistakes that lead to FWA, as well as the penalties and ways to prevent FWA in your firm. This training material must be thoroughly reviewed once per year. Plan ahead and leave ample time to complete this training based on the proposal submission deadline. Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to \$10,000, up to five years in prison, or both. Understanding the indicators and types of fraud, waste, and abuse that can occur is critical for the SBIR/STTR awardees' role in preventing the loss of research dollars.

DARPA SBIR 22.4 Topic Index
Release 3

- HR0011SB20224-04 Innovative Fabrication Techniques for Millimeter-wave Linear Beam Vacuum Electron Devices
- HR0011SB20224-05 Readout Integrated Circuit Development for 2-micron Cutoff Linear Mode Staircase Avalanche Photodiodes
- HR0011SB20224-06 Hardening Aircraft Systems through Hardware (HASH)

HR0011SB20224-04 TITLE: Innovative Fabrication Techniques for Millimeter-wave Linear Beam Vacuum Electron Devices

OUSD (R&E) MODERNIZATION PRIORITY: Cybersecurity, Directed Energy (DE), Microelectronics, Networked Command, Control, and Communications (C3), Space

TECHNOLOGY AREA(S): Electronics, Materials/Processes

OBJECTIVE: Develop new design, fabrication, alignment, and assembly techniques to significantly reduce the cost and time of manufacturing high power, linear beam VE devices, increase the overall manufacturing yield, and reduce the dependence on skilled touch-labor for the precision fabrication and assembly of devices, particularly at millimeter-wave frequencies.

Develop new design, fabrication, alignment, and assembly techniques to significantly reduce the cost and time of manufacturing high power, linear beam VE devices, increase the overall manufacturing yield, and reduce the dependence on skilled touch-labor for the precision fabrication and assembly of devices, particularly at millimeter-wave frequencies.

DESCRIPTION: A linear beam vacuum electron device converts the kinetic energy of a longitudinally-streaming electron beam (or multiple parallel beams) into radio-frequency (RF) energy through the interaction with an electrodynamic structure. The electron beam is immersed in an externally-generated magnetic field and the “spent” beam is deposited in an electron collector. The entire device operates in hard vacuum, typically 10^{-9} torr.

Current VE manufacturing practices are labor-intensive, requiring many processing steps and highly-skilled touch labor at each step along the way. At millimeter-wave frequencies, the tight fabrication and alignment tolerances stress the limits of conventional manufacturing practices. This SBIR program seeks to develop new approaches to the design, fabrication, alignment, and assembly of millimeter-wave linear beam VE devices to decrease production cycle times, increase manufacturing yields, and reduce costs. A key goal is to develop new, readily reconfigurable methods of building VE devices that can reduce the time and cost of fabrication by a factor of 10 or more. Technologies of interest include, but are not limited to, advances in materials; CAD/CAM; subtractive, additive, and/or hybrid manufacturing; precision self-assembly and alignment; robotics and automation; and automated inspection and characterization. Novel methods of machining, forming, joining, and assembling materials that are commonly used in VE devices – such as refractory metals, oxygen-free high conductivity copper, high voltage ceramics, and high energy product permanent magnets – are of particular interest.

PHASE I: Phase I is a 10-month program to develop the designs and process flows leading to the fabrication (in Phase II) of a proof-of-concept W-band (75-110 GHz) linear beam VE amplifier comprising a thermionic electron gun, beam-wave interaction circuit, and an electrically-isolated electron beam collector. Table 1 summarizes the minimum performance parameters of the amplifier. The object of this SBIR is not to create a new breakthrough W-band device. Rather, the W-band VE amplifier will serve as a test vehicle to demonstrate the effectiveness of new VE manufacturing techniques. The goal of the SBIR is to develop new, readily reconfigurable ways of manufacturing high power millimeter-wave VE devices that reduce the fabrication time by at least a factor of 10 compared with the state-of-the-art. Approaches that support the types of millimeter-wave interaction circuits that are compatible with high power (hundreds of watts), broadband (multi-GHz) devices are of particular interest including but not limited to structures such as folded waveguides, coupled cavities, and extended interaction cavities.

Table 1: W-band amplifier specifications

Parameter	Metric
Operating band (GHz)	75-110
Center frequency (GHz)	Performer defined
Bandwidth (GHz)	> 1
Peak output power (W)	≥ 20
Gain (dB)	≥ 10
Duty (%)	≥ 0.1
Beam transmission (%)	>95 at zero-drive >90 at saturation
Hermiticity (sealed amplifier)	$< 10^{-9}$ torr

At the beginning of Phase I, analyses and simulations with computational electromagnetic particle-in-cell and/or experimentally-validated large-signal codes shall demonstrate the ability of the proposed W-band amplifier design to meet the performance metrics of Table 1. During Phase I, interim experimental demonstrations of new fabrication and alignment techniques that support high precision and hermiticity goals are desirable (if feasible). By the end of Phase I, performers shall present (1) a full mechanical design of the W-band test amplifier (including piece-parts, sub-assemblies, and final assembly); (2) a detailed description of the manufacturing process flow that highlights the innovative approaches to achieving cycle time, yield, and cost goals; (3) a comparison with the VE manufacturing state-of-the-art; and (4) a Phase II roadmap that includes the fabrication and experimental demonstration of the W-band amplifier.

Proposers interested in submitting a Direct to Phase II (DP2) proposal must provide documentation to substantiate that the scientific and technical merit and feasibility described above has been met and describe the potential applicability of the proposed manufacturing approach(es) to the small lot/discontinuous production scales that are typical of DoD VE procurements. Documentation should include all relevant information that may include but is not limited to: technical reports, published journal articles, prototype models and validation data, and examples of internally-developed processes. For detailed information on DP2 requirements and eligibility, please refer to the DoD BAA 2022.4 and DARPA BAA Instructions.

Schedule/Milestones/Deliverables There will be a Kick-off Meeting at the onset of the program and periodic review meetings to be held by video-teleconferencing. Phase I milestones for this program should include:

- Month 2: Analyses and computational simulations demonstrating that the W-band amplifier design is capable of meeting the performance goals outlined in Table 1 (including electron beam generation and transport, beam-wave interaction, and thermal management).
- Month 4: Report on initial mechanical designs, assembly techniques, and manufacturing process flows related to the W-band amplifier.
- Month 8: Interim reporting on mechanical designs, assembly techniques, and manufacturing process flows related to the W-band amplifier. Experimental demonstrations of new fabrication and/or alignment techniques, if applicable.
- Month 10: Final Phase I Report that includes (1) a full mechanical design of the W-band test amplifier (including piece-parts, sub-assemblies, and final assembly); (2) a detailed description of the manufacturing process flow that highlights the innovative approaches to achieving cycle time, yield, and cost goals; (3) a comparison with the VE manufacturing state-of-the-art; and (4) a Phase II roadmap that includes the fabrication and experimental demonstration of the W-band amplifier.

PHASE II: Phase II is an 18-month program to demonstrate the effectiveness of new mechanical designs, fabrication and alignment approaches, and process flows leading to a significant reduction in millimeter-wave VE device fabrication time (by at least a factor of 10 compared with the state-of-the-art), high manufacturing yield, and reduced costs. If appropriate, automation techniques may be developed and demonstrated in the Phase II Base program to support improved process flows. Using the technical approaches developed in Phase I, a minimum of one (1 each) W-band VE amplifier will be fabricated and tested.

Throughout Phase II, as appropriate, measurements of piece-parts and sub-assemblies shall demonstrate their ability to achieve manufacturing tolerance, alignment, and hermiticity goals. Experimental measurements of the final sealed W-band amplifier shall demonstrate that the device meets the performance metrics of Table 1 and provide validation of new fabrication and assembly techniques. A 6-month Phase II Option will further the development of automated approaches to fabrication, alignment, characterization, and inspection that leverage techniques demonstrated in the Phase II Base program. Key goals of the Phase II Option are to develop a roadmap for production-scale implementation of these approaches and to explore ways these approaches can address small lot/discontinuous production challenges that are characteristic of many DoD VE system procurements.

i. **Schedule/Milestones/Deliverables** There will be a Kick-off Meeting at the onset of the program and periodic review meetings to be held by video-teleconferencing. Phase II milestones for this program should include:

- Month 3: Quarterly Program Review (QPR) and report summarizing initial fabrication progress, schedule, plan for full power testing of the W-band amplifier, and future work.
- Month 6: QPR and report summarizing fabrication progress and planned work. As appropriate, present measurements of piece-parts and sub-assemblies demonstrating their ability to meet manufacturing tolerance, alignment, and hermiticity goals.
- Month 9: QPR and report summarizing fabrication progress and planned work. As appropriate, present measurements of piece-parts and sub-assemblies demonstrating their ability to meet manufacturing tolerance, alignment, and hermiticity goals. Update on amplifier test procurement and experimental setup.
- Month 12: QPR and report summarizing fabrication and assembly results, experimental validation, and comparisons with program metrics. Revised plans through the end of Phase II.
- Month 15: QPR and report summarizing the fabrication and initial testing of the W-band amplifier, experimental validation, and planned work through the end of Phase II.
- Month 18: End-of-Phase Review and report presenting descriptions of key innovations in design, fabrication, alignment, and assembly; experimental validation results; and comparisons with program metrics. Assessment of improvements over the VE manufacturing state-of-the-art. Proposed plan for a Phase II Option to develop automated approaches to fabrication, alignment, characterization, and inspection.

The Phase II Option milestones should include:

- Month 21: QPR and report summarizing the interim development of automated approaches to fabrication, alignment, characterization, and inspection. Experimental demonstrations, as appropriate.
- Month 24: End-of-Option Review and report summarizing the final automated approaches to fabrication, alignment, characterization, and inspection. Assessment of improvements relative to the VE manufacturing state-of-the-art and recommendations for production-scale implementation, particularly in the context of small lot/discontinuous production challenges that are characteristic of many DoD VE system procurements.

PHASE III DUAL USE APPLICATIONS: (U) Commercial and DoD/military applications for high power millimeter-wave VE amplifiers include compact transmitters for sensors, radar, and high-speed data links. The new design, fabrication, and alignment techniques developed by this SBIR will significantly reduce the cost and time of manufacturing and increase the overall manufacturing yields, facilitating the increased access to and adoption of the technology. In addition, the SBIR will develop new manufacturing process flows that leverage advances in automation and robotics to reduce the dependence on skilled touch-labor for the precision fabrication, assembly, and inspection of components and assemblies.

REFERENCES:

1. T. J. Horn and D. Gamzina, "Additive manufacturing of copper and copper alloys," ASM Handbook, Vol. 24, Additive Manufacturing Processes, D. Bourell, W. Frazier, H. Kuhn, and M. Seifi, eds., 2020.
2. Y. Koren, X. Gu, and W Guo, "Reconfigurable manufacturing systems: Principles, design, and future trends," *Front. Mech. Eng.* 13(2) 2018.
3. A. Slocum, "Kinematic couplings: A review of design principles and applications," *Int. J. Mach. Tools Manuf.* 50(4) 2010.

KEYWORDS: Vacuum electronics; millimeter-wave; precision manufacturing; reconfigurable manufacturing

HR0011SB20224-05 TITLE: Readout Integrated Circuit Development for 2-micron Cutoff Linear Mode Staircase Avalanche Photodiodes

OUSD (R&E) MODERNIZATION PRIORITY: Microelectronics

TECHNOLOGY AREA(S): Sensors

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with 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, model, and fabricate a readout integrated circuit specifically tailored for high-gain linear mode staircase avalanche photodiodes that operate at 2 μm cutoff, high frame rates, and thermoelectric cooling compatible temperatures

DESCRIPTION: Avalanche photodiodes (APDs) are photodiodes with an internal gain mechanism that exploit the photoelectric effect to convert a single photon to multiple electrons. Functionally, they are the semiconductor analog of photomultipliers. APDs use a high reverse bias voltage to create a strong internal electric field that accelerates electrons (or holes) created by the absorption of incident photons through the crystal lattice to produce secondary electrons (holes) by impact ionization. APDs have been widely deployed for use in telecommunications, military, and research applications for imaging, single photon detection, and ranging.

Linear mode staircase APDs are a particular design proposed by Capasso^[1] in the early 1980s that theorized a device that incorporated both energetic and spatial determinicity in the gain resulting in gains of $2N$ where N is the number of steps in the staircase. Attempts to meet the performance gains projected have continued,^[2,3] in particular, recent advances in the Gain Enhancement by Novel Impact Ionization (GENII) program have resulted in demonstrations of high gain (>1000), high operating temperature ($>240\text{K}$), and low excess noise factor (<1.1) at modest dark current ($<10 \mu\text{A}/\text{cm}^2$) at the pixel level with an innovative AlInAsSb-based digital alloy staircase APD structure with a per-step gain near the theoretical limit of two^[4]. In order to demonstrate the military relevance and further advance the technology and manufacturing readiness levels (TRL and MRL), a custom readout integrated circuit (ROIC) must be designed, fabricated, and tested with the staircase APD structures.

Likewise, read-out integrated circuits have been developed for linear-mode APDs^[5-7]. State of the art APD ROICs have larger pixel pitch (~ 100 microns or more) and require higher voltages to operate. It is desirable for the ROIC to operate at low voltage and be designed for smaller pixel pitches and still achieve SOA performance. The overall technical objectives of this topic are to produce a staircase APD ROIC that can meet the metrics laid out in Table 1.

Metric	Goal
Array size	32 x 32
Pixel Pitch (μm)	<50
Frame rate (kHz)	>10
Op. Temp (K)	240
Dynamic Range (bits)	16
Range Resolution (cm)	<30
Power (W)	0.5
Dark Current ($\mu\text{A}/\text{cm}^2$)	10
Excess noise factor	<1.1

PHASE I: As this is a Direct to Phase II (DP2) solicitation, Phase I proposals will not be accepted or reviewed. In order to qualify for DP2, proposers must provide documentation to substantiate the following:

- Proposer has previously demonstrated their ability to design, fabricate, and test APD ROICs (e.g. sample data from prior APD ROIC efforts)
- Proposer has preliminary performance models for a 32x32 staircase APD array that meets the metrics detailed in Table 1
- Proposer should have detector results that demonstrate APD behavior (e.g., published paper or third-party test results)

PHASE II: For the base Direct to Phase II effort, the proposer shall develop:

- Detailed design ready for tape-out of linear mode APD ROIC able to meet the metrics detailed in Table 1
- Detailed simulated performance for 32 x 32 staircase APD array

i. **Schedule/Milestones/Deliverables**

Phase	Month	Milestone
Base Phase 2	1	Kickoff meeting. The kickoff meeting should identify the detailed technical approach, preliminary expected performance, detailed specifications, detailed program schedule, anticipated risks and corresponding mitigation approach(es), level of effort and key personnel required, and any anticipated follow up actions.
	3	Update report. A report and corresponding meeting to present an update on architecture trades and progress towards detailed requirements.
	5	Requirements review. A report and corresponding meeting to present the detailed system requirements review (SRR).
	7	Update report. A report and corresponding meeting to present an update progress towards preliminary design.
	9	Preliminary design. A report and corresponding meeting for preliminary design review (PDR). Initial FPA performance estimates, pixel level layouts, and details of each layer proposed in the ROIC shall be provided.
	11	Update report. A report and corresponding meeting to present an update progress towards block level review.
	13	Block level review. A report and corresponding meeting for block level review. Pixel level schematics and variations as well as top level periphery approach shall be provided.
	17	Critical design. A report and corresponding meeting for critical design review (CDR). All elements required to bring the ROIC design to tapeout shall be provided.
	18	Final Report. A report detailing all technical progress made in the base effort.

PHASE III DUAL USE APPLICATIONS: (U) Phase III efforts will demonstrate a fully packaged camera composed of high operating temperature, linear mode staircase APDs. Potential commercial applications include single-photon detection, ranging, and imaging.

REFERENCES:

1. F. Capasso and W. T. Tsang, "Superlattice, graded band gap, channeling and staircase avalanche photodiodes towards a solid-state photomultiplier," 1982 International Electron Devices Meeting, 1982, pp. 334-337, doi: 10.1109/IEDM.1982.190288.
2. R. S. Fyath and J. J. O'Reilly, "Effect on the performance of staircase APDs of electron impact ionization within the graded-gap region," in IEEE Transactions on Electron Devices, vol. 35, no. 8, pp. 1357-1363, Aug. 1988, doi: 10.1109/16.2559.
3. G. M. Williams, M. Compton, D. A. Ramirez, M. M. Hayat and A. S. Huntington, "Multi-Gain-Stage InGaAs Avalanche Photodiode With Enhanced Gain and Reduced Excess Noise," in IEEE Journal of the Electron Devices Society, vol. 1, no. 2, pp. 54-65, Feb. 2013, doi: 10.1109/JEDS.2013.2258072.
4. S.D. March, A.H. Jones, A.J. Muhowski, S.J. Maddox, M. Ren, S.R. Bank, "Digital Alloy Staircase Avalanche Photodetectors with Tunneling-Enhanced Gain", IEEE Journal of Selected Topics in Quantum Electronics, 28, 3803513 (2022).

5. J. Asbrock, S. Bailey, D. Baley, J. Boisvert, G. Chapman, G. Crawford, T. de Lyon, B. Drafahl, J. Edwards, E. Herrin, C. Hoyt, M. Jack, R. Kvaas, K. Liu, W. McKeag, R. Rajavel, V. Randall, S. Rengarajan, J. Riker, "Ultra-High sensitivity APD based 3D LADAR sensors: linear mode photon counting LADAR camera for the Ultra-Sensitive Detector program," Proc. SPIE 6940, Infrared Technology and Applications XXXIV, 69402O (5 May 2008).
6. J.D. Beck, R. Scritchfield, P. Mitra, W. Sullivan III, A.D. Gleckler, R. Strittmatter, R.J. Martin, "Linear-mode photon counting with the noiseless gain HgCdTe e-APD," Proc. SPIE 8033, Advanced Photon Counting Techniques V, 80330N (13 May 2011).
7. W. Sullivan III, J. Beck, R. Scritchfield, M. Skokan, P. Mitra, X. Sun, J. Abshire, D. Carpenter, B. Lane, "Linear mode photon counting from visible to MWIR with HgCdTe avalanche photodiode focal plane arrays," Proc. SPIE 9492, Advanced Photon Counting Techniques IX, 94920T (13 May 2015).

KEYWORDS: Photodiode, photodetector, staircase avalanche photodiode, readout integrated circuit

HR0011SB20224-06 TITLE: Hardening Aircraft Systems through Hardware (HASH)

OUSD (R&E) MODERNIZATION PRIORITY: Cybersecurity

TECHNOLOGY AREA(S): Air Platform, Information Systems

OBJECTIVE: The effort will develop, validate and harden aircraft systems against errors, failures, and cyber-attacks arising from the introduction of electronic pilot kneeboards and maintenance connections into the cockpit.

DESCRIPTION: Electronic pilot kneeboards and the cost advantages of condition- and network-based maintenance processes offer new potential mission benefits and new requirements for connectivity in the cockpit of DoD aircraft systems. At the same time, these open new concerns associated with pilot and operator errors, system failures, and cyber-vulnerabilities. Hardware hardening capabilities are required that are impervious to malicious software yet mindful of Size, Weight, and Power (SWaP) constraints. Unlike most ground-based installations, DoD aircraft defenses must respond in real-time, provide alerts to the pilot, prevent undesirable outcomes, and instantly adapt to the level of threat.

The last five years have seen a quiet revolution in the underlying fabric of systems engineering with the coming of age of many enabling technologies: open standards for system and sensor busses have emerged that enable competitive acquisition processes; System-on-Chip and Field Programmable Gate Array (FPGA) devices offer new levels of integration and performance; High-Level Synthesis accelerates circuit design; Partial Reconfiguration allows real-time circuit adaptivity; formally verified software subsystems offer new levels of system assurance. These advances are revolutionizing commercial networking and systems design, but have yet to have a significant presence in the cockpit, especially on DoD legacy platforms.

This SBIR topic will develop, harden and validate system design, software, and hardware innovations that improve aircraft resilience while reducing SWaP. Approaches should address the hardware to be developed, expected path of integration, metrics of success, assessment methods, and integration of solutions into robust, real-time cyber defenses of interest to the DoD.

PHASE I: The Phase I feasibility study shall include the documentation of a basic prototype consisting of the co-designed software code and hardware capabilities that are demonstrably impervious to advanced cyber-attacks and malicious software infiltrations of the supply chain yet mindful of Size, Weight, and Power (SWaP) constraints for connectivity in the cockpit of DoD aircraft systems.

Proposers interested in submitting a Direct to Phase II (DP2) proposal must provide documentation to substantiate that the scientific and technical merit and feasibility described above has been met and describes the potential military and/or commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. For detailed information on DP2 requirements and eligibility, please refer to Section 4.2, Direct to Phase II (DP2) Requirements, and Appendix B of the DARPA Instructions for DoD BAA 2022.4

PHASE II: Phase II shall produce system design, implementation, and maintenance capabilities to significantly advance the state of the art in security and resilience of cockpit connectivity and integration of modern computational architectures and user interfaces. These integrated systems of co-designed software and hardware architectures will support Artificial Intelligence (AI)-based or Neuromorphic-based capabilities, including a cyber-attack detection capability. This capability will detect anomalous sequences of instructions, using strategies for tight integration of CPUs and Artificial Intelligence

(AI)/Machine Learning (ML)/neuromorphic fabrics. It will provide for effective cyber warning with an acceptable false alarm rate in a SWaP-constrained environment for efficient runtime cyber warning. Strong technical approaches will provide innovative concepts for coupling AI/ML or neuromorphic logic with conventional CPU cores. Thus, it will provide the ability to monitor an instruction queue of the frontside bus of CPU cores to mitigate cyber vulnerabilities. The AI or ML techniques shall capture an understanding of a system design and determine vulnerabilities.

The DoD has requirements for implementing cyber resiliency and tamper resistance in its aircraft platforms, ordnance systems and associated support systems. The DoD has significant interest in advanced software engineering and digital design technologies that implement robust security related to Platform IT (PIT), programmable logic, and physical digital electronics hardware involving, but not limited to, the following:

- Software, hardware and/or programmable logic implementing security that significantly advances the state of the art while simultaneously supporting performance and SWaP in areas regarding:
 1. Protocol checking logic for detection of maliciously formed packets with advanced secure parsing and input validation logic residing on hardware or FPGA fabric, to implement a vetting function prior to reaching an objective network stack process residing on the objective CPU core. Said capability shall provide minimal impact on performance, latency and throughput.
 2. Packet inspection logic supporting high throughput and minimal latency for detection of malicious payloads prior to reaching an objective network stack process residing on the objective CPU core.
 3. Avionics networking defensive logic, especially targeting MIL-STD-1553, ARINC-429, ARINC-629, ARINC-664, Fibre Channel and Ethernet. Said approaches shall be retrofittable with minimal impact on target platforms.
 4. Advanced approaches to implement secure loader and secure monitor functionality on a SoC type implementation with security core residing on fabric interacting with processes running on contained CPU cores for robust detection of malicious activity on protected CPU cores.
 5. Innovative methods to improve the capability of standard FPGA security cores, regarding performance and resource utilization.
 - a. Methods to detect and/or prevent the adversary utilizing undefined semantics for malicious purposes.
 - b. Methods to detect and/or prevent the adversary from utilizing emergent behaviors of existing implementations for malicious purposes.
 - c. Methods to implement Root of Trust (RoT), secure boot (cold boot), and secure restart (warm boot).
 - d. Methods to advance the secure loading of FPGA configuration files over existing approaches.
 - e. Methods in volume protection that increase security while simultaneously supporting high heat dissipation.
 6. Methods to implement security in a powered-off state with only limited battery powered functionality available for sensors and defensive logic.
 - a. Methods that address known computer processor hardware vulnerabilities that are retrofittable into existing systems. [IMPORTANT: Offeror in an UNCLASSIFIED proposal should not explicitly mention specific platform subject to said vulnerability.]
 - b. Methods that address known crypto implementational security issues (not basic cryptological algorithm issues) in embedded crypto systems that are retrofittable into existing systems. [IMPORTANT: Offeror in an UNCLASSIFIED proposal should not explicitly mention specific platform subject to said vulnerability.]

- c. Methods to thwart Reverse Engineering (RE) of sensitive software, hardware and/or programmable logic that strongly obscures the functionality, effectively denying the ability to perform RE but provides for the ability to operate in a hidden/obfuscated/encrypted state with minimal and/or acceptable impact on performance and/or latency.
 - d. Methods for implementing a covert communication channel (intended to be unknown to the attacker) between various avionics components or subsystems to support alerting, logging or a coordinated response to a RE attack or a cyber attack.
- Techniques to provide for provability and traceability of software, hardware and programmable logic regarding:
 1. Innovative approaches to formal methods that in addition to proof of correctness, provide proofs of Confidentiality, Integrity, and Availability (CIA):
 - a. Approaches to supporting scalability of formal methods to support large scale software packages and large circuit design Hardware Description Language (HDL) code bases.
 - b. Robust approaches to dealing with covert channels, timing channels and side channels.
 - c. Provability regarding software targeting multiprocessing implementations including Symmetric Multi-Processing (SMP) and other multiprocessing arrangements such as Asymmetric Multi-Processing (AMP) (in part, related to the previous bullet).
 - d. Techniques to support verification for mixed implementations involving both software with hardware and/or programmable logic, where the software is tightly coupled to hardware/programmable logic in a target such as a System on a Chip (SoC).
 - e. Techniques to provide for formal verification of Machine Learning (ML) and neuromorphic hardware and use cases where software is coupled to a ML/neuromorphic system in support of some Naval Aviation Enterprise (NAE) application such as sensor data processing, tracking or autonomy.
- Technologies that provide the ability to rapidly and effectively assess the provenance of software, programmable logic and hardware in a manner significantly more robust than code signing (cf. the recent SolarWinds attack subverting the software build environment to bypass code signing). These technologies must provide the capability to prove that no unauthorized and potentially malicious modification has been made anywhere in the supply chain or development system. They shall have traceability back to the software/hardware development system and relate to the software module/hardware cell level. They shall provide the ability to vet the individual software/IP blocks/hardware cells at the target or at the software loader/device programmer, accessing artifacts providing proof such as:
 1. Software/hardware/programmable logic fully confirms to system program office approved design specification with no additional functionality.
 2. Software/hardware/programmable logic was only developed and/or modified by authorized developer personnel.
 3. Software/hardware/programmable logic was only developed and/or modified using approved toolchains.
 4. Software/hardware/programmable logic was only developed and/or modified on approved development systems.
 5. Software/hardware/programmable logic was only developed and/or modified during an approved period.

Successful offerors in their proposals will demonstrate a strong understanding of the technology areas that they respond to and they will articulate a compelling necessity for S&T funding to support their respective proposed technology approaches over existing capabilities.

Schedule/Milestones/Deliverables Phase II fixed payable milestones for this program shall include:

- Month 2: New Capabilities Report, that identifies additions and modifications that will be researched, developed, and customized for incorporation in the pilot demonstration.
- Month 4: PI meeting presentation material, including demonstration of progress to date, PowerPoint presentations of accomplishments and plans.
- Month 6: Demonstration Plan that identifies schedule, location, computing resources, and any other requirements for the pilot demonstration.
- Month 9: Initial demonstration of stand-alone pilot application to DARPA; identification of military transition partner(s) and other interested DoD organizations
- Month 12: PI meeting presentation material, including demonstration of progress to date, PowerPoint presentations of accomplishments and plans.
- Month 15: Demonstration to military transition partners (s) and other DoD organizations.
- Month 18: PI meeting presentation material, including demonstration of progress to date, PowerPoint presentations of accomplishments and plans.
- Month 21: PI meeting presentation material, including demonstration of progress to date, PowerPoint presentations of accomplishments and plans.
- Month 24: Final software and hardware delivery, both object and source code, for operation by DARPA or other Government personnel for additional demonstrations, with suitable documentation in a contractor proposed format. Deliver a Final Report, including quantitative metrics on decision making benefits, costs, risks, and schedule for implementation of a full prototype capability based on the pilot demonstration. This report shall include an identification of estimated level of effort to integrate the pilot capability into an operational environment, addressing computing infrastructure and environment, decision making processes, real-time and archival data sources, maintenance and updating needs; reliability, sensitivity, and uncertainty quantification; and transferability to other military users and problems. The report shall also document any scientific advances that have been achieved under the program. (A brief statement of claims supplemented by publication material will meet this requirement.) Provide Final PI meeting presentation material.

Phase II Option: The option shall address preliminary steps toward the certification, accreditation and/or verification of the resulting base effort's hardening capability.

Schedule/Milestones/Deliverables for Phase II Option Phase II fixed payable milestones for this program option shall include:

- Month 2: Plan that identifies the schedule, location, computing resources and/or any other requirements for the hardening capability's certification, accreditation, and/or verification.
- Month 4: Presentation on the detailed software and hardware plan for the technical capability.
- Month 7: Interim report on progress toward certification, accreditation and/or verification of the technical capability.
- Month 10: Review and/or demonstration of the prototype capability with the documentation supporting certification, accreditation and/or verification.
- Month 12: Final Phase II option report summarizing the certification, accreditation and/or verification approach, architecture and algorithms; data sets; results; performance characterization and quantification of robustness.

PHASE III DUAL USE APPLICATIONS: (U) The DoD and the commercial world have similar challenges with respect to maintaining the cyber integrity of their computing and communications infrastructure. The Phase III effort will see the developed technical capability transitioned into a DoD

enterprise aircraft system that can be used to discover, analyze, and mitigate cyber threats. Government and commercial aircraft systems have similar challenges in tracking, understanding, and mitigating the varied cyber threats facing them in the cockpit of aircraft systems. Thus, the resulting hardening capability is directly transitionable to both the DoD and the commercial sectors: military and commercial air, sea, space and ground vehicles; commercial hardening of critical industrial plant (i.e. control systems, manufacturing lines, chemical processes, etc.) through secure programmable logic controllers; securing cloud infrastructure associated with optimization of industrial processes and condition-based maintenance of air, sea, space and ground vehicles.

As part of Phase III, the developed capability should be transitioned into an enterprise level system that can be used to detect heavily obfuscated or anti-debugging and integrity checking techniques employed by a cyber intruder. The resulting hardening capability is directly transitionable to the DoD for use by the services (e.g., Naval Aviation Enterprise (NAE), etc.) that have requirements for implementing cyber resiliency and tamper resistance in its aircraft platforms. This is a dual-use technology that applies to both military and commercial aviation environments affected by cyber adversaries.

REFERENCES:

1. C. Adams, "HUMS Technology", Aviation Today, May 2012.
2. <https://www.aviationtoday.com/2012/05/01/hums-technology/>
3. Shanthakumaran, P. (2010) "Usage Based Fatigue Damage Calculation for AH-64 Apache Dynamic Components", The American Helicopter Society 66th Annual Forum, Phoenix, Arizona.
4. P. Murvay and B. Groza, "Security Shortcomings and Countermeasures for the SAE J1939 Commercial Vehicle Bus Protocol," in IEEE Transactions on Vehicular Technology, vol. 67, no. 5, pp. 4325-4339, May 2018, doi: 10.1109/TVT.2018.2795384.

KEYWORDS: aircraft systems, cyber attacks, operator errors, cyber vulnerabilities, hardware hardening