DARPA

SBIR 16.3 DIRECT TO PHASE II PROPOSAL INSTRUCTIONS

IMPORTANT NOTE REGARDING THESE INSTRUCTIONS

Offerors responding to DARPA topics listed in this announcement must follow all the instructions provided in the DoD Program Broad Agency Announcement AND the supplementary DARPA instructions contained in this section.

THESE INSTRUCTIONS ONLY APPLY TO PROPOSALS SUBMITTED IN RESPONSE TO DARPA 16.3 DIRECT TO PHASE II TOPICS. Please contact our office if you require Phase II Instructions or Direct to Phase II instructions for another announcement.

Introduction

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA SBIR Program is designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to bridge the gap between fundamental discoveries and the provision of new military capabilities.

The responsibility for implementing DARPA's Small Business Innovation Research (SBIR) Program rests with the Small Business Programs Office.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Attention: DIRO/SBPO
675 North Randolph Street
Arlington, VA 22203-2114
sbir@darpa.mil
http://www.darpa.mil/work-with-us/for-small-businesses

Direct to Phase II (DP2)

15 U.S.C. §638(cc), as amended by NDAA FY2012, Sec. 5106, PILOT TO ALLOW PHASE FLEXIBILITY, allows the DoD to make an award to a small business concern under Phase II of the SBIR program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project.

DARPA is conducting a "Direct to Phase II" pilot implementation of this authority for this 16.3 SBIR Announcement only and does not guarantee the pilot will be offered in future announcements. Each eligible topic will indicate what documentation is required to determine if Phase I feasibility has been met and the technical requirements for a Direct to Phase II proposal.

ELIGIBILITY

Not all DARPA topics are eligible for a DP2 award. Offerors should read the topic requirements carefully. DP2 topics may accept Phase I and Direct to Phase II proposals or Direct to Phase II proposals only. DARPA reserves the right to not make any awards under the Direct to Phase II pilot. All other instructions remain in effect. Direct to Phase II proposals must follow the DARPA Direct to Phase II Announcement Instructions.

REQUIREMENTS

Offerors interested in submitting a DP2 proposal in response to an eligible topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

DARPA will not evaluate the offeror's related Phase II proposal if it determines that the offeror has failed to demonstrate that technical merit and feasibility has been established or the offeror has failed to demonstrate that work submitted in the feasibility documentation was substantially performed by the offeror and/or the principal investigator (PI).

Feasibility documentation cannot be based upon any prior or ongoing federally funded SBIR or STTR work and DP2 proposals **MUST NOT** logically extend from any prior or ongoing federally funded SBIR or STTR work. Offerors interested in submitting a Phase II proposal to DARPA based upon prior or ongoing SBIR or STTR work should contact sbir@darpa.mil for instructions.

System Requirements

Use of the DARPA SBIR/STTR Information Portal (SSIP) is MANDATORY. The registered Corporate Official (CO) **MUST** authenticate into the SSIP (via the DARPA Extranet) to retrieve the selection decision notice, to request debriefings, and to upload reports (awarded contracts only). DARPA SBPO will automatically create an extranet account for new users and send the SSIP URL, authentication credentials, and login instructions AFTER the 16.3 selection period has closed. DARPA extranet accounts will ONLY be created for the individual named as the CO on the Proposal Cover Sheet. Offerors may not request accounts for additional users at this time.

DARPA contractors who are not eligible to receive a Common Access Card (CAC) are required to obtain a digital certificate from an approved External Certification Authority (ECA) vendor.

- If the SBC has or will register for multiple ECAs, one of the registered ECA e-mail addresses MUST match the CO e-mail address (listed on the Proposal Cover Sheet).
- Additional information will be sent to small business concerns (SBCs) selected for contract award

WARNING: The Corporate Official (CO) e-mail address (from the Proposal Cover Sheet) will be used to create a DARPA Extranet account. The same e-mail MUST also be used for ECA registration. Updates to Corporate Official e-mail after proposal submission may cause significant delays to communication retrieval and contract negotiation (if selected).

Notification of Proposal Receipt

Within 5 business days after the Announcement closing, the individual named as the "Corporate Official" on the Proposal Cover Sheet will receive a separate e-mail from sbir@darpa.mil acknowledging receipt for each proposal received. Please make note of the topic number and proposal number for your records. The CO should add this address to their address book and whitelist to ensure all communications are received.

Notification of Proposal Status

The source selection decision notice will be available no later than 90 days after the Announcement close date for DP2 offerors. The individual named as the "Corporate Official" (CO) on the Proposal Cover Sheet will receive an email for each proposal submitted from sbir@darpa.mil with instructions for retrieving their official notification from the SSIP. Please read each notification carefully and note the proposal number and topic number referenced. The CO must retrieve the letter from the SSIP 30 days from the date the e-mail is sent.

After 30 days the CO must make a written request to sbir@darpa.mil for the selection decision notice. The request must explain why the offeror was unable to retrieve the selection decision notice from the SSIP within the original 30 day notification period.

Debriefing

DARPA will provide a debriefing to the offeror in accordance with Federal Acquisition Regulation (FAR) 15.505. The selection decision notice contains instructions for requesting a proposal debriefing. Please also refer to section 4.10 of the DoD Program Announcement.

Announcement Protests

Protests regarding the **Announcement** should be submitted in accordance with the DoD Program Announcement section 4.11.

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

Human and/or Animal Use

Your topic may have been identified by the program manager as research involving Human and/or Animal Use. In accordance with DoD policy, human and/or animal subjects in research conducted or supported by DARPA shall be protected. Although these protocols were most likely not needed to carry out the Phase I, significant lead time is required to prepare the documentation and obtain approval in order to avoid delay of the DP2 award. Please visit http://go.usa.gov/cBtYW to review the Human Use PowerPoint presentation to understand what is required to comply with human protocols and http://go.usa.gov/cBtYd to review the Animal Use PowerPoint presentation to understand what is required to comply with animal protocols. Offerors proposing research involving human and/or animal use are encouraged to separate these tasks in the Technical Volume and Cost Volume in order to avoid potential delay of contract award.

a. **Human Use:** Reference sections 3.12 and 4.7 of the DoD Program Announcement for additional information.
    - DoD Directive 3216.02, *Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research* (http://www.dtic.mil/whs/directives/corres/pdf/321602p.pdf).
    - For all proposed research that will involve human subjects in the first year or phase of the project, the institution must provide evidence of or a plan for review by an Institutional Review Board (IRB) upon final proposal submission to DARPA. The IRB conducting the review must be the IRB identified on the institution's Assurance. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. Consult the designated IRB for guidance on writing the protocol. The informed consent document must comply with federal regulations (32 CFR 219.116). A valid Assurance along with evidence of appropriate training for all investigators should accompany the protocol for review by the IRB.
    - In addition to a local IRB approval, a headquarters-level human subjects regulatory review and approval is required for all research conducted or supported by the DoD. The Army, Navy or Air Force office responsible for managing the award can provide guidance and information about their component's headquarters-level review process. Note that confirmation of a current Assurance and appropriate human subjects protection training is required before headquarters-level approval can be issued.

b. **Animal Use:** Reference sections 3.11 and 4.8 of the DoD Program Announcement for additional information.
    - For submissions containing animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the PHS Policy on Humane Care and Use of Laboratory Animals, available at http://grants.nih.gov/grants/olaw/olaw.htm.
    - All Recipients must receive approval by a DoD certified veterinarian, in addition to an IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the USAMRMC Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the Recipient will be required to complete and submit an ACURO Animal Use Appendix, which may be found at http://mrmc.amedd.army.mil/index.cfm?pageid=research_protections.acuro_animalappendix

DP2 Award Information

a. **Type of Funding Agreement**. DARPA DP2 awards are typically Cost-Plus-Fixed-Fee contracts.

- Offerors that choose to collaborate with a University must highlight the research activities that are being performed by the University and verify that the work is FUNDAMENTAL RESEARCH.
- Offerors are strongly encouraged to implement a government acceptable cost accounting system to avoid delay in receiving a DP2 award. Phase II contractors MUST have an acceptable system to record and control costs, including procedures for job costing and time record keeping. Items such as overhead and G&A rates WILL require logical supporting documentation during the DCAA review process. Visit www.dcaa.mil and download the "Information for Contractors" guide for more information.
    - Offerors who do not have a cost accounting system that has been deemed adequate for determining accurate costs must provide the DCAA Pre-award Accounting System Adequacy Checklist in order to facilitate DCAA's completion of Standard Form (SF) 1408. The checklist may be found at: http://www.dcaa.mil/preaward_accounting_system_adequacy_checklist.html.
- Offerors that are unable to obtain a positive DCAA review of their accounting system may on a case-by-case basis, at the discretion of the Contracting Officer, be awarded a Firm Fixed Price Phase II contract or an Other Transaction (OT). For definition and information on Other Transactions for Prototype see the Fact Sheet and Other Transactions Guide for Prototype Projects at http://www.darpa.mil/work-with-us/for-small-businesses/participate-sbir-sttr-program. While agreement type (fixed price or expenditure based) will be subject to negotiation, the use of fixed price milestones with a payment/funding schedule is preferred. Proprietary information must not be included as part of the milestones.

b. **Average Dollar Value**. The maximum value of a DARPA DP2 award is $1,500,000 or $1,510,000 if Discretionary Technical Assistance is proposed (see section below).

Communication with DARPA Program Managers (PM)

Offerors participating in the DP2 process may only communicate with PMs during the pre-Announcement period, published at http://www.acq.osd.mil/osbp/sbir/index.shtml and on SITIS once the Announcement has opened. Information regarding SITIS is available directly from https://sbir.defensebusiness.org/.

Discretionary Technical Assistance (DTA)

DARPA has implemented the Transition and Commercialization Support Program (TCSP) to provide commercialization assistance to *SBIR* and/or *STTR awardees in Phase I* and/or *Phase II*. Offerors awarded funding for use of an outside vendor for discretionary technical assistance (DTA) are excluded from participating in TCSP.

DTA requests must be explained in detail with the cost estimate and provide purpose and objective (clear identification of need for assistance), provider's contact information (name of provider; point of contact; details on its unique skills/experience in providing this assistance), and cost of assistance (clearly identified dollars and hours proposed or other arrangement details). The cost cannot be subject to any profit or fee by the requesting firm. In addition, the DTA provider may not be the requesting firm itself, an affiliate or investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g., research partner).

Offerors proposing DTA must complete the following:

1. Indicate in question 17, of the proposal coversheets, that you request DTA and input proposed cost of DTA (in space provided).
2. Provide a one-page description of the vendor you will use and the technical assistance you will receive. The description should be included as the LAST page of the Technical Volume. This description will not count against the 40-page limit of the technical volume and will NOT be evaluated.
3. Enter the total proposed DTA cost, under the "Discretionary Technical Assistance" line along with a detailed cost breakdown under "Explanatory material relating to the cost proposal" via the online cost proposal. The proposed amount may not exceed $5,000 per year and a total of $10,000 per Phase II contract.

Approval of DTA is not guaranteed and is subject to review of the Contracting Officer. Please see section 4.22 of the DoD Program Announcement for additional information.

Phase II Option

DARPA has implemented the use of a Phase II Option that may be exercised at the DARPA Program Manager's discretion to continue funding Phase II activities that will further mature the technology for insertion into a larger DARPA Program, DoD Acquisition Program, other Federal agency, or commercialization into the private sector. The statement of work for the Phase II Option MUST be included with the Phase II Technical Volume and should describe Phase II activities, over a 12 month period that may lead to the successful demonstration of a product or technology. The statement of work for the option counts toward the 40-page limit for the Phase II Technical Volume. If selected, the government may elect not to include the option in the negotiated contract.

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 commercialization strategy part of the proposal.

The Technical Volume of each Phase II proposal must include a commercialization strategy section. The Phase II commercialization strategy shall not exceed 5 pages, and will NOT count against the 40-page proposal limit. The commercialization strategy should include the following elements:

1. A summary of transition and commercialization activities conducted during Phase I, and the Technology Readiness Level (TRL) achieved. Discuss how the preliminary transition and commercialization path or paths may evolve during the Phase II project. Describe key proposed milestones anticipated during Phase II such as: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.
2. 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.
3. 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) that this technology will be/or has the potential to be integrated. Identify the potential DoD end-users, Federal customers, and/or private sector customers who would likely use the technology.
4. Business Model(s)/Procurement Mechanism(s). Discuss business models, procurement mechanisms, and, as relevant, commercial investors or partners, and/or licensing/teaming agreements you plan to employ to sell into your targeted markets.
    a. What is the business model you plan to adopt to generate revenue from your innovation?
    b. Describe procurement mechanisms and potential private sector and federal partners you plan to employ to reach the targeted markets/customers.
    c. If you plan to pursue a licensing model, what is your plan to identify potential licensees?
5. Market/Customer Sets/Value Proposition. Describe the market and customer sets you propose to target, their size, and their key reasons they would consider procuring the technology.
    a. What is the current size of the broad market you plan to enter and the “niche” market opportunity you are addressing?
    b. What are the growth trends for the market and the key trends in the industry that you are planning to target?
    c. What features of your technology will allow you to provide a compelling value proposition?
    d. Have you validated the significance of these features and if not, how do you plan to validate?
6. Competition Assessment. Describe the competition in these markets/customer sets and your anticipated advantage (e.g., function, performance, price, quality, etc.)
7. Funding Requirements. List your targeted funding sources (e.g., federal, state and local, private (internal, loan, angel, venture capital, etc.), estimated funding amount, and your proposed plan and schedule to secure this funding. Provide anticipated funding requirements both during and after Phase II required to:

- mature the technology
- mature the manufacturing processes, if applicable
- test and evaluate the technology
- receive required certifications
- secure patents, or other protections of intellectual property
- manufacture the technology to bring the technology to market for use in operational environments
- market/sell technology to targeted customers

8. Sales Projections. Provide a schedule that outlines your anticipated sales projections and indicate when you anticipate breaking even.
9. 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.)?
10. Anticipated Commercialization Results. Include a schedule showing the anticipated quantitative commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its Company Commercialization Report (see Section 7.5.e) at least annually.
11. 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.
12. 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.

DP2 PROPOSAL INSTRUCTIONS

A complete DP2 proposal consists of four volumes:

Volume 1: Proposal Cover Sheet
Volume 2: Technical Volume
PART ONE: Feasibility Documentation **(75 page maximum)**
PART TWO: Technical Proposal **(40 page maximum)**
Volume 3: Cost Volume
Volume 4: Company Commercialization Report

Each DP2 proposal must be submitted through the DoD SBIR/STTR Submission Web site by the Announcement deadline. After authenticating, choose “Start New Direct to Phase II Proposal.” Review your submission after upload to ensure that all pages have transferred correctly and do not contain unreadable characters. Contact the DoD Help Desk immediately with any problems

a. Proposal Cover Sheet (Volume One)

Prepare the Proposal Cover Sheet in accordance with section 5.4 (a) of the DoD Program Announcement Instructions.

b. Technical Volume (Volume Two)

- The Technical Volume upload must include two parts. Label the Feasibility Documentation "PART ONE: Feasibility Documentation." Part Two of the Technical Volume should be labeled "PART TWO: Technical Proposal.
- Begin on page 1 and number all pages of your Technical Volume consecutively. Use no type smaller than 10-point on standard 8-1/2" x 11" paper with one inch margins. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by the DoD SBIR/STTR Submission Web site when the Cover Sheet was created. The header may be included in the one-inch margin.
- The Technical Volume should cover the following items in the order given below.

VOLUME TWO - PART ONE: Feasibility Documentation

- Provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results.
- Maximum page length for feasibility documentation is 75 pages. If you have references, include a reference list or works cited list as the last page of the feasibility documentation. This will count towards the page limit.
- Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).
- If technology in the feasibility documentation is subject to IP, the offeror must have IP rights. Refer to section 11.5 of these DARPA instructions for additional information.
- 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.

VOLUME TWO - 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.

a) 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.

b) Human/Animal Use: Offerors 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.

c) Phase II OPTION Statement of Work. The statement of work should provide an explicit, detailed description of the activities planned during the Phase II Option, if exercised. Include how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail.

(3) **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the offeror, 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 offeror'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.

(4) **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.

(5) **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 principal investigator, 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, country of origin and level of involvement.

(6) **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.

(7) **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 described in detail and identified in the Cost Volume. A minimum of one-half of the research and/or analytical work in Phase II, as measured by direct and indirect costs, must be carried out by the offeror, unless otherwise approved in writing by the Contracting Officer. No portion of an SBIR award may be subcontracted back to any Federal government agency, including Federally Funded Research and Development Centers (FFRDCs). SBA may issue a case-by-case waiver to this provision after review of the DoD component's written justification that includes the following information: (a) an explanation of why the SBIR research project requires the use of the Federal facility or personnel, including data that verifies the absence of non-federal facilities or personnel capable of supporting the research effort; (b) why the Agency will not and cannot fund the use of the Federal facility or personnel for the SBIR project with non-SBIR money; and (c) the concurrence of the small business concern's chief business official to use the Federal facility or personnel. Award is contingent on the sponsoring agency obtaining a waiver.

(8) **Prior, Current or Pending Support of Similar Proposals or Awards.** Warning -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program announcements, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

(9) **Commercialization Strategy.** Each DP2 proposal must contain a five-page commercialization strategy as part of the Technical Volume describing the offeror's strategy for commercializing this technology in DoD, other Federal Agencies and/or private sector markets. See Commercialization Strategy section above for required strategy elements. The commercialization strategy will NOT count against the 40-page proposal limit.

c. Cost Volume (Volume 3)

Offerors are REQUIRED to use the online Cost Volume (https://sbir.defensebusiness.org/) for the Phase II and Phase II Option costs. The Cost Volume (and supporting documentation) DOES NOT count toward the 40-page limit of the Technical Volume. Phase II awards and options are subject to the availability of funds.

The Phase II Base Cost Volume must not exceed the maximum dollar amount of $1,000,000 (24 months) or $1,010,000 if DTA is proposed. Offerors proposing a Phase II Option must also submit a Phase II Option Cost Volume, not to exceed $500,000 (12 months). The total Phase II cost volume must not exceed $1,500,000, or $1,510,000 if DTA is proposed.

Some items in the Cost Breakdown Guidance may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow DARPA to understand how the offeror plans to use the requested funds if the contract is awarded.

1. List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
2. 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 the DoD Component; unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
3. Cost for travel funds must be justified and related to the needs of the project.
4. Use the "Explanatory Material Field" in the DoD Cost Volume worksheet to provide details on subcontractor, material and travel costs, if necessary.
5. 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 DP2 proposal.
6. Costs for the base and option (if proposed) are clearly separated and identified in the cost volume.
7. Include the cost of each ECA to be purchased. Reimbursement is limited to a maximum of three ECAs per company. See Contract Requirements section below for additional information.
8. If proposing DTA, include cost in accordance with instructions in DTA section above. Cost cannot exceed $5,000 per year ($10,000 total).

If selected for award, the offeror should be prepared to submit further documentation to the DoD Contracting Officer to substantiate costs (e.g., a brief explanation of cost estimates for equipment, materials, and consultants or subcontractors). For more information about the Cost Volume and accounting standards, see the DCAA publication called "Information for Contractors" available at http://www.dcaa.mil/audit_process_overview.html.

d. Company Commercialization Report (CCR) (Volume 4)

All offerors are required to prepare a CCR in accordance with section 5.4.e. of the DoD Program Announcement.

Modifications or Withdrawal of Proposals

Modification
Late modifications of an otherwise scientifically successful proposal, which makes its terms more favorable to the Government, may be considered and may be accepted.

Withdrawal
Proposals may be withdrawn by written notice at any time. Proposals may be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal.

PHASE II EVALUATION CRITERIA

DP2 proposals will be evaluated in accordance with section 8.0 of the DoD Program Announcement. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for DARPA SBIR or STTR awards in the SBIR/STTR topics they review and/or provide comments on to the Government. All advisors are required to comply with procurement integrity laws and are required to sign Non-Disclosure Agreement and Rules of Conduct/Conflict of Interest statements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their offerors as "Government Only."

CONTRACTUAL REQUIREMENTS

External Certification Authority (ECA)
Offerors must include, in the Cost Volume, the cost of each ECA proposed to be purchased in order to be reimbursed for the cost of ECAs. Reimbursement is limited to a maximum of three ECAs per company. The cost cannot be subject to any profit or fee by the requesting firm.

Offerors should consider purchasing the ECA subscription to cover the Phase II period of performance, to include the option year. Offerors will only be reimbursed for ECA costs once per subscription. Offerors that previously obtained a DoD-approved ECA may not be reimbursed under any potential SBIR/STTR Phase II contract. Likewise, offerors that are reimbursed for ECAs obtained as a requirement under an SBIR/STTR Phase II contract, may not be reimbursed again for the same ECA purchase under any subsequent government contract. Additional information regarding ECA requirement may be found in section 1.0, System Requirements.

Security Requirements
If a proposed effort is classified or classified information is involved, the offeror must have, or obtain, a security clearance in accordance with the Industry Security Manual for Safeguarding Classified Information (DOD 5220.22M).

Payment Schedule
Payment will be made in accordance with General Provisions FAR 523.216-7, *Allowable Cost and Payments.*

Phase II Reports
All DARPA SBIR awardees are required to submit reports in accordance with the Contract Data Requirements List – CDRL and any applicable Contract Line Item Number (CLIN) of the Phase II contract.

DARPA SBIR 16.3 Topic Index

*These instructions **ONLY** apply to **DP2** Proposals. For Phase I, refer to the DARPA 16.3 Phase I Topics and Proposal Instructions available at (http://www.acq.osd.mil/osbp/sbir/index.shtml).*

Proposals Types Accepted

Topic Number	Topic Title	Phase I	DP2
SB163-001	Tools for Sharing and Analyzing Neuroscience Data	YES	YES
SB163-002	Genetic/Genomic Approaches to Improve Insect Production for Human Use	YES	YES
SB163-003	Next Generation Genome Editing Tools	YES	YES
SB163-004	Real-Time Metrology and Feedback Control for Additive Manufacturing	YES	YES
SB163-005	TRUsted Structures Technology (TRUST)	YES	YES
SB163-006	Real-time Audio Authentication to Combat Vishing Attacks	YES	NO
SB163-007	Explainable Machine Learning for Resource Allocation	YES	YES
SB163-008	Assessing Deterrence in the Gray Zone	YES	YES
SB163-009	Low Voltage Power Sources for Long-Life Electronics	YES	YES
SB163-010	Compact, Efficient, Fiber-Coupled High Power Laser Diode Pump Module	NO	YES
SB163-011	Wide Area Undersea Communications Through Intelligent Mobile Networks	YES	YES
SB163-012	Adapter Multifunctional Elements Reconfigured in a Coherent Array (AMERICA)	YES	YES
SB163-013	Task Accomplishing Systems from Composable Kits (TASCK)	YES	YES
SB163-014	Gun-launched Integrated Guidance Navigation and Control	NO	YES

DARPA SBIR 16.3 Topic Descriptions

SB163-001 TITLE: Tools for Sharing and Analyzing Neuroscience Data

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Biomedical, Information Systems

OBJECTIVE: Develop and demonstrate an 'open data' platform comprising software tools for parsing, storing, aggregating, analyzing, and sharing complex neuroscience data.

DESCRIPTION: There is a critical DoD need to develop tools that will advance fundamental and applied neuroscience research, and enable sharing of critical meta-data and raw data across electronic platforms. In recent years, the neuroscience field has benefited from advances in instrumentation and computing resources that routinely generate large, rich datasets in many model systems. However, access to these precious data is typically restricted to the source lab and close collaborators, limiting scientific output. In addition, published results are often highly processed versions of only a small fraction of the source data, further restricting public access to the data and impeding efforts to perform verification studies, much less meta analyses. Given the rapid growth in neuroscience and increasing concerns over lack of reproducibility in science, there is an increasing need for tools that enable widespread sharing of data and analysis procedures throughout the scientific community.

An 'open data' platform will provide the neuroscience community with access to valuable data, increasing scientific productivity and promoting greater transparency. Data sharing facilitates efficiency in scientific process through reductions in the costs of collecting data and leveraging existing datasets to derive additional results. Furthermore, sharing of analytic tools reduces the necessity for each lab to develop custom software for analyzing data types that other labs may have developed already. Open access also promotes greater transparency in the scientific process, making it easier to replicate findings, and to reconcile discrepancies in published works. Neuroscience data sharing has been limited by several factors, including file size, highly customized formatting, source variability, complex metadata, and unreliable data quality. Additionally, the scientific community is facing ever increasing scrutiny over the lack of reproducibility in science. This topic seeks to advance neuroscientific data sharing by developing standardized software tools that can address these issues and garner wide adoption in order to facilitate collaboration, discovery, and repeatability in the field.

Solutions to three particular challenges are of interest in this topic. The first is to develop automated methods for combining and annotating data sets to permit large-scale analyses by third parties. This is particularly challenging given the wide variety of experimental methods, data collection equipment, and data quality, identifying appropriate datasets for co-analysis, as well as methods for combining datasets. Second, the software system must support a flexible set of analysis procedures that can be annotated and archived along with the source data, such that the entire workflow from data generation through analysis can be documented and tracked. Collectively, these capabilities would allow for greater transparency in the reporting of scientific results and facilitate access by third party investigators. Thirdly, a robust data rights system must be implemented. Each data set is generated by investigators with unique requirements, and they may have highly-specific restrictions on the use of the data they share with third parties. The data rights system must be flexible enough to allow for publication embargo, restrictions on download of raw data, and Health Insurance Portability and Accountability Act (HIPAA) requirements.

Successful proposals will identify and address the needs of data contributors, data users, instrument manufacturers, and the scientific community at large. The proposal should contain tangible approaches to facilitate adoption by a wide swathe of neuroscientists, neuroengineers, neurologists, and instrumentation manufacturers. Uploading data should be as user-friendly as possible, for instance by auto-parsing metadata automatically from common file types. Shareable formats utilized by the software should adhere to scientific community standards whenever possible or define new standards where none exist. Straightforward analysis, data quality metrics, modeling functions, and tools for documenting data handling should be part of a successful solution. It is intended that the software system will be cloud-based, ensuring that the data is widely available to the scientific community.

PHASE I: Develop the software foundation for a suite of tools to store and analyze metadata, securely store the raw data, selectively grant access to the data, and provide application programming interfaces to interact with common tools for data analysis, including Matlab and R. This extensible framework may initially be limited to a handful of highly-relevant data types (e.g., fMRI, electrophysiology, cellular imaging, biomarker measurements, optical micrographs, etc.) but must have a clearly documented and open interface to add support for new data types and file formats. The specific neuroscience data type(s) and analysis methods must be defined in the proposal. The initial feature set need not be comprehensive, but the software framework should be extensible to allow for additional data types and methods to be added later. A key deliverable of Phase I is generation of a commercialization report describing a clear and viable business model to sustain development and maintenance of the software system. This report must contain clear and tangible approaches to foster wide adoption of the software system among the various communities and should include relevant letters of support from any external parties required for this plan. This report must contain quantified metrics for success regarding adoption during and beyond Phase II.

PHASE II: Extend the Phase I system to enable data import of a wider range of formats and online analysis functions. Proposers should demonstrate this capability by incorporating multiple large datasets available from the literature and/or from collaborators, selectively granting access to collaborators, and performing an initial meta-analysis of the resulting data sets. The Phase II system should also provide mechanisms for communication between the data contributor and parties interested in utilizing it in their research. These communications should include permission requests, conditions of use (such as embargo duration, requirements for authorship or acknowledgement, or ability to download raw data for offline analysis), dialog regarding the metadata, and feedback on the results. In addition, the software must comply with all relevant HIPAA requirements for human subjects research and provide mechanisms to protect personally identifiable information (PII) and verify institutional review board (IRB) approval should the data rights allow for transfer of PII. Finally, as this is a primarily online system, it must track adoption and usage levels by end-users and include means to measure metrics for the impact of each stored element of data.

The final Phase II system must include open application programming interfaces to allow for customization by the end user. Final deliverables for Phase II include a report documenting the adoption of the system and responsiveness to user needs. Furthermore, the Phase II pilot user-group must be surveyed to objectively determine the requirements for Phase III upgrades and modifications.

Direct to Phase II: Existing software solutions that achieve the objectives stated within Phase I are applicable for Direct to Phase II submission. The proposal should clearly describe how the objectives of Phase I have been attained.

PHASE III DUAL USE APPLICATIONS: Neuroscience research has the potential to improve the performance of servicemen and women and increase effectiveness in their duties. The commercial software resulting from this SBIR will be made available as a tool to advance fundamental and applied neuroscience research for both the private and military sectors. The tool will serve as the foundation to incorporate meta-data and a subset of raw data into electronic health records.

Demonstrate the efficacy of the proposed software system by collecting and storing a significant quantity of relevant data, and subsequently performing innovative meta-analysis research to generate unique and quantitative insight into the correlation between previously isolated sub-disciplines. This work should yield a number of peer-reviewed publications and inspire new therapeutic approaches for neurological conditions. In addition, during Phase III, the software system should have demonstrable wide adoption in the research and medical communities. Additionally, the software developed in this program will provide a platform for collaboratively sharing data in the development of clinical treatments for PTSD, anxiety, TBI, and other neurological ailments faced by active military. It will also enable sharing of critical meta-data and raw data between Tricare and the VA.

REFERENCES:
1. Gewin V., Data sharing: An open mind on open data, Nature 529, 117–119.

KEYWORDS: data, data sharing, data mining, data analytics, biology, neuroscience, electrophysiology, neuroscience data, big data, analytics, cellular imaging, central nervous system, peripheral nervous system

SB163-002 TITLE: Genetic/Genomic Approaches to Improve Insect Production for Human Use

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Materials/Processes

OBJECTIVE: Develop genetic or genomic approaches to reduce the negative characteristics associated with insect colony maintenance or recovery of insect-derived products and demonstrate genetic modification of insects to improve the nutritional quality of final food, feed, or pharma products.

DESCRIPTION: There is a DoD need to explore the utility of insect-derived products as a buffer against potential future instability resulting from disruptions to traditional food and resource supply chains. The use of insects for sustainable production of food, feed, and pharma products could also potentially be applied in far-forward deployed operating situations, and might ultimately even be an enabler for space exploration. Insects are already a reliable source of food, feed, and pharma products for human use, but at times can be difficult to exploit due to either pathogen outbreaks in colonies during rearing or contamination of organic and inorganic materials during processing. At the same time, genetic and genomic approaches to alter expression systems in insects are becoming available and can be used to improve the value of insect-derived products. Immense opportunities now exist to drastically improve the utility of insect production systems regardless of the intended insect-derived end product.

Food security is quickly becoming a global security issue due to increasing human populations and consumption demands. Several factors could lead to a possible catastrophic decline in food availability in the near future, including climate change, energy shortages, and decreased agricultural production due to reduced soil fertility and water availability, and greater numbers and distribution patterns of pests and plant pathogens. Identification of reliable alternatives for traditional foods—and in particular alternative sources of protein—could help meet future nutritional demands, improve food security and bolster geopolitical stability. New technologies to support these alternatives must lend themselves to large-scale implementation if they are to be feasible, cost-effective, and ecofriendly.

Insects offer one potential solution to current and future food shortages and nutrient deficiencies. Although 80% of the world's population regularly consumes insects for food, this is a relatively new concept for the Western world. Production of traditional protein sources such as beef, pork, chicken, and fish is expensive, resource intensive, and not sustainably scalable to a growing population. Insect sourcing for food products that can be consumed directly by humans is an alternative to traditional meat production; insect-derived feeds could also be used for aquaculture or livestock production to reduce the ecological footprint of these food sources. Insects are highly nutritious relative to traditional protein-rich foods. For instance, milled cricket flour (a popular food additive) contains 31g of protein and 8g of fat per 200 calories compared to 22g of protein and 15g of fat for the same 200 calories in beef.

Insects have also been used to produce non-food products for human use. The use of insects for production of silk and dyes is well known, but other uses of insect-derived products have been identified more recently. For example, certain insects produce powerful antimicrobial peptides (AMPs) such as drosocin, apidaecin 1b, and pyrrhocoricin, which can be recovered and purified for human use. Additionally, insect germlines could be modified to produce high levels of desired compounds such as retinol or ascorbic acid for delivery to populations with diets deficient in these nutrients. The recent discovery that chitin-based products can be used to improve whole-blood clotting time and plasma recalcification time has led to the development of insect-derived products like chitin, chitosan, partially N-acetylated chitosan, N,O-carboxymethylchitosan, N-sulfated chitosan, and N-(2-hydroxy)propyl-3-trimethylammonium chitosan chloride as potentially more cost-effective alternatives to existing commercial blood products.

Gene technologies could be used to improve production of edible insect products or to alleviate losses due to biotic or abiotic threats. Molecular approaches to these issues will be an integral part of increasing general output in these systems in the future and could be used to improve quality of product and ease of processing, and minimize loss of recovered product.

This SBIR topic seeks approaches to identify and address issues associated with large-scale insect rearing and/or the improvement of production outcomes. We encourage applications that use emerging genetic/genomic tools to these ends. Expected outcomes could be the management of viral or bacterial pathogens through up- or down-regulation of genes that exist in the host or pathogen, improvement of colony insect populations to adapt to altered environments, or the manipulation of pathways that provide products for human use.

PHASE I: Identify molecular targets for improving production and performance of insects that will ultimately be produced in large-scale operations. Individual projects could address at least one of several challenges expected, which include: (1) refining pathogen management, (2) improving quality and quantity of desirable insect organic materials that exist, (3) reducing or eliminating the production of undesirable products, (4) addition of genes to produce desirable products that did not previously exist in the insect.

Integrate genetic modifications into systems (transgenic or paratransgenic systems are acceptable) to increase the nutrient output of insects being produced for food sourcing. The addition of pathways associated with vitamin A, C, D, and K are especially desirable.

Identify a diverse group of insect species that process animal/human, food, and plant waste for energy and biomass recovery. This would not have to result directly into human food sourcing (i.e., primary production of food production); rather, the potential for improving food stock production for fish and livestock production would be appropriate, with humans as secondary consumers.

The key deliverable for Phase I will be the demonstration of proof of concept that the selected challenge has been overcome and can be scaled to a larger format. These demonstrations can be performed in repeated experiments in small colonies on multiple insect species where alteration of insect-derived end products can be shown through chemical analysis.

PHASE II: The small-scale, small-colony approach taken in Phase I will be transferred to and implemented in a large-scale insect products-sourcing platform. The goal of Phase II is the integration of technologies used to produce insects for food, feed, or pharma. Therefore, the deliverable for Phase II is the demonstration of a large-scale insect production system utilizing integrated gene technologies. Communication with the proper regulatory agencies will be a key component to determine how these technologies can be safely and ethically monitored for proper use.

Direct to Phase II: Potential proposers with existing technologies that are ready to be implemented in a large-scale format are encouraged to apply for direct to Phase II. The proposal should clearly describe how the objectives of Phase I have already been attained.

PHASE III DUAL USE APPLICATIONS: Phase III (Commercial): The genetic/genomic technologies developed in Phases I and II will be integrated into a fundamental platform to improve the production of insect-derived products. These integrated technologies will serve as the foundation for further improvement. Phase III will be a demonstration of a fully adopted system that utilizes two or more gene technologies to improve production. These improvements must also be ecologically sustainable. In addition to the development of a plan for regulatory oversight, Phase III projects should address the challenge of encouraging human acceptance of insects and insect-derived products as food.

Phase III (Military): The integration of insect-derived food products into the Combat Feeding Directorate is a potential option for technology transition. The objective of Phase III (Military) will be to determine feasibility, utility, and acceptance levels of these products and production systems by military personnel, especially in deployment scenarios.

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1. Bukkens, S. G. F., & Paoletti, M. G. (2005). Insects in the human diet: nutritional aspects. Ecological implications of minilivestock: Potential of insects, rodents, frogs and snails, 545-577.

2. Durst, P. B., Johnson, D. V., Leslie, R. N., & Shono, K. (2010). Forest insects as food: humans bite back. RAP publication.

3. Gahukar, R. T. (2011). Entomophagy and human food security. International Journal of Tropical Insect Science, 31(03), 129-144.

4. Janvikul, W., Uppanan, P., Thavornyutikarn, B., Krewraing, J., & Prateepasen, R. (2006). In vitro comparative hemostatic studies of chitin, chitosan, and their derivatives. Journal of applied polymer science, 102(1), 445-451.

5. Katayama, N., Yamashita, M., Wada, H., & Mitsuhashi, J. (2005). Entomophagy as part of a space diet for habitation on Mars. The Journal of Space Technology and Science, 21(2), 2_27-2_38.

6. Raubenheimer, D., & Rothman, J. M. (2013). Nutritional ecology of entomophagy in humans and other primates. Annual Review of Entomology, 58, 141-160.

7. DARPA Industry Day Presentation, September 7, 2016

KEYWORDS: Insect-derived products, genetic engineering, RNAi, gene regulation

SB163-003 TITLE: Next Generation Genome Editing Tools

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Biomedical, Chemical/Biological Defense

OBJECTIVE: Enhance the utility of genome editing tools by developing nuclease-based effectors that have reduced off- target effects and increased efficiency of delivery across a range of eukaryotic hosts.

DESCRIPTION: There is a critical DoD need to develop next-generation genome editing tools that will provide a multifunctional platform capability to address emerging and engineered biothreats to animals, people, and agriculture, create new sensors to detect chem/biothreats, and rapidly develop new agricultural and preclinical animal models for countermeasure development and validation.

The emergence of precision genome editing tools, including clustered regularly interspaced short palindromic repeats (CRISPR), transcription activator-like effector nucleases (TALENs), and zinc finger nucleases, has provided an unprecedented ability to modify genomes in a manner that is rapid, adaptable, and has the potential to be highly multiplexed. Among these, CRISPR-based tools have emerged as the gene editors of choice for many applications, given their modular architecture, low cost, ease of design and synthesis, and adaptability for a broad range of applications (for review, see 1, 2).

These tools have the potential to enable and accelerate new capabilities and applications in public health, agriculture, biotechnology, and fundamental biological research discovery. While genome editing tools have already been widely adopted by research and development communities, major technical hurdles exist that must be addressed before the full potential of these tools can be realized for advanced applications that move beyond a research setting. These technical challenges include unwanted off-target effects at genome sites outside of the target locus/loci, low efficiency of activity at target sites due to delivery and/or expression challenges, and an overall lack of understanding of organism-level responses to these tools to include host immunogenic responses.

Off-target activity at sites outside of intended genome target(s) can result in unwanted and potentially deleterious effects in cells and organisms that can outnumber on-target modifications. Progress has been made to improve the fidelity of gene editors, including the development of "nickases" that minimize off-targets effects, however, reductions in off-target activity often results in decreased on-target activity, reducing the overall efficiency of the system (3). More recent demonstrations indicating that Cas9 nucleases can be engineered for significantly increased specificity are encouraging (4,5), however, proof of concept is still lacking that these approaches can be applied to a broad range of host cell types/species and to nuclease variants derived from various sources. In addition, the desire to use genome editing tools in a multi-target, multiplex capacity for a range of applications significantly increases the chances for spurious off-target activity. Finally, the efficient delivery and timely activation of the molecular tools required to edit genomes in vivo in target cells and organisms presents an additional challenge that must be addressed. Optimal delivery of viral and non-viral solutions for gene encoded gene editors will require efficient transfer to target cells/tissues, packaging that is amenable to single construct/simple formulation, and temporal control of activity and expression of gene editors to achieve measureable impact at target sites with minimal off target activity.

This topic is focused on improving the utility of genome editing tools by developing the next generation of nuclease-based effectors that overcome these key technical hurdles associated with current generation genome editing tools. Anticipated outcomes include development of nuclease based gene editors with no detectable off-target activity in a range of host cells in multiplex mode, improved in vivo target efficiency, and improved packaging of genome editor components into a single genetic construct for host cell delivery. Successful technologies will combine high fidelity and efficiency into viral vectors, mRNA, or other suitable methods for transfer of gene- encoded constructs in vivo.

PHASE I: Establish the technical feasibility of new approaches to address off-target activity and delivery challenges for the development of next generation gene editors. Proposers must address at least one of the following technical challenges:

The first challenge seeks to develop gene editing methodologies that enable modification of a target genome at multiple unique loci simultaneously in the absence of off-target activity (e.g., single constant nuclease enzyme with 10 variable guide RNAs) without compromising fidelity or efficiency. Modification of the genome may involve sequence-modifying and/or non-sequence modifying approaches (e.g., epigenetic gene silencing approaches, etc.). Methods for improved in vitro, in vivo, or in silico detection of off-target activity of the gene editors are also anticipated.

The second challenge seeks to develop a capability to deliver gene editors in a single genetic construct and/or simple formulation that is broadly applicable to multiple cells lines relevant for pre-clinical and clinical study and/or agricultural investigation (to include plant, mammalian, and insect cells). Temporal control of gene editors should be built into the system to prevent long-term expression/activation of gene editors in vivo, which may result in an increased likelihood for off-target effects. For example, delivery of engineered nucleases as mRNA or purified protein may reduce the frequency of off-target effects by lowering the protein amount and time of expression, but this may also be achieved through transcriptional controls or other methods as proposed by investigators. A delivery strategy should be sufficiently modular to accommodate a gene editor and a minimum of 10 guide sequences simultaneously without compromising fidelity or efficiency.

For the challenge areas described above, methods to quantitatively measure on-target and off-target activity should be clearly described with a focus on strategies that allow fast, sensitive and cost-effective detection of on- and off-target activities. Performance goals for efficiency of delivery and on-target activity must be established by the proposers with appropriate technical rationale, comparison with the state of the art, and risk mitigation strategies. For a given approach, the number of unique loci that will be targeted must be clearly indicated, accompanied by the appropriate rationale to support why this number is sufficient to achieve desired effect for a given application. For the selected challenge, develop an initial concept design and describe an approach for transitioning this technology from a laboratory benchtop to an established commercial protocol.

Phase I deliverables will include: 1) a technical report detailing the experiments and results supporting the successful demonstration of a next-generation genome editing tool(s) that results in no detectable off-target activity and/or can be delivered using a single-genetic construct with high efficiency to meet the selected technical challenge; and 2) a Phase II transition plan for demonstrating sufficient reproducibility of gene editor performance, advanced development to demonstrate a multiplex capability, and potential research advancement to merit commercialization. The Phase II transition plan will include a description of the commercialization path, any barriers to market entry, and any identified early adoption partners.

PHASE II: Finalize and validate the genome editing tools and experimental approaches from Phase I and initiate the development and production of the technology to address the selected technical challenge. Progress from in vitro (i.e., cell-culture) demonstration to whole-organism in vivo proof-of-concept demonstration for the selected challenge.

Establish appropriate performance parameters through experimentation to determine the efficaciousness, robustness, and fidelity of the approach being pursued. Develop, demonstrate, and validate the reagents and protocols necessary to meet the key metrics as defined for the selected technical challenge. Phase II deliverables include a prototype set of reagents, a detailed technical protocol sufficient to allow replication of results in an outside laboratory, and valid test data, appropriate for a commercial production path.

PHASE III DUAL USE APPLICATIONS: Next-generation genome editing tools will provide a multifunctional platform capability for the DoD to address emerging and engineered biothreats to animals, people, and agriculture, create new sensors to detect chem/biothreats, and rapidly develop new agricultural and preclinical animal models for countermeasure development and validation. The successful development of these next-generation genome editing capabilities has a significant potential for translation into commercial biotech and pharmaceutical applications where new platforms to create new pipeline molecules, facilitate bioproduction, and create validation assays with great speed and at low cost are required. Next-generation genome editors will advance investigation in agriculture to increase crop yields and protect against climate and pest threats. Ultimately, the ability to edit genomic targets within a host cell in the absence of off-target effects will be transformative for the development of clinical applications and the application of these tolls in open systems and environments for a broad range of applications.

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5. Slaymaker, IM et al., Rationally Engineered Cas9 Nucleases with Improved Specificity. Science. 2016; 351: 84-88.

6. DARPA Industry Day Presentation, September 6, 2016

KEYWORDS: gene editing, genome engineering, CRISPR, multiplex, nuclease

SB163-004 TITLE: Real-Time Metrology and Feedback Control for Additive Manufacturing

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Materials/Processes

OBJECTIVE: Develop a real-time system for active feedback control and process characterization of multi-material additive manufacturing.

DESCRIPTION: Current 3-D printing systems can be used for a variety of applications and on-going research is allowing for more complex products with different material properties and uses. With this expansion from single-material to multi-material printing provided by several on-going DARPA programs, there is a need within industry and the DoD for a real-time metrology system and inspection platform. This could significantly increase the quality of printed parts and reduce the risk of critical print defects.

Most current methods rely on scanning the printed product upon completion of printing rather than scanning in real-time. Systems monitoring printing processes while printing currently exist but are often limited to one material.

Increasing the number of materials poses several unique metrology requirements. The materials have different optical properties which can make it difficult to scan large areas rapidly while maintaining high resolution. While scanning, the data generated from the platform should also be used in characterization of the process and feedback control of the system. The feedback control should serve to ensure fidelity in the print geometry, guarantee adequate interfaces between adjacent materials, and be able to adapt to different classes of materials for additive manufacturing.

The software package associated with the hardware should enable scan data to be processed efficiently in or near real-time. The feedback method should be robust to the printing process used and be applicable to different printer systems.

A successful platform will address these requirements in an integrated hardware and software package that can be efficiently embedded into a new or currently existing additive manufacturing system.

PHASE I: Design an in-situ metrology system for geometry monitoring and closed feedback of additive manufacturing processes for multi-material printing. Determine key requirements and establish performance metrics for evaluation. Define an embedded, data-parallel software processing pipeline and architecture that satisfies the process requirements. Investigate and define candidate feedback control strategies. Implement a basic prototype system that demonstrates operating principles and fundamental performance capabilities.

Required Phase I deliverables will include a final report detailing the design of the system, requirements, software pipeline, and results of the investigation of the candidate feedback control strategies.

PHASE II: Finalize the design of Phase I and complete fabrication of the geometry scanning system. Evaluate the performance of the stand-alone system and compare it to process requirements. Integrate the metrology scanning system with a specific additive manufacturing system. Implement the software processing pipeline established in Phase I and demonstrate operating performance. Implement and validate adaptive feedback strategies. Demonstrate and compare the performance of candidate adaptive feedback strategies and establish key tradeoffs and use cases for each strategy. Validate adaptive feedback strategies with multi-material printed part examples. Evaluate quality and robustness of interfaces between different materials. Evaluate improvements in geometric accuracy including surface finish properties. Design and evaluate data-logging system for gathering information/statistics of a print. Design and evaluate basic analytics tools.

Required Phase II deliverables will include a final report and a demonstration of system.

PHASE III DUAL USE APPLICATIONS: The end goal of this effort is to provide real-time metrology for 3-D printing systems already in place within the industry or DoD or systems developed by the small business. The DoD will directly benefit from the real- time scanning of printed materials made possible by the development of a platform capable of handling multi- material printing. Develop a rich set of new materials that are enabled by the closed-loop control process to establish material interfaces that are enabled. Improve the system’s throughput and robustness to meet the needs of DoD or commercial end-user.

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3. DARPA Industry Day Presentation, September 8, 2016

KEYWORDS: additive manufacturing, process characterization, automated inspection, rapid prototyping, metrology, quality assurance

SB163-005 TITLE: TRUsted Structures Technology (TRUST)

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Information Systems, Materials/Processes

OBJECTIVE: Develop and test one or more techniques to detect whether an additively manufactured part has been tampered with, or deviates from its specification thereby jeopardizing its integrity, ideally without requiring extensive destructive or non-destructive inspection. The secondary objective is to prevent stealing of a part description.

DESCRIPTION: There is a critical DoD need to develop techniques that will mitigate vulnerabilities in the additive manufacturing chain. Additive manufacturing encompasses several methods to build parts by depositing and fusing small amounts of material at a time. Additive manufacturing has the potential to democratize manufacturing because of its low cost of entry and ease of sharing files that contain full part descriptions. However, these features also makes it uniquely susceptible to malicious tampering.

Several additive manufacturing technologies are rapidly improving to a point where soon it will be feasible to make mission critical parts. A mission critical part is one where failure of the part may lead to material losses, injury or loss of life. It is therefore important when a validated part description is manufactured that the results can be trusted and appropriate assurances made that all the process validation requirements are met. This becomes of paramount importance and particularly challenging when manufacturing is outsourced.

The current manufacturing workflow consists of multiple actors:

1. The authoring tool which created the specification of the object to be made
2. The transmission medium to communicate the specification to the machine tool controller
3. The machine tool post processor which converts the part specification into actions to build the part
4. The machine tool controller and hardware (lasers, stepper motors, etc.)
5. The material

Currently, there is little assurance that part specifications will be adequately protected from intentional or unintentional changes after they leave the authoring tool, nor are there any assurances that the required manufacturing processes or materials were used. Resulting deviations in manufactured artifacts can be difficult, if not impossible, to detect without extensive inspection or destructive testing. Some of these vulnerabilities are described in the National Institute of Standards and Technology report NIST.IR.8041, available here: http://nvlpubs.nist.gov/nistpubs/ir/2015/NIST.IR.8041.pdf.

The intent of this topic is to identify all vulnerabilities in the additive manufacturing workflow, then propose and prototype solutions to one or more of the following (but not limited to):

- Tamper proof description and transmission of specification
- Embedded validation of the machine tool specification
- Enable easy detection of tampering in the final artifact, embedding provenance
- Embedding material signatures

Proposers are encouraged to leverage solutions from other domains such as: encryption, digital watermarking, digital rights management and techniques inspired from detecting computer viruses.

It is expected that the outcome of this investigation will disrupt multiple aspects of the current additive manufacturing workflow, including but not limited to: part description, process description, embedded validation, changes to machine tool controller software and hardware.

PHASE I: Identify all the weaknesses in the entire additive manufacturing chain, and estimate the level of effort required to mitigate the vulnerabilities. The Phase I final report will include a Phase II work plan to address the most critical vulnerabilities identified.

PHASE II: Test and prototype strategies to counteract vulnerabilities identified in Phase I. Organize one or more hack-a-thons to test approaches. The Phase II final report will contain the results and description of the best in class approaches to counteract vulnerabilities.

PHASE III DUAL USE APPLICATIONS: Additive manufacturing is eminently poised to replace large portions of the DoD supply chain, unfortunately along with the many advantages afforded by this come significant and new vulnerabilities. Technologies developed and tested under this effort will be available for transition to the service labs, depots, and suppliers providing increased National security. Commercial applications include software and hardware products that enable secure production and provenance validation of a 3D printed product.

REFERENCES:
1. Paulsen, Celia. "Direct Digital Manufacturing (DDM) Symposium." (2015).

2. Chhetri, Sujit Rokka, Arquimedes Canedo, and Mohammad Abdullah Al Faruque. "Poster: Exploiting Acoustic Side-Channel for Attack on Additive Manufacturing Systems." (2016).

3. Sturm, L., Williams, C. B., Camelio, J. A., White, J., & Parker, R. "Cyber-physical vunerabilities in additive manufacturing systems." Context 7 (2014): 8.

4. Department of Defense Small Business Innovation Research (SBIR), "Security in Cyber-Physical Networked Systems" Retrieved April 19, 2016, from https://www.sbir.gov/sbirsearch/detail/697260

5. DARPA Industry Day Presentation, September 6, 2016

KEYWORDS: Additive Manufacturing; 3D Printing; Direct Digital Manufacturing; Cyber Physical Systems; Cybersecurity; Industrial Control Systems; Information Security

SB163-007 TITLE: Explainable Machine Learning for Resource Allocation

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.
TECHNOLOGY AREA(S): Human Systems, Information Systems

OBJECTIVE: Develop machine learning techniques capable of both learning to match resources to needs and explaining the rationale for those matches to human decision makers.

DESCRIPTION: There is a critical DoD need for new machine learning and human-computer interaction techniques to produce more explainable resource allocation and recommendation systems. Dramatic success in machine learning has led to an explosion of AI applications, including recommendation systems that can learn subtle matches between resources and needs. However current machine learning models are opaque and inherently difficult for end-users to understand.

Attempts to explain current machine learning models have been limited to methods that try to portray a set of complex and often highly-dimensional features used in the system's computation. Such explanations are often too detailed, at the wrong level of abstraction, and make little sense to common users trying to understand why a system acted the way it did. It is vital to develop more explainable techniques. Current sophisticated machine learning techniques are capable of finding useful matches, such as those between veteran skill sets and commercial jobs, but these techniques need to be enhanced to explain non-obvious matches to both parties.

For example, it would be possible to apply current machine learning techniques to learn meaningful but non-obvious matches between veterans' skills and commercial job requirements that would result in successful employment. Yet current techniques would not be able to explain the rationale for these non-obvious matches to prospective employers or veterans. Current sophisticated machine learning techniques are capable of finding useful job matches such as these, but these techniques need to be enhanced to explain these non-obvious matches to both parties.

There are numerous services that assist veterans in the transition to civilian life and in the search for jobs; yet adapting military skill sets for civilian posts as well as the veteran employment referral process are lagging. Automation can automatically learn and update these matches to ensure veterans remain competitive candidates in this rapidly changing job market. Furthermore, new job and skill categories often arise in the civilian job market, where there is no direct military parallel for these posts. For example, "data science", for which no direct translation may exist, but which may be already part of the service in many military units. By leveraging existing mappings of military codes to occupations and data publicly available from online source (e.g. job boards), it may be possible to learn a better and more fine-grained mapping that is explainable to veterans and employers. In contrast to current practice, the resulting mapping as well as the explanations could be constructed automatically and dynamically from data.

This topic seeks the development and application of new machine learning and human-computer interaction techniques to produce more explainable resource allocation and recommendation systems. This can include developing techniques to learn richer models and more fine-grained mappings that are more interpretable. Additionally, the development of explanation principles, feature summarization schemes, interface metaphors, visualization and explanation generation techniques can be utilized to present a comprehensible explanation to the user.

Proposers should describe their approach for designing and developing new machine learning and human-computer interaction techniques to produce more explainable resource allocation and recommendation systems. They should also select a resource allocation problem domain, such as matching veterans' skills to commercial job requirements, and propose the development of a system to address that problem.

PHASE I: Develop a plan for creating machine learning tools and techniques that can both learn subtle resource allocation recommendations and generate appropriate explanations for different contexts. Required Phase I deliverable includes a final report that details the proposed techniques, a short analysis of the online data sources and a description of how the online data will be used, and a determination of the feasibility of the generation of mappings and explanations.

PHASE II: Demonstrate that the techniques from Phase I can be practically and effectively applied to a domain, such as veteran transition and job search, including the generation of appropriate explanations. Required Phase II deliverables include all documentation and software for the techniques and a proof-of-concept demonstration of the techniques on website that beta users can access.

PHASE III DUAL USE APPLICATIONS: The successful development of this technology will provide a solution for a variety of resource allocation problems, such as helping veterans to transition easier in the civilian job market and for employers to recruit great talent among veterans much faster and easier. The automatic generation of explanations for matches is key and could be integrated into existing veteran websites. This tool could be used for a variety of military resource allocation problems such as supply management or personnel assignments. This tool could also be used for a variety of commercial resource allocation problems such as product recommendations or employment search.

REFERENCES:

1. http://www.benefits.va.gov/vocrehab/

2. http://www.military.com/veteran-jobs/skills-translator/

3. https://www.military1.com/army-enlistment/318806-army-mos-codes

4. http://www.bls.gov/soc/home.htm

5. DARPA Industry Day Presentation, September 6, 2016

6. Additional Q&A from TPOC, uploaded in SITIS on September 19, 2016.

KEYWORDS: resource allocation, recommendation systems, skill set matching, generate explanations, online data analytics, machine learning

SB163-008 TITLE: Assessing Deterrence in the Gray Zone

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop and demonstrate technologies to enable measuring and explaining the success of deterrent strategies and tactics in “Gray Zone” conflicts.

DESCRIPTION: Deterrence is a strategy intended to dissuade an adversary from undesirable action. Our nation is entering a period where adversary action and our response to those actions will frequently take place in a segment of the conflict continuum that some are calling the “Gray Zone,” characterized by intense political, economic, informational, and military competition more fervent in nature than normal steady-state diplomacy, yet short of conventional war. A core impediment to studying deterrence in this realm lies in the fact that success is defined by the absence of an adversarial action. Success is difficult to demonstrate because absence of actions could result from alternative variables not always attributable to the deterrent strategy itself. To confound observation further, the presence and absence of conflict is no longer black and white. There exists a continuum of action between war and peace comprised of (but not limited to) propaganda distribution, unconventional warfare, cyber harassment, covert operatives, diplomatic aggression, economic warfare, terrorism, and proxy forces. Adversarial actors often tune strategies to weaken their opponent, or cause them to spend political or economic capital, without triggering a repercussion threshold, further complicating assessment of a deterrent counter strategy.

This topic seeks new technologies that can measure and explain the effectiveness of deterrent strategies in the Gray Zone leveraging open source data. To assess the success of a deterrent, it is necessary to establish evidence that the deterrent effect was achieved, and that the deterrent action taken was a primary cause of the achieved effect. The first requires identifying evidence of a change in intentions on the part of the adversary, and the second requires identifying and assessing alternative explanations for that change in intent. Both require advances over the state of the art in ability to model threat intentions and to explain observations based on data, and require a systematic perspective that examines the complex set of conditions, actors, tactics, strategies, and outcomes across conflict holistically.

PHASE I: Create a notional framework that captures and incorporates the significant factors associated with deterrence in the “Gray Zone.” The goal is to provide a notional framework with a practical number of significant entities, conflict/competition types, and deterrent strategies to allow a commander or analyst to understand the system and what affects change and how. Basic capability must be demonstrated to build a portion of the proposed framework in software demonstrating the ability to measure effects of selected deterrent strategies in a relevant scenario. Define metrics and thresholds for successful assessment and demonstrate ability to measure those metrics. Phase I deliverables will include a demonstration to the government; a report documenting research results, the design for the deterrence framework, and results of testing against the identified scenario; and source code developed under the Phase I effort.

PHASE II: Leveraging the framework derived in Phase I, complete the system design and build a prototype that further enhances and develops the capabilities in Phase I to a level of capability that can be assessed for operational utility. The prototype should demonstrate successful performance against the metrics defined in Phase I using scenarios and data sets identified in conjunction with an operational partner such as a combatant command. Conduct testing in conjunction with the partner to assess utility of the prototype capability. Phase II deliverables will include demonstrations to the government in each year of the Phase II program; and an interim report each year but the final year documenting research results, the design of the demonstration prototype, and results of testing against relevant scenarios; a final report at the end of Phase II documenting research results, the design of the demonstration prototype, results of testing against relevant scenarios, and a plan for Phase III transition; and source code for each demonstration prototype.

PHASE III DUAL USE APPLICATIONS: The envisioned end state of the research is a capability that can provide a robust capability for operational (combatant command) users to assess and understand the effectiveness of deterrent strategies against adversaries in “Gray Zone” conflict situations. This capability should be able to be deployed to a combatant command in conjunction with, or integrated as part of, a suite of command and control applications in use by an operational command. Specifically, this research should result in a commercializable technology for assessing and explaining adversary intentions and actions from open source data. This technology should find dual-use applicability to strategic business decision-making applications in highly competitive industries such as information technology.

REFERENCES:
1. Huth, P. K. (1999), "Deterrence and International Conflict: Empirical Findings and Theoretical Debate", Annual Review of Political Science 2, pp. 25–48

2. Jentleson, B.A.; Whytock, C.A. (2005), "Who Won Libya", International Security, 30, Number 3, Winter 2005/06, pp. 47–86

3. Paul, Christopher (2016), “Confessions of a Hybrid Warfare Skeptic.” Small Wars Journal (March): http://smallwarsjournal.com/jrnl/art/confessions-of-a-hybrid-warfare-skeptic

4. Schelling, T. C. (1966), "2", The Diplomacy of Violence, New Haven: Yale University Press, pp. 1–34

5. United States Special Operations Command. "The Gray Zone." U.S. Army Special Operations Center of Excellence. 2015-03-24: http://www.soc.mil/swcs/ProjectGray/Gray%20Zones%20-%20USSOCOM%20White%20Paper%209%20Sep%202015.pdf

6. DARPA Industry Day Presentation, September 7, 2016

KEYWORDS: Gray Zone, Conflict, Deterrent, Explanation, Open Source, Threat Intent, Modeling

SB163-009 TITLE: Low Voltage Power Sources for Long-Life Electronics

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Electronics, Materials/Processes

OBJECTIVE: Produce primary cell batteries or alternative power sources whose voltages can be fine-tuned by adjusting the voltaic chemistry and / or structure of the cells and that can directly output stable voltages in the 0.3 to 0.7 V range without the use of power hungry electronic voltage regulators.

DESCRIPTION: There is a critical DoD need to develop power sources that will increase the mission lifetime for unattended sensors and sensor radio networks. Commercially available small batteries and power sources are limited to output voltages greater than 1.2V and require external components such as regulators to produce stable supply voltages less than 1V. Recent advances in deep subthreshold analog and digital electronics are creating classes of intelligent electronics capable of achieving power consumption levels as low as 10 nW (1). These subthreshold circuits require power supply voltages typically in the range of 0.3 to 0.7 V. While subthreshold circuits can now achieve extremely low power, the regulators needed to produce the 0.3 to 0.7 V level supply voltages from typical battery voltages in excess of 1.2V can easily dominate the total power consumption. In order to take advantage of these recent advances in extremely low power subthreshold circuits to greatly extend the lifetime of electronic systems, new battery or small scale power source technologies are needed that are capable of directly producing stable and tailorable voltage levels in the 0.3 – 0.7 V range.

This topic seeks primary batteries or other power sources that can directly produce stable output voltages between 0.3 and 0.7 V over the lifetime, operating temperature range and specified output current range of the power source. Solutions where the battery or power source voltage can be tailored in the range of 0.3 to 0.7 V, for example by stacking lower voltage cells, are highly desired. In addition to the desired voltage properties, the power source must also have a coin cell like form factor, a self-discharge rate of less than 1% per year at room temperature, be stable over an output current range from 0 to 1 µA and have a capacity greater than 80 mAH. Proposer defined metrics that should be justified in the context of the deep subthreshold electronics use case include temperature dependence, internal resistance and discharge curves. All proposed battery or power source chemistries must not contain toxic materials considered detrimental to the environment, and preferably make use of renewable materials.

PHASE I: Design, analyze and develop a plan for constructing a prototype battery or power source with a predicted performance of:

(1) Output voltage(s) [V] = 0.3 – 0.7 V
(2) Maximum voltage variation over temperature and current [%] = 5
(3) Minimum output current range [nA] = 0 – 1000
(4) Maximum self-discharge rate at room temperature [%] = 1
(5) Maximum size [mm^3] = 500
(6) Minimum capacity [mAH] = 80
(7) Minimum temperature range [?C] = -10 to 50
(8) Self-discharge rate over temperature [%] = proposer defined
(9) Internal resistance [O] = proposer defined
(10) Discharge curves [V vs. mAh] = proposer defined
(11) Battery or power source chemistry = proposer defined

Required Phase I deliverables will include:
(1) A report detailing the battery or power source chemistry, design and expected performance.

PHASE II: Phase II: Use Phase I analysis to produce and measure at least two prototype batteries or power sources demonstrating the Phase I government and performer defined specifications:

Required Phase II deliverables include:
(1) Report containing design, simulation, manufacturing files and test results from 2 packaged batteries or power sources.
(2) Delivery of 2 packaged batteries or power sources to the government.
(3) A datasheet containing all the information needed for the government to characterize the power source or use the power source in an application.

PHASE III DUAL USE APPLICATIONS: The power sources developed could address the DoD need to increase the mission lifetime for unattended sensors and sensor radio networks, as well as address commercial uses, such as in the powering of devices operating within "Internet of Things" ecosystems.

REFERENCES:
1. http://www.darpa.mil/news-events/2015-04-13

2. DARPA Industry Day Presentation, September 7, 2016

KEYWORDS: electric battery, lifetime, coin-cell

SB163-010 TITLE: Compact, Efficient, Fiber-Coupled High Power Laser Diode Pump Module

PROPOSALS ACCEPTED: Direct to Phase II ONLY.

TECHNOLOGY AREA(S): Air Platform, Weapons

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop a high-power, fiber-coupled laser diode pump module with high efficiency in a compact package that is consistent with the stringent size and weight requirements for air platform integration.

DESCRIPTION: Fiber-based HEL systems are showing promise as robust, reliable, highly efficient laser weapon systems, which have the potential to be sufficiently small and lightweight for integration onto small military platforms. Whether using spectral or coherent beam combining, these fiber laser arrays are pumped by high-power fiber-coupled laser diode modules. These modules are a key driver of the overall required size, weight, and required electrical power of HEL systems. Highly efficient diodes significantly reduce both the required diode electrical power input and thermal management system requirements due to their lower heat generation. However, currently available commercial modules are largely targeted to the laser welding and manufacturing industry, where efficiency, size and weight are not a priority.

The focus of this topic is to reduce the size and weight of high-power, fiber-coupled diode pump modules while maintaining high wall-plug efficiency. The goal is to produce a pump module that has significantly lower size, weight, and required power than is currently available. To accomplish this, the module will need to have a volume of less than 0.32 cm3/W, a specific weight of less than 0.45 g/W (dry weight), and operate at >55% efficiency as measured by the ratio of the usable pump power in the core of the output delivery fiber to the electrical power input. These fiber-coupled modules must produce >660 W and be able to use flight qualifiable coolants (ammonia, R140A, etc.).

PHASE I: Develop a detailed model of a fiber-coupled, high-power laser diode pump module that meets the specifications in the topic description. The model should include simulations and calculations to describe the thermal management capability and efficiency roll-up.

PHASE II: Construct and demonstrate a prototype of a high-power, fiber-coupled laser pump diode module, suitable for use in pumping a high-power fiber laser. After a mode-stripper to remove cladding modes, the module must have a power of >660W with >55% efficiency ex-fiber and operate at 976 nm with <4 nm full width at half-maximum bandwidth. It must have a specific volume of less than 0.32 cm3/W, including the cooling manifold, a specific weight of less than 0.45 g/W (dry weight), and be able to use coolant consistent with a flight qualifiable system. The allowed coolant flow rate should be no higher than 9.7 L/min and pressure drop no more than 50 psi. Lower values are preferred. In addition, the technology employed in this prototype must be scalable ultimately to 1000W per module at no greater specific volume and weight and at a minimum of 55% efficiency. Phase II deliverables will include: 1) A working prototype fiber-coupled module with the above listed specifications, the performance of which will be verified by an independent government laboratory; 2) Monthly reports; 3) Final Report.

PHASE III DUAL USE APPLICATIONS: Commercial Application: The high power laser diode market is >$4B and is growing rapidly. Laser industry users will benefit from the high efficiency and small size of these diodes in the form of power savings and factory floor space.

DoD/Military Application: Multiple offensive and defensive missions conducted from small military platforms.

REFERENCES:
1. Andy Extance, “Laser Weapons Get Real,” Nature, vol. 521, pp. 408-410, May 2015.

KEYWORDS: Directed energy, laser diodes, air platforms, fiber lasers, high energy lasers

SB163-011 TITLE: Wide Area Undersea Communications Through Intelligent Mobile Networks

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Battlespace, Information Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop and demonstrate innovative method to increase the reliability, range, and expanse of acoustic undersea communications throughout large ocean basins.

DESCRIPTION: There is a critical DoD need to increase the reliability, range and expanse of acoustic undersea communications with manned and unmanned platforms and distributed sensing systems. The highly variable nature of the ocean environment results in complex propagation paths for acoustic signals. This variability severely impacts the reliability of communications such that undersea communication networks are limited to relatively short spacing distances on the order of 100’s to a few thousands of meters so that reliable links are maintained. Spacing on these scales results in extremely large numbers of communication nodes and is impractical for providing pervasive communications throughout large ocean basins.

Knowledge of the undersea acoustic propagation environment can be exploited to identify optimal positioning locations of mobile nodes to greatly improve propagation ranges and minimize the number of relay nodes. What is desired are operational concepts and algorithms that are able to employ mobile communication nodes that sample the environment, create a shared propagation model, determine optimal positioning, and re-position themselves to provide reliable communications throughout the environment with minimal nodes.

PHASE I: Conceive a notional operational concept that identifies a system of mobile acoustic communication nodes that collectively can measure the environment and create a pervasive undersea communication network throughout a large ocean basin. Using representative large ocean basin environments, model acoustic communication propagation between mobile nodes and develop dynamic algorithm that determines node positioning to provide pervasive communications throughout the volume while minimizing the number of nodes. Simulate message transport between nodes throughout the volume. Deliverables should include final report describing the concept and detailing acoustic modelling and node positioning optimization algorithm results.

PHASE II: Characterize ocean testing environment, implement algorithms and integrate acoustic modems into limited number of mobile undersea nodes, and demonstrate the communication network over appropriate scale lengths to validate the concept. Deliverables will include final report detailing the measurements and communication results along with plan for scaling concept to provide communications throughout large ocean basins.

PHASE III DUAL USE APPLICATIONS: Commercial: Undersea communications to support research, mining, and infrastructure monitoring and development. DoD: Undersea communications with manned and unmanned platforms and distributed sensing systems.

REFERENCES:
1. Heidemann, J.; Stojanovic, M; Zorzi, M; "Underwater Sensor Networks: applications, advances, and Challenges" Philosophical Transactions of the Royal Society A (2022) 370 pp 158-175

2. Lurton, Xavier; An Introduction to Underwater Acoustics Principles and Applications; Springer-Praxis Books in Geophysical Sciences 2004
3. DARPA Industry Day Presentation, September 8, 2016

KEYWORDS: Communications, undersea, acoustics, modems, networking, constellation, unmanned undersea vehicles, modelling, sensing

SB163-012 TITLE: Adapter Multifunctional Elements Reconfigured in a Coherent Array (AMERICA)

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Design, prototype, and demonstrate in a ground-based experiment, the Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA), which may be physically deconstructed to realize a phased array antenna built directly onto an adjoined microsatellite secondary payload.

DESCRIPTION: There is a critical Defense Department (DoD) need for innovative approaches to reduce the cost to deliver payloads to orbit. Many of the communications and imaging microsatellites at the vanguard of the New Space revolution hitch a ride to low Earth orbit (LEO) aboard launch vehicles carrying larger, primary satellite payloads. In a typical launch vehicle payload assembly, the primary satellite is stacked atop an ESPA ring, an aluminum ring similar in appearance to a section of pipe. A common ESPA ring has a bolt circle diameter of 1.58 m, with a height of 0.6 m. Up to six circular ports with flanges are arranged about the circumference of the ring that serve as the attachment points for microsatellite secondary payloads. Each secondary payload port has a 0.38-m bolt circle diameter.

Recently, space launch service providers have created discrete satellites with the ESPA structure. Some include propulsion subsystems to realize a so-called “space tug” that is useful in transporting secondary payloads to their planned orbits. In the future, these ESPA space tugs may include robotic arms and similar mechanisms to expand their on-orbit assembly and servicing capabilities. Aside from providing rigid support for the primary and secondary payloads and space tug subassemblies during launch, the bulk of the ESPA ring structure serves little mission-related purpose once the payloads are deployed.

In today’s space systems where every kilogram launched to LEO costs tens of thousands of dollars, significant value may be realized by an ESPA that is engineered to be truly multifunctional. New technology could generate greater revenue from a smarter, multifunctional ESPA. This SBIR topic seeks new innovation to realize a multifunctional ESPA consisting of subelements that would provide structural support to two or more secondary payloads during launch and, upon arrival in LEO, would be at least 90 percent deconstructed and reconfigured by a service apparatus included in the ESPA space tug. In this case, the deconstructed ESPA subelements are intended for reassembly directly onto one of the secondary payloads as functional elements of a large-aperture radio frequency (RF) phased array antenna.

The post-launch deconstruction of the ESPA and subsequent reassembly into the new phased array configuration would have be accomplished within a mission-compatible time period not to exceed 90 minutes. As stated previously, the service apparatus would be assumed to exist in the ESPA space tug service vehicle that flies with the launch vehicle. The service vehicle would store and/or generate some or all of the energy required to accomplish the change in system configuration (from ESPA support structure to phased array antenna), not to exceed 600 MJ. The total mass of the multifunctional ESPA ring could not exceed that of the basic ESPA described above (approximately 105 kg). Note this mass refers to the ring structure itself and not the service vehicle’s internal systems. The resulting phased array antenna would have to be capable of closing a Ka-band link from an altitude of 1,000 km to a terrestrial 0.5-m very small aperture terminal (VSAT) receiver with minimum 3 dB link margin. Nominal atmospheric attenuation is assumed in a non-interference environment.

PHASE I: Perform computational analysis and trade studies leading to a top-level, preliminary design of the multifunctional ESPA ring. The preliminary design should include a system concept of operations (CONOPS) that describes the sequence of converting from multifunctional ESPA ring to phased array antenna with a rough order-of-magnitude estimate of cycle time and energy. In addition, analysis must quantify the expected phased array antenna performance in terms of a link budget. Phase I would culminate in a preliminary design review (PDR).

PHASE II: Refine the preliminary system design to create a detailed design of the multifunctional ESPA system and mission CONOPS. The detailed design would include subsystem- and component-level definitions with updated mass, energy, and link budgets leading to a critical design review (CDR) and limited prototyping and functional testing of key subsystems and components.

PHASE III DUAL USE APPLICATIONS: Commercial Application: The prime user of the technology would likely be launch service original equipment manufacturers (OEMs) such as CSA-Moog, the maker of the ESPA. These companies continuously strive to add more functionality and capability to these products, as evidenced by the advent of the SHERPA ring, which has control and propulsion capabilities. The so-called “killer app” would be one in which a commercial LEO communications or imaging microsatellite would be augmented after launch with the deconstructed ESPA ring elements/building blocks to form a large, high-performance phased array antenna, larger than any deployable array that could be accommodated within the microsatellite.

DoD/Military Application: By using launch vehicle payload mass more efficiently, the multifunctional ESPA system could yield greater RF performance (and hence greater revenue or return on investment (ROI)) per kilogram for microsatellite secondary payloads. Greater RF performance would enable new data products for the warfighter, including delivery of overhead imagery and near real-time video, all for lower capital investment in a microsatellite secondary payload. Lastly, it would also open an avenue for a broader on-orbit service economy that creates commerce on Earth.

REFERENCES:
1. Maly, J. R., and Shepard, J. T. ESPA as Base Vehicle for Servicing Missions, NASA Goddard Space Flight Center International Workshop on On-Orbit Satellite Servicing, Moog/CSA Engineering, Inc., 2010.

2. Lo, A. S. et al. Secondary Payloads Using the LCROSS Architecture, American Institute of Aeronautics and Astronautics, 2010.

KEYWORDS: Evolved Expendable Launch Vehicle Secondary Payload Adapter, EELV, ESPA, phased array antenna, in-space manufacturing, robotic assembly, satellite, space

SB163-013 TITLE: Task Accomplishing Systems from Composable Kits (TASCK)

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.3 DoD Program Solicitation and the DARPA 16.3 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Electronics, Ground/Sea Vehicles

OBJECTIVE: Develop the ability to rapidly compose task-oriented, task-performing platforms using a combination of modular mechanical elements (e.g., actuation, structural, energy), service-oriented software, digitally encapsulated electronics, and on-demand middleware, orchestrated through a compositional toolchain.

DESCRIPTION: There is a critical Defense Department (DoD) need to responsively field new military capabilities. Moving to a compositional model for task-oriented systems would allow designs that facilitate many rapid future adaptations, the nature of which do not have to be specified in advance. Compositional approaches to platforms would seek to create system capabilities by combining subsystems that are maximally homogenous and minimally stateful, while acknowledging limitations to approaching these extrema in cyber-physical systems. This approach would have great value in rapidly developing military-specific capabilities and also enabling rapid technical advances via re-use. A notional example of a task-oriented system could include a specialized robotic manipulation system.

The principal metric of goodness of a composable platform architecture is time to meet an unknown, previously unspecified need. This approach stands in contrast to standard multi-objective systems engineering approaches that focus on simultaneously satisfying or optimizing around multiple performance requirements. It is expected that a composable approach could produce instantiated systems faster than a conventional optimization-centric approach with manageable performance trades.

In an envisioned future, an engineer or non-expert user would be able to leverage hardware and software parts bins and—in the space of minutes, hours, or days—be able to produce a functional platform system to support a specific application. The user would be able to interact with available components and a compiler-like toolchain for the composition process.

Composable architectures have been used in pure software systems, with self-orchestrating services creating higher-level capabilities. Cyber-physical systems are often highly stateful and not cleanly encapsulated, with complex multi-physics interactions between components.

This topic seeks to explore the viability of the concept of composable architectures for task-oriented platforms and under this effort would apply the concept to ground robotic systems, which are expected to benefit from improved development timelines and be capable of tolerating some degree of performance overhead in support of improved service encapsulation.

This exploration is expected to encompass development of a foundational framework for a composable architecture, supporting toolchains, and initial toolbox elements. The effort is expected to conclude with a hardware-software demonstration constrained by time. If successful, the effort would lower the barrier for entry to robotics development. As a result, significant military and commercial spinoff opportunities are anticipated, and proposers are encouraged to consider such opportunities.

As a point-of-departure culminating in a Phase II demonstration concept, proposers should consider the following content: (1) Develop and demonstrate a highly mobile, Soldier-carried reconnaissance/engineering robot that would perform a mission set over 30-60 minutes and 100 meters in an urban training facility, roughly equivalent to a move-to-detect, move-to-contact, enter/clear-a-room scenario. In addition, with the same component hardware and compositional toolchain software set, compose (2) a mobile manipulation robot to do a subset of two to three maintenance/assembly tasks (for example, exchange radio batteries between radios and chargers, remove tire lug nuts, etc.). The system should not simply be a two-point design, but should be (3) extensible to unanticipated applications. In a notional culminating demo, (1) and (2) would be demonstrated within hours of each other.

PHASE I: Develop a foundational hardware library, software repository, and initial compositional toolchain that support concept demonstrations in a simulation environment. These elements could evolve in a spiral fashion across subsequent phases and follow-on activity. Analyze a trade space (scale, metrics, and tasks) for demonstrating multiple robotics applications, notionally including both a reconnaissance/engineering robot mission as well as a mobile manipulation maintenance/assembly mission. Identify and develop a preliminary digital library of versatile hardware elements as modules/components that have a degree of self-contained functionality (e.g., processing, actuation, information transfer) and common interfaces to facilitate plug-and-play construction for digitally composing and analyzing designs. Create an initial repository of service-oriented software that would provide access to critical execution functions such as mobility control, perception, path planning, mission functions, manipulation, and human interface elements. Develop a bus-based architectural and physical backbone to allow for more open-ended extensibility of electronics and physical components beyond simply the aforementioned components. Create an initial compositional toolchain (builder/compiler) and user interface to assist in composing elements to meet demonstration goals. The compositional toolchain would notionally include a goal-seeking builder, which would assist a human designer in achieving functional goals via available components, extensions via known interfaces, or creating on-demand middleware. The middleware components would assist in adapting non-conforming hardware and software into the compositional framework (translator elements that encapsulate behavior to drive towards lower statefulness). The compositional toolchain would also include a compiler, which would take results from the builder and develop specifications or possibly produce functional equivalents that are applied to an application. Demonstrate concepts in simulation, showing accomplishment of representative reconnaissance/engineering robot and maintenance/assembly robot missions based on determined trade space.

PHASE II: Conduct user demonstrations of developed composable kits toward objective functions and time constraints. Identify and develop an expanded and more complete digital library of versatile hardware elements as components that have fully self-contained functionality (e.g., processing, actuation, information transfer) and common interfaces to facilitate plug-and-play construction for digitally composing and analyzing designs based on the Phase I simulation demonstration results. Develop, test, and validate performance of the entire library of required hardware components. Finalize a complete repository of service-oriented software that would provide access to critical execution functions of subsystems and complete robots required of the demonstrations. Complete the compositional toolchain (builder/compiler) to allow composing elements to meet demonstration goals. As a first approach, allow compiling of varied functions (based on the demonstrations) by an expert user/researcher at developmental timescales (hours) and prove performance by limited testing. As a second approach, allow compiling by a non-expert user but robot-application expert (for example, a Soldier) to compile at demonstration timescales (minutes) and prove performance by limited testing. Perform final demonstrations with Soldier-equivalent users in a militarily relevant environment. Set up demonstrations that show the flexibility of the toolset to adapting to previously unknown applications.

PHASE III DUAL USE APPLICATIONS: Commercial – Ideally, at the end of a Phase II, a performer team would have products (software and/or hardware) that are directly viable for research community sale and use, which could spur follow-on developments in the research and commercial sectors and ultimately drive back toward military capabilities. Platform products, to specifically include robotic platforms, of composable design toolchains as well as flexible components would allow for affordable, marketable, and producible robotic subsystems for application to static and mobile robotic-based manufacturing, household robotics, healthcare robotics, logistics/material handling, unmanned systems, and construction robotics, to include robotics for use in hazardous environments. Design modularity would allow for module and toolchain products that could be purchased and implemented by end-users for custom applications at rapid assembly/programming paces versus developing robots, thus eliminating huge cost and time barriers. A successful development could fundamentally change the paradigm of robotics system development.

Military – Composable platforms, specifically robotics as demonstrated in this effort, would have direct application to the current mission space of small reconnaissance robots for infantry units, engineering robots, mobile manipulation, explosive ordnance, and remote/unmanned needs for robots in hazardous environments. The diversity of component composition would allow for multi-mode configurations for different mission sets with the same elements (for example, wheeled maneuver recomposed for walking maneuver, then recomposed for climbing maneuver, all with the same components), while the compositional toolchain would allow for rapid and non-expert user recoding of control schemes for immediate use in such different configurations. The result would be robots that are no longer custom for a specific use, and yet are highly optimizable for multiple missions using largely the same hardware and software.

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6. DARPA Industry Day Presentation, September 7, 2016

KEYWORDS: Platforms, Robots, Components, Composable, Design, Systems Engineering, Adaptability

SB163-014 TITLE: Gun-launched Integrated Guidance Navigation and Control

PROPOSALS ACCEPTED: Direct to Phase II ONLY.

TECHNOLOGY AREA(S): Air Platform, Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop, test, and validate innovative material systems, components, and structures for a four-channel control actuation system (CAS) with an integrated inertial measurement unit (IMU) and guidance electronics unit (GEU) capable of surviving the high-g launch environment and imparting precise maneuverability to guided projectiles throughout supersonic flight.

DESCRIPTION: There is a critical Defense Department (DoD) need to advance the capability of guided projectiles to enable new missions and improve outcomes of current air-to-ground, ground-to-ground, and long-range ballistic missions. Guided projectiles must tightly integrate control actuation, navigation sensing and filtering, and guidance computation into a small package capable of gun-launch survivability. Electromechanical and processing demands drive the need for large subsystems, reducing volume for other projectile subsystems. A tightly integrated maneuver package would improve total packaging and performance and enable a high-performance 40 mm or smaller guided projectile.

Significant advances are needed for integration of traditionally separate subsystems. By integrating chip-based navigation, guidance computation, and control electronics into a single package tightly coupled to an optimized CAS, significant volume savings could be realized.

The topic objectives of the fully integrated assembly are:
- Significantly reduce the overall size and weight of the CAS by identifying and evaluating optimal materials/material systems with sufficient strength-to-weight ratio for maneuver
- Maximize efficiency and consolidate the assembly through refining gear-train options for the CAS
- Optimize speed and torque parameters vs. power draw by selecting best configuration for the CAS motor interface
- Enhance performance through aero-optimization of control-surface designs
- Examine canard deployment and incorporate it if appropriate for improved system performance
- Achieve in-flight course corrections through precise maneuvering of each canard by implementing a miniature four-channel positional feedback-sensing system
- Develop and ensure optimal performance of a low-cost IMU with integrated GEU with reduced bias stability, angular random walk, and non-linearity of gyroscope solution
- Ensure assembly survives 50,000+ g launch and environmental conditions through innovative, robust packaging and validate survivability via testing
- Reduce the overall volume claim of an integrated CAS/GEU/IMU by >50 percent over the current state of the art (SOA)
- Minimize latency of a combined CAS/GEU/IMU

Additional optional objectives include:
- Devise and demonstrate an integrated g-switch that is customized for the gun-firing g-event
- Optimize power consumption on regulation/conditioning
- Devise and validate performance of an innovative accelerometer

This topic is ONLY interested in fully integrated solutions incorporating CAS, IMU, and GEU into a single package capable of fitting within a 40 mm or smaller projectile. The key technical challenge for a guided projectile is tight subsystem integration, therefore proposals for individual CAS, IMU, or GEU improvements will not be considered.

PHASE I: Feasibility documentation must address prior work to achieve the current state of the art and/or progress for an innovative solution for the gun-launched (high-g shock survivable) integrated guidance navigation and control (GNC). The current SOA is several small individually packaged modules connected by wire physically layered on top of each other with the empty spaces (gaps) filled with epoxy or foam. Hence, the overall package is much larger than it has to be because each module has to have its own power management, protective packaging, and shock isolation. Putting all or some of these modules on the same chip would drastically reduce space and increase performance. Inter-component data bandwidth would increase chip bus speeds and overall size could be much smaller. The fundamental components to be packaged – CAS, IMU, and GEU – already exist as individual components. The R&D challenges include integrating heterogeneous components on a chip because some of these components require more power (e.g., CAS), while others require more shock isolation (e.g., IMU) and others require a low-noise environment (e.g., radio frequency (RF) communications). Packing these components tightly together and potentially on the same chip require innovation and combining them in a compact and durable package with validation via physical testing are being sought.

PHASE II: Develop, test, and validate innovative material systems, components, and structures for a four-channel CAS with IMU and GEU combined in a compact and durable package with validation via physical testing. A prototype will be constructed and demonstrated to survive a high-g launch and function under high performance demands.

At minimum, the assembly will demonstrate reduced packaging size, increased maximum maneuver, and reduced maneuver latency. The final Phase II deliverable will be a detailed design of the assembly and a detailed test report describing the improved performance achieved.

PHASE III DUAL USE APPLICATIONS: Commercial – Solving the integration and manufacturing challenges through the SBIR program would substantially lower integration risks that commercial receivers of the technology would face. Small GNC packages would enable a new class of ultra-small unmanned air vehicles capable of flying longer ranges for longer times on tighter paths. Tightly integrated IMU solutions have enabled current mobile device navigation. By including control and actuation, next-generation mobile devices could become truly mobile and move to suit user needs such as flying around a user for better camera angles or crawling up vertical surfaces to achieve better signals. This system could also be used on mobile devices to improve navigation in virtual simulations and drive haptic and tactile feedback to users.

Military – This technology would be immediately applicable to ongoing guided projectile technology programs such as DARPA's Multi Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) and the U.S. Navy High Velocity Projectile (HVP). Guided projectiles have the potential to enable new missions and improve outcomes of many current missions such as air-to-ground engagements, ground-to-ground engagements, and long-range ballistic engagements. This technology may eventually be built into thousands, if not hundreds of thousands, of manufactured projectiles.

REFERENCES:
1. DARPA BAA-14-45 Multi Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES)

2. DARPA Industry Day Presentation, September 8, 2016

KEYWORDS: Guidance electronic unit, inertial navigation system, control actuation system, integrated packaging, guided projectile