DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
14.3 Small Business Innovation Research (SBIR)

1.1 INTRODUCTION

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA SBIR and STTR Programs are 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
Home Page http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR.aspx

Offerors responding to the DARPA topics listed in Section 12.0 of the DoD 14.3 SBIR Solicitation must follow all the instructions provided in the DoD Program Solicitation. Specific DARPA requirements in addition to or that deviate from the DoD Program Solicitation are provided below and reference the appropriate section of the DoD Solicitation.

3.0 DEFINITIONS

3.4 Export Control

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

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

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

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

(4) The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

Please visit http://www.pmddtc.state.gov/regulations_laws/itar.html for more detailed information regarding ITAR/EAR requirements.

3.5 Foreign National

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

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

ALL offerors proposing to use foreign nationals MUST follow section 5.4. c.(8) of the DoD Program Solicitation and disclose this information regardless of whether the topic is subject to ITAR restrictions. There are two ways to obtain U.S. citizenship: by birth or by naturalization. Additional information regarding U.S. citizenship is available at http://travel.state.gov/law/citizenship/citizenship_782.html. Definitions for "lawful permanent resident" and "protected individual" are available under section 3.5 of the DoD instructions.

4.0 PROPOSAL FUNDAMENTALS

PLEASE NOTE: Use of the DARPA SBIR/STTR Information Portal (SSIP) is MANDATORY. Offerors will be required to authenticate into the SSIP (via the DARPA Extranet) to retrieve their source 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 14.3 source selection period has closed. DARPA extranet accounts will ONLY be created for the individual named as the Corporate Official (CO) on the proposal coversheet. Offerors may not request accounts for additional users at this time.

4.6 Classified Proposals

DARPA topics are unclassified; however, the subject matter may be considered to be a "critical technology" and therefore subject to ITAR/EAR restrictions. See **Export Control** requirements above in Section 3.1.

4.10 Debriefing

DARPA will provide a debriefing to the offeror in accordance with FAR 15.505. The source selection decision notice (reference 4.4 Information on Proposal Status) contains instructions for requesting a proposal debriefing. Please also refer to section 4.0 of the DoD Instructions.

Notification of Proposal Receipt

Within 5 business days after the solicitation closing date, 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.

Information on Proposal Status

The source selection decision notice will be available no later than **90 days after solicitation close.** The individual named as the "Corporate Official" 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 source selection decision notice. The request must explain why the offeror was unable to retrieve the source selection decision notice from the SSIP within the original 30 day notification period. Please also refer to section 4.0 of the DoD Instructions.

4.13 Phase I Award Information

a. Number of Phase I Awards. The number of Phase I awards will be consistent with DARPA's budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until evaluation of all qualified proposals for a specific topic is completed. Normally offerors will receive their source selection decision notice for a Phase I award within 90 days of the closing date for this solicitation. Selections are posted at www.dodsbir.net/selections.
b. Type of Funding Agreement. DARPA Phase I awards will be Firm Fixed Price contracts.
c. Dollar Value. DARPA Phase I awards shall not exceed $100,000 for the base effort, or $105,000 for the base effort if technical assistance services are proposed, and shall not exceed $50,000 for the option if exercised.
d. Timing. Across DoD, the median time between the date that the SBIR solicitation closes and the award of a Phase I contract is approximately four months.

4.22 Discretionary Technical Assistance (DTA)

Offerors that are interested in proposing use of a vendor for technical assistance must complete the following:

1. 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 20-page limit of the technical volume and will NOT be evaluated.
2. Input 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. You may also submit the detailed cost breakdown as an appendix to the one-page description. Label this appendix "DTA COST Breakdown" – it will not count against the 20-page limit of the technical volume.

Approval of technical assistance is not guaranteed and is subject to review of the Contracting Officer. Please see section 4.22 of the DoD instructions for additional information.

5.0 PHASE I PROPOSAL

Phase I Option

DARPA has implemented the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I companies selected for Phase II will be eligible to exercise the Phase I Option. The Phase I Option covers activities over a period of up to four months and should describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The statement of work for the Phase I Option counts toward the 20-page limit for the Technical Volume.

A Phase I Cost Volume ($155,000 maximum) must be submitted in detail online via the DoD SBIR/STTR submission system. Offerors that participate in this solicitation must complete the Phase I Cost Volume, not to exceed the maximum dollar amount of $100,000, or $105,000 if technical assistance services are proposed, and a Phase I Option Cost Volume, not to exceed the maximum dollar amount of $50,000. Phase I awards and options are subject to the availability of funds.

Offerors are REQUIRED to use the online Cost Volume for the Phase I and Phase I Option costs (available on the DoD SBIR/STTR submission site).

Human or Animal Subject Research

DARPA discourages offerors from proposing to conduct Human or Animal Subject Research during Phase I due to the significant lead time required to prepare the documentation and obtain approval, which will delay the Phase 1 award. See sections 4.7 and 4.8 of the DoD Instructions for additional information.

5.4 (6) Commercialization Strategy

DARPA is equally interested in dual use commercialization of SBIR 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 discussion should include identification of the problem, need, or requirement relevant to a Department of Defense application and/or a private sector application that the SBIR project results would address; a description of how wide-spread and significant the problem, need, or requirement is; and identification of the potential DoD end-users, Federal customers, and/or private sector customers who would likely use the technology.

Technology commercialization and transition from Research and Development activities to fielded systems within the DoD is challenging. Phase I is the time to plan for and begin transition and commercialization activities. The small business must convey an understanding of the preliminary transition path or paths to be established during the Phase I project. That plan should include the Technology Readiness Level (TRL) expected at the end of the Phase I. The plan should include anticipated business model and potential private sector and federal partners the company has identified to support transition and commercialization activities. In addition, key proposed milestones anticipated during Phase II such as: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.

5.5 Phase I Proposal Checklist:

The following criteria must be met or your proposal may be REJECTED.

____1. Include a header with company name, proposal number and topic number to each page of your Technical Volume.
____2. Include tasks to be completed during the option period and include the costs in the Cost Volume.
____3. Break out subcontractor, material and travel costs in detail. Use the "Explanatory Material Field" in the DoD Cost Volume for this information, if necessary.
____4. The base effort does not exceed $100,000, or $105,000 if technical assistance services are proposed, and six months and the option does not exceed $50,000 and four months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the statement of work section of the Technical Volume.
____5. The technical volume does not exceed twenty (20) pages. Any page beyond 20 will be redacted prior to evaluations.

____6. Upload the Volume 1: Proposal Cover Sheet; Volume 2: Technical Volume; Volume 3: Cost Volume; and Volume 4: Company Commercialization Report electronically through the DoD submission site by 6:00 AM (ET) on October 22, 2014.
____7. After uploading your file on the DoD submission site, review it to ensure that all pages have transferred correctly and do not contain unreadable characters. Contact the DoD Help Desk immediately with any problems.

6.0 PHASE I EVALUATION CRITERIA

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 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".

Please note that qualified advocacy letters will count towards the proposal page limit and will be evaluated towards criterion C. Advocacy letters are not required. Consistent with Section 3-209 of DoD 5500.7-R, Joint Ethics Regulation, which as a general rule prohibits endorsement and preferential treatment of a non-federal entity, product, service or enterprise by DoD or DoD employees in their official capacities, letters from government personnel will NOT be accepted.

A qualified advocacy letter is from a relevant commercial procuring organization(s) working with a DoD or other Federal entity, articulating their pull for the technology (i.e., what need the technology supports and why it is important to fund it), and possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program. If submitted, the letter should be included as the last page of your technical proposal. Advocacy letters which are faxed or e-mailed separately will NOT be accepted.

Limitations on Funding

DARPA reserves the right to select and fund only those proposals considered to be of superior quality and highly relevant to the DARPA mission. As a result, DARPA may fund multiple proposals in a topic area, or it may not fund any proposals in a topic area.

7.0 PHASE II PROPOSAL

All offerors awarded a Phase I contract under this solicitation will receive a notification letter with instructions for preparing and submitting a Phase II Proposal and a deadline for submission. Visit http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_Program.aspx for more information regarding the Phase II proposal process.

Direct to Phase II

15 U.S.C. §638(cc), as amended by NDAA FY2012, Sec. 5106, PILOT TO ALLOW PHASE FLEXIBILITY, allows the Department of Defense to make an award to a small business concern under

Phase II of the SBIR program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project.

DARPA is conducting a "Direct to Phase II" pilot implementation of this authority for this 14.3 SBIR solicitation only and does not guarantee the pilot will be offered in future solicitations. 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.

Not all DARPA topics are eligible for a Direct to Phase II award. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. 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 steps outlined below:

STEP 1:

1. Offerors must create a Phase I coversheet using the DoD Phase I Proposal submission system (follow the DoD Instructions for the Cover Sheet located in section 5.4.a).
2. Offerors must upload the documentation that satisfies the Phase I feasibility requirement* (upload this documentation in the DoD Phase I Proposal submission system as the "Technical Volume" – DO NOT follow the technical volume format specified in the solicitation instructions for your justification).
    a. 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.
    b. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).
    c. If technology in the feasibility documentation is subject to IP, the offeror must have IP rights. Refer to section 11.5 of the DARPA instructions for additional information.
    d. Include a one page summary on Commercialization Potential addressing the following:
        1. Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
        2. Describe the potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.
    e. DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated and WILL be redacted.
3. Offerors DO NOT upload a Phase I Cost Volume.
4. **The Phase I Cover Sheet and applicable documentation must be submitted to http://dodsbir.com/submission by 6:00 a.m. (ET) on October 22, 2014.**

STEP 2:

1. Offerors must submit a Phase II proposal using the DARPA Phase II proposal instructions available as an attachment to the solicitation, titled DARPA SBIR/STTR Phase II Proposal Preparation Instructions, dated August 1, 2014.
2. The Phase II proposal must be submitted by 6:00 a.m. (ET), October 22, 2014.

* NOTE: Offerors are required to provide information demonstrating that the scientific and technical merit and feasibility has been established. **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)**. Refer to the Phase I description (within the topic) to review the minimum

requirements that need to be demonstrated in the feasibility documentation. Potential offerors must not have received a Phase I award for similar work.

11.0 CONTRACTUAL CONSIDERATIONS

11.1(f) Publication Approval (Public Release)

National Security Decision Directive (NSDD)189 established the national policy for controlling the flow of scientific, technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. The directive defines fundamental research as follows: "Fundamental research" means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons."

It is DARPA's goal to eliminate pre-publication review and other restrictions on fundamental research except in those exceptional cases when it is in the best interest of national security. Please visit http://www.darpa.mil/NewsEvents/Public_Release_Center/Public_Release_Center.aspx for additional information and applicable publication approval procedures.

11.4 Patents

Include documentation proving your ownership of or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: (1) a representation that you own the invention, or (2) proof of possession of appropriate licensing rights in the invention. Please see section 11.4 of the DoD instructions for additional information.

11.5 Intellectual Property Representations

Provide a good faith representation that you either own or possess appropriate licensing rights to all other intellectual property that will be utilized under your proposal. Additionally, proposers shall provide a short summary for each item asserted with less than unlimited rights that describes the nature of the restriction and the intended use of the intellectual property in the conduct of the proposed research. Please see section 11.5 of the DoD instructions for information regarding technical data rights.

11.7 Phase I Reports

All DARPA Phase I 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 I contract. Reports must be provided to the individuals identified in Exhibit A of the contract. Please also reference section 4.0 of the DoD Preface.

DARPA SBIR 14.3 Topic Index

DARPA SBIR 14.3 Topic Descriptions

SB143-001 TITLE: Energy Harvesting for Next Generation Neurotechnology

TECHNOLOGY AREAS: Biomedical, Human Systems

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 7.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

OBJECTIVE: Improve next generation neurotechnology by developing energy harvesting technologies to enable self-powered neural interfaces.

DESCRIPTION: Neuroprosthetics are becoming a reality for many warfighter applications including control of prosthetic devices and restoration of neural and behavioral function following injury. Looking forward, novel neural interfaces are being designed and developed that enable closed-loop sensing, onboard computation, and action all within a fully implantable device (1). Current implantable devices rely on battery power which limits operational lifetimes of the devices and introduces risk to patients including tissue damage from battery leakage and surgical procedures to replace depleted batteries. Harvesting power directly from innate processes of the body represents an attractive alternative to batteries for future neural interfaces.

Research into energy-harvesting strategies to replace batteries in biomedical devices has produced a variety of methods to extract power from mechanical, electrical, chemical and thermal processes in the human body (2, 3). Strategies have shown promise for powering ultra-low power sensors (4, 5), however, the power required for a fully implantable and adaptable closed-loop sensing and stimulation system far exceeds the current capabilities of energy harvesting technology. Additionally, strategies for energy harvesting to power medical devices in organs such as the heart may not be suitable for powering neural devices. It has been suggested that fuel cell strategies leveraging glucose in the cerebral spinal fluid may be physiologically viable and able to produce adequate power, but these technologies have not been tested in vivo (4).

The amount of power required for an adaptable, closed-loop neural interface depends on a number of factors including frequency of sensing and stimulation, and computational burden of modeling and control algorithms. This solicitation calls for the development of energy harvesting strategies from natural processes in the human body that will result in the ability to power a fully implantable neural interface during sensing, analyzing and stimulating multiple brain regions for therapeutic purposes. Elimination of batteries in these neural interfaces will lead to smaller, more reliable, longer lasting, and more effective devices. Successful advancements in energy harvesting technology will enable next generation neurotechnologies to transition to academic, government, and commercial researchers to gain a much deeper understanding of brain function, and to clinicians to improve the quality of life for service members and veterans.

PHASE I: Develop preliminary design concept and determine technological feasibility of bio-harvesting energy strategies to power fully implantable, closed-loop neural interfaces for a minimum of ten years. The final report must include performance metrics against plans for Phase I. Specifically, the final report must include: a) discussion of design parameters and performance characteristics of proposed energy harvesting strategies to support both steady state and peak power consumption of a fully implantable, sensing and stimulating, neural interface for ten years, b) description of the physical behavior of the chosen energy harvesting technique by a mathematical model to allow for iterative studies of varying design parameters on energy output, c) discussion of one or more component materials and technologies that will enable chronic implantation in a human patient, d) justification of design parameters, and one or more approaches for validating developed technology in an animal model. Phase I plans should include preliminary design plans, key component technological milestones and plans for at least one test and evaluation in vitro.

PHASE II: Finalize and validate energy harvesting design strategy developed in Phase I. Develop and demonstrate operation of a prototype energy harvesting technology in vivo. Emphasis will be placed upon prototype performance parameters, physiological practicality, and the ability to validate measurements in an animal model. Phase II deliverables will include: (1) A working prototype of the energy harvesting technology including specifications for use in vivo (2) power generation specifications demonstrating utility in an animal model (3) test data on its performance and ability to harvest energy in vivo.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow section 7.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE III: Commercial and military application will focus on integrating energy harvesting technology with a currently available fully implantable closed-loop neural interface for control of a prosthetic limb, treatment of neuropsychiatric illness, or restoration of memory due to a traumatic brain injury. This integrated technology will represent the next generation of self-powered neural interfaces.

REFERENCES:

[1] DARPA's Systems-Based Neurotechnology for Emerging Therapies (SUBNETS) and Restoring Active Memory (RAM) Programs: http://www.darpa.mil/Our_Work/BTO/Programs/Systems-Based_Neurotechnology_for_Emerging_Therapies_SUBNETS.aspx and http://www.darpa.mil/Our_Work/BTO/Programs/Restoring_Active_Memory_RAM.aspx

[2] Starner T (1996) Human-powered wearable computing. IBM Syst J 35(3.4):618-629.

[3] Andoralov V, Falk M, Suyatin DB, Granmo M, Sotres J, Ludwig R, Popov VO, Schouenborg J, Blum Z and Shleev S (2013) Biofuel Cell Based on Microscale Nanostructured Electrodes with Inductive Coupling to Rat Brain Neurons. Sci Rep 3:3270.

[4] Rapoport BI, Kedzierski JT, Sarpeshkar R (2012) A Glucose Fuel Cell for Implantable Brain–Machine Interfaces. PLoS ONE 7(6): e38436.

[5] Dagdeviren C, Yang BD, Su Y, Tran PL, Joe P, Anderson E, Xia J, Doraiswamy V, Dehdashti B, Feng X, Lu B, Poston R, Khalpey Z, Ghaffari R, Huang Y, Slepian MJ, Rogers JA (2013) Conformal piezoelectric energy harvesting and storage from motions of the heart, lung, and diaphragm. PNAS 111(5):1927-32.

KEYWORDS: energy harvesting, neurotechnology, neural interface

SB143-002 TITLE: Next Generation Plasma Modeling Tools

TECHNOLOGY AREAS: Space Platforms, Nuclear Technology

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 7.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

OBJECTIVE: Develop next generation 3D plasma predictive design tools capable of simulating rapidly evolving plasma phenomena consisting of both kinetic and fluid behaviors, which must be deployable in modern massively parallel architectures, such as CPU-GPU systems.

DESCRIPTION: Complex neutral and non-neutral plasma behaviors involving kinetic, fluid, and radiation transport effects are common across multiple DoD systems. These systems can include plasma thrusters, high-speed air/space vehicles, radiation effect simulators and systems employing high-voltage, high-power drivers such as railguns and RF sources. For example, in z-pinch driven effects simulators, the plasma can be adequately described initially using a fluid approach when coupled to an appropriate circuit model of the driver. However, as the pinch implodes, kinetic effect plays a significant role and must be accounted for in the simulations in order to calculate the correct radiation output. Overall the above systems are of relevance to multiple users in the Army, Air Force, and Navy.

Currently, simulation tools exist to model these behaviors in the relevant setting and in many cases have achieved predictive capabilities. However, in many scenarios these simulations require computation resources at a scale not practical for device parameter scans and optimization; for example, in cases where kinetic effects are important, usually the entire problem must be done kinetically even if parts of the problem would be amendable to a simpler and faster fluid approach. Additionally, current commercially available state-of-the art approaches such as Particle-in-Cell (PIC) codes have not been scalable to new massively parallel CPU-GPU architectures. Overall, simulation packages currently used do not have all the desired attributes integrated, specifically, 1) the ability to switch between fluid and kinetic approaches in-situ in the calculation; 2) scalability to massively parallel CPU-GPU architectures, and 3) robust implicit and auto-mesh refinement algorithms that work with 1) and 2).

A further complication is the requirement that the software architecture retain the above attributes while simultaneously allowing easy incorporation of physics sub-models required for simulating specific problems; for example, radiation production and transport physics required for some source simulations, and atomic and materials physics models required for breakdown simulations.

DARPA seeks innovative approaches that will permit predictive and massively parallelizable simulations of complex plasmas at acceptable computational costs that will enable revolutionary capabilities in design and optimization of devices driven by these plasmas.

PHASE I: Develop innovative approaches to modeling plasmas with both kinetic and fluid behaviors, and conduct preliminary assessment of those approaches in test model problems. The focus should be on fidelity and computational scalability; a flexible model implementation is desired where a user can make explicit trades between fidelity, run-time, and computer architecture. In addition, develop detailed analysis of predicted performance of the proposed approach and plans for developing the approach into a comprehensive simulation tool in Phase II. The Phase I deliverable is a final report documenting the effort and results.

PHASE II: Develop a comprehensive 3D simulation tool using the approaches identified in Phase I. Develop a prototype and establish a preliminary benchmark using various standard problems, and apply the tool to a DoD relevant problem with coupled fluid and kinetic effects (e.g. atmospheric flashover and breakdown, plasma flow switches, z-pinches, etc.). Phase II deliverables will include a final report documenting the effort, a document describing the simulation architecture, a copy of the simulation tool, and a user’s manual.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow section 7.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE III: Commercial uses of the simulation tool could include modeling of next generation conventional and plasma accelerators for applications in the medical and inspection industries and next generation plasma processing tools, such as highly sought EUV lithography sources, for the semiconductor industry. An efficient, capable plasma simulator software package will have multiple military applications, ranging from modeling breakdown effects and electron sources in high-voltage high power devices such as microwave sources, to precisely determining radiation output from complex pinch plasmas used for effects testing, as well as characterizing space ionosphere behaviors and lighting behaviors relevant to DoD operations.

REFERENCES:

[1] C. K. Birdsall, “Particle-in-Cell Charged-Particle Simulations, Plus Monte Carlo Collisions With Neutral Atoms, PIC-MCC”, IEEE Trans. Plasma Science, Vol. 19(2), 1991. (Available at ptsg.eecs.berkeley.edu/publications/Birdsall1991TOPS.pdf)

[2] J. P. Verboncoeur, “Particle simulation of plasmas: review and advances”, Plasma Physics and Control Fusion, Vol. 47, A231-A260, 2005. (Available at ptsg.eecs.berkeley.edu/~johnv/seminarS2006/Verboncoeur.pdf?)

[3] A. Hand, “EUV lithography cannot come soon enough”, June 22, 2010, EDN Network (Available at http://www.edn.com/electronics-news/4363455/EUV-lithography-cannot-come-soon-enough)

KEYWORDS: Plasma modeling, plasma simulations, accelerators, plasmas, radiation sources, breakdown, lighting, thrusters, microwave sources

SB143-003 TITLE: Mobile Cloud Analytic Environment

TECHNOLOGY AREAS: Information Systems, Sensors

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 7.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

OBJECTIVE: Develop and demonstrate a small, lightweight cloud computing environment capable of distributed processing of very large data sources in forward deployed areas for behavior detection and modeling using locally-sensed Radio Frequency (RF) and other available data sources. Demonstrate use within and across small units and vehicles, to include manned and unmanned aircraft.

DESCRIPTION: A mobile cloud would dramatically improve situational awareness for the military tactical environment by providing 100-to-1000 fold increase in computational capability for warfighters in hostile environments. Currently, the majority of the relevant information collected for tactical operations comes from forward areas where the operations are conducted. Due to severe computational constraints, this information must be passed to large data processing centers that, of necessity, are located far away in rear echelons, frequently thousands of miles away. After being processed, the results must be transmitted back to the tactical operators who collected the data in the first place. The bandwidth constraints of moving huge amounts of data two ways over wireless and satellite links are prohibitively expensive. As a consequence, only a small percentage of the data available to the tactical warfighter is actually processed, and an even smaller percentage is made available to them. A mobile cloud environment could remove these constraints by delivering an unprecedented amount of computational capability at low power, weight, and volume to the tactical warfighter.

Mobile Cloud capabilities would permit the local military units to:
1. Understand their own performance in real-time by collecting and analyzing the large amounts of blue force information that is currently available, but is largely discarded because the data is too large to transmit to an enterprise cloud facility and there is no current ability to locally process the data.
2. Understand red force behavior by locally collecting and analyzing nearby enemy information.
3. Understand the environment by collecting and analyzing information about the surrounding terrain.

PHASE I: Develop a detailed design of a cloud computing environment that would provide distributed processing of big data in forward deployed areas for behavior detection and modeling using locally-sensed Radio Frequency (RF) and other available data sources. Develop advanced analytics for detection and characterization of behaviors of entities and systems that emit RF signals. Analyses should not be limited to simple frequency analysis but also take into account interactions between sensed entities and within the environment. Environments would include urban as well as less-developed operational areas.

PHASE II: Construct a small, lightweight, low-power cloud computing research prototype environment from commercially available components. The mobile cloud should contain most of the cloud computing tools currently used in fixed base operations, and should be able to dynamically add and remove compute nodes, memory, and storage. Demonstrate and validate use of mobile cloud and analytic tools across distributed multiple entities, such as dismounted soldiers and vehicles. Demonstrate use on manned and unmanned vehicles down to Tier II UAS size. Phase II deliverables would include (1) source code and executables of all software components; (2) the experimental results from system tests, and (3) a commercialization plan. Demonstrate use within and across small units, vehicles, as well as manned and unmanned aircraft.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow section 7.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE III: Deploying portable cloud computing environments with big data capabilities in remote locations would enhance command and control, intelligence, surveillance and reconnaissance coordination in military operations. Providing portable big data cloud computing environments in remote areas would enhance the capabilities of first responders in fighting civil disasters such as floods, forest fires, and hurricanes where conventional cloud computing is not available. In addition, this technology could be used in large search activities in remote areas.

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KEYWORDS: Cloud computing, activity modeling, RF analysis

SB143-004 TITLE: <u>High Performance, Integrated Transistors for On-Chip Power Supplies</u>

TECHNOLOGY AREAS: Materials/Processes, Electronics

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 7.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

OBJECTIVE: Develop and characterize heterogeneously on-chip integrated electronic circuits for switched power supplies that can significantly reduce size and cost while improving efficiency, therefore having transformational impact on a wide range of electronic systems.

DESCRIPTION: Power supply and voltage regulation circuits are critical components in electronic systems for military and commercial applications. Often, many power supply units are needed in an electronic system and therefore can significantly affect the efficiency, overall size and cost. Energy efficiency also impacts size and cost, particularly in portable electronic devices, because of limited battery capacity and the desire to reduce the need for additional cooling enabling smaller and cheaper devices. Integration of on-chip power supplies is a way to improve all three aspects simultaneously and is therefore highly desirable.

Current power supplies/voltage regulators with discrete components are relatively large and operate at low frequencies. The size of the footprint (area) and height is driven in part by the large size of the output filter that is required at the typically relatively low switching frequencies (~1MHz). The silicon CMOS power supply circuit also contributes to a large footprint due to high current drive requirements. Transistors capable of higher switching frequencies and higher output current densities would enable smaller inductors and capacitors and more compact circuits leading to a decrease in overall size.

One possible solution to increase the switching frequency of voltage regulators is the use of switching transistors based on compound semiconductors (GaAs, GaN, SiC, etc.). Heterogeneously integrating these transistor switches (such as transistor pairs for buck converters) with the Si CMOS driver circuit on-chip as an ultra-compact power stage would provide much reduced size and highly-efficient power conversion. Novel technologies that closely integrate silicon CMOS circuits with compound semiconductor circuits will enable the desired on-chip integration. While compound semiconductors are seen as the most likely technology for the switching transistors, other transistor technologies may be possible.

PHASE I: Design transistor circuits for a switched voltage regulator (e.g. transistor pair for buck converters) in a manner compatible with future heterogeneous integration. The circuit should be designed for voltage regulation up to 30V, with switching frequencies above 2 GHz, power stage efficiencies over 90% and targeting a 50% size reduction compared with commercial state of the art. Circuit designs such as multiphase approaches that help reduce component size and power loss are encouraged. Integrate transistor switches with discrete CMOS driver circuit if needed to demonstrate increasing performance improvements. Perform a detailed analysis of predicted performance of the circuits. Based on the analysis establish performance goals for Phase II.

Required Phase I deliverables will include a technical report and a brief describing the predicted performance of a) the transistor switches, and b) the transistor switches integrated with a Si CMOS driver circuit (the switching frequency shall be at least 2MHz and the regulated voltage >10V). Performance metrics shall include: RDS-on, Q(sub G), current density, breakdown voltage, voltage slew rate for the switching transistors as well as operating frequency, power efficiency, and size for the demonstration circuit.

PHASE II: Develop, test and demonstrate advanced transistor circuits compatible with on-chip integration (based on the compound semiconductor process used in Phase I). The focus is on voltage regulation up to 30V and switching frequencies of at least 2MHz. Power stage efficiencies of >90% shall be achieved. The goal is a size reduction of at least 50% compared to a commercially available state of the art power supply. Integrate advanced transistor switches with a discrete Si CMOS driver circuit at different integration levels including system in package (SiP) to demonstrate increasing performance improvements (the switching frequency shall be at least 5MHz and the regulated voltage >10V). Conduct testing of the circuits and establish the performance parameters. Demonstrate the feasibility of on-chip integration of the advanced transistors via a manufacturing process by integrating them onto a silicon substrate. Integrate the on-chip transistors with a Si CMOS driver circuit. Establish all the transistor and circuit performance parameters and compare them to the baseline results from Phase I. Required Phase II deliverables include: prototype circuits of the advanced switching transistors integrated with CMOS driver circuits, a manufacturing plan for transitioning the technology to low rate production, a report and a briefing on the test results.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow section 7.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE III: The power supply technology developed is envisioned to impact a wide range of defense and commercial applications. In the defense or military market it may be applied to communication, navigation or information systems for soldiers, small unmanned vehicles or sensor systems. In the commercial market, applications will be in portable electronic devices such as cell phones, medical devices or computer systems. Unique fabrication processes developed under this SBIR can be integrated with other established manufacturing processes and expand their application field into higher frequency and higher power electronics.

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KEYWORDS: On-chip power supply, voltage regulator, power management, dynamic voltage regulation, switching frequency, compound semiconductor, heterogeneous integration, field effect transistor

SB143-005 TITLE: <u>Robust Coordination under Extreme Uncertainty</u>

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop contingency generation methodologies for command and control that guarantee an acceptable level of performance under extreme uncertainty and operational constraints

DESCRIPTION: The DoD is contemplating future systems of systems architectures teaming manned and unmanned platforms. When facing a near peer adversary, the critical battle management challenge for such architectures will be to organize and direct semi-isolated teams of air vehicles operating under great uncertainty regarding the enemy state and the status and plans of other friendly assets. Battle management today is a largely manual process relying on robust communications. Under limited uncertainty, performance optimization techniques provide a solid framework for the design of battle management decision aids. Classic performance optimization techniques can be extended to tolerate moderate uncertainty [1], and to operate within the tight constraints of a denied airspace.

However, as uncertainty increases, robustness, and not optimal performance, must be the principal concern. In fact, as shown recently in [2], the architecture of complex systems —natural and man-made—is primarily dictated by a need for robustness, and not to maximize performance. Under extreme uncertainty it is likely easier, and preferable, to maximize robustness of an adequately performing solution, than to optimize performance itself. For this topic, alternatives to traditional command and control approaches are sought that are specially tailored for extreme conditions. Proposals should detail algorithms and system architectures to increase robustness by steering the performance envelope of the systems' sub-teams away from areas likely to interact unfavorably with uncertain conditions.

Evidence for the value of this approach is found in the study of social and commercial interactions. Research in social sciences and psychology has long studied the factors that maximize the value created by distributed agents when transaction costs are high. In particular the work presented in [3] shows that, in a given population of interdependent actors, “positive coordination” within small coalitions who are required to obtain the agreement of outside actors through “negative coordination” are able to achieve high welfare gains while economizing on transaction costs.

A second relevant observation is that teamwork is, above all, based upon a layer of trust among team members. Trust is even more important in a combat-like environment in which humans and machines are working collaboratively. An untrustworthy autonomous system, instead of being helpful, quickly becomes one more thing to worry about during an already stressful situation. A large body of research in human psychology and human-machine collaboration (see, for example, [4]), indicates that predictability of a teammate's behavior is an essential component of trust among teams.

Using these principles as a starting point, proposals should develop a dynamic coordination and deconfliction framework that would enable consistent performance of man machine teams operating under severe uncertainty, without requiring unsustainable cognitive loads on mission personnel. Such a capability will provide warfighters with a decisive advantage against a near peer – providing the capability to optimally respond to the situation in real time and accomplish the mission, despite great uncertainty.

PHASE I: Select a specific peer threat (an adversary whose capabilities rival our own) and highly contested environment mission (such as the suppression of enemy air defenses). Develop algorithms that, based on the current situation estimate and uncertainty, continuously generate all distinct options available to sub-teams within a mission package and evaluate their effectiveness as well as their predictability from the point of view of other sub-teams. Further, develop algorithms that compute constraints on the interactions with other sub-teams in order to maintain some level of effectiveness and predictability. The Phase I deliverable is a final report that includes a detailed analysis of predicted performance of the algorithm for the selected mission.

PHASE II: Develop an integrated coordination and deconfliction methodology for mixed manned-unmanned teams based on Phase I algorithms. Demonstrate the ability to increase man-machine team performance by implementing the coordination and deconfliction policy within a simulation. Develop metrics to evaluate the cognitive load imposed on human controllers by the coordination and deconfliction policy under different uncertainty assumptions. The Phase II deliverables are a prototype software implementation, tested in simulation, and a final report documenting the algorithms, the prototype implementation, experimental results, and transition plan.

PHASE III: The coordination and deconfliction algorithms will be of use to air and ground battle managers, as well as pilots in tactical aircraft, operating in denied environments. The technology would be of use to civilian first responders and disaster relief organizations coordinating loosely integrated teams under significant uncertainty and restricted communications.

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[1] Amato, C., Konidaris, G. D., Cruz, G., Maynor, C. A., How, J. P., & Kaelbling, L. P. (2014). Planning for Decentralized Control of Multiple Robots Under Uncertainty. arXiv preprint arXiv:1402.2871.

[2] John C Doyle and Marie Csete. Architecture, constraints, and behavior. Proceedings of the National Academy of Sciences, 108 (Supplement 3):15624–15630, 2011.

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KEYWORDS: Battle Management, Command and Control, Decision Aids, Mixed Initiative, Robust

SB143-006 TITLE: Next Generation Tactical Wearable Night Vision

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: SOCOM

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 3.3 of the solicitation.

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 7.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

OBJECTIVE: Develop technology for and demonstrate potential of compact, lightweight, heads-up, broad-band night vision display system for ground soldiers featuring cross-band infrared sensing and illumination for robust all-condition viewing. This revolutionary new system capability is envisioned to have the ultimate potential to replace the essential, but dated military standard Night Vision Goggles (NVG).

DESCRIPTION: Night vision goggles and other devices based on image intensifier tubes have been around for decades [1]. While the resolution and contrast of these NVG has improved, progress has been very slow to decrease their weight and size while increasing the field of view (FOV). The awkward, intrusive and cumbersome procedures for mounting, removal and/or holding these devices for the soldier can impair their ability to perform basic tasks and operations. Frequent usage of current NVGs increases the risk for short-term and long-term neck injuries, due to weight and form factor. Additionally, since these are analog devices, there are no provisions for sharing information for increased situational awareness (SA) with others in the squad or command centers.

Furthermore, the proliferation and commoditization of night vision technology has eroded the tactical advantage of night operations enjoyed by the U.S. military. By moving next generation night vision into more infrared bands, and across bands, next generation night vision technologies can help provide U.S. military forces a renewed advantage.

Wearable computing technology is quickly advancing, being driven by progress in consumer electronics. An ideal vision for future soldier-relevant night and all-condition vision display technology would harness this revolution, packaging advanced night vision imaging technology in and around light, compact wearable heads-up displays (HUDs).

Specific military hardware advances of interest for integration into a system solution include: (a) high-frame-rate (for mobility), low-noise, small-format short-wave infrared (SWIR) [2,3] or broad-band infrared cameras which do not require cooling; (b) handheld and weapons-mountable low-speckle SWIR illuminators and pointers; (c) clip-on SWIR imagers (COSI) for weapon sights; and (d) high-brightness large FOV see-through augmented reality (AR) heads-up displays (HUDs) [4,5,6] with low-light leakage, contrast control and Cursor-on-Target (CoT) capabilities. These advanced compact SWIR cameras routinely provide imaging capabilities throughout the near infrared (NIR) and SWIR wavelength bands (700-1700 nm), whereas, current night vision technology provides visualization only out to around 1.0 um. Ideally, one or more sensors would provide a full spectrum of coverage across Visible-NIR-SWIR (400-1700nm). Additionally, SWIR cameras provide enhanced visualization through obscurations (e.g. haze, fog, smoke) that would normally cause significant visual degradation in the visible wavelength band both with the naked eye or silicon imager cameras. With the addition of a SWIR illuminators (active SWIR), high-contrast high-resolution night and all-condition viewing is possible, providing covert viewing and targeting capabilities currently unavailable to enemy forces. Despite much active military research, wearable high-FOV NIR/SWIR viewing devices are still lacking.

Further, new approaches to military night and all-condition viewing technologies are sought which could interact with emerging portable tactical computing via exchange of video, geo-position, and other situational awareness data (e.g. sound or other external sensor data). Any requisite software or computing elements should preferably be implemented on consumer devices, such as a tablet or phone, and preferably on an open-source operating system. The Cursor-on-Target (CoT) Extensible Markup Language (XML) schema is the preferred SA standard for the broad interoperability and increased transition opportunities. It is envisioned that capabilities may be enhanced via the development of future applications, enabled by an Application Programming Interface (API).

Enhanced visibility and usability of the HUD in day and night time conditions is also required. Sharp, high brightness displays are sought which can present high contrast imagery even in sunny day desert conditions. Technology approaches to providing visible to SWIR light imagery from clear to dark conditions is desirable. Any such technologies should ideally present no haze or distortion to the end user and not infer undesirable polarization. Low system latency (e.g. able to effectively engage moving objects and to travel at high speeds without risking the wearer) and ability to adjust to changing light conditions are key to aid in effective transition from low to bright light conditions (e.g. entering and exiting an enclosed space or structure).

In summary, a Next Generation Tactical Wearable Night Vision Device is envisioned, with Specific Objectives as listed below. It is recognized that this objective vision may not be fully realizable during the course of a Phase II SBIR. However, concrete and compelling hardware/software progress towards this vision is expected to be demonstrated.

- Form Factor and Appearance that blends with commercial sunglasses/eyewear, coverage of both eyes preferable
- Volume less than or equal to twice that of commercial sunglasses/eyewear
- Weight less than current visual augmentation systems
- Power greater than 24 hours run time on one charge, with power source included in weight metric
- Cost of less than $5000 in volume of 1000 or more
- Visual Acuity of Snellen 20/20 at clear starlight to direct day sun over 90 degree vertical and 120 degree horizontal Field of View (FOV)
- Low latency (photon in to receipt by eye) of less than or equal to 2ms
- Supports interface with tactical computing elements and communications systems, to include the transmission of sound and video to other team members
- 6 Axis Inertial Measurement Unit, Compass, GPS
- Interoperable external data and power interfaces
- Withstand Military Specifications for environmental, EMI, and ballistics

An effective demonstration would make real progress across metrics in multiple technical areas as outlined, and deliver a substantial step forward in the usability and practicality of wearable military tactical night and all-condition viewing HUD technology described as an objective system.

PHASE I: Design a concept for a night and all-condition viewing HUD with advanced features as described. Develop an analysis of predicted performance, and define key component technological milestones. Establish performance goals in terms of parameters such as visual clarity and brightness; field of view; day, night and obscured condition visualization; image frame rate for effective soldier mobility; and size, weight and power (SWaP). In addition, provide a contrast with existing systems. Perform an initial mockup, possibly using 3D printed parts and/or solid models, showing that it is wearable. Phase I deliverables would include a description of the night and all-condition viewing HUD design and functions, performance assessment against existing approaches, and a risk reduction and demonstration plan.

PHASE II: Develop and demonstrate a prototype night and all-condition viewing HUD with advanced features including integrated broad-band infrared sensing. Construct and demonstrate the operation of a laboratory prototype HUD, which would have the core features needed to achieve robust, night and all-condition heads-up visualization capabilities. Exercise relevant software functions and exposure to different lighting conditions. Demonstrate shuttering technology. Perform additional analyses as needed to project eventual performance capabilities. Phase II deliverables would include a final design with all drawings, simulations and modeling results; one to two prototypes of the night and all-condition viewing HUD; software applications as needed; performance data compared with performance and environmental goals; and a schedule with financial data for program execution.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow section 7.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the offeror and/or the principal investigator (PI).

PHASE III: Night and all-condition viewing heads-up displays could become an integral component in commercial and security surveillance systems where wearable night vision technologies are currently used. Possible customers could include (but are not limited to): civilian law enforcement and commercial vehicle operation users for enhanced vision and SA during night-time and/or obscured vision conditions. Further, the Generation Tactical Wearable Night Vision could be applicable to first responder operations, including forest and urban firefighting, offering visual augmentation and situational awareness tools including display of team geo-location data.

Night and all-condition viewing heads-up displays could become an integral component in Department of Defense (DoD) and military Intelligence, Surveillance, and Reconnaissance (ISR) systems, where ground agent wearable night vision technologies are currently used. This technology could be used for (but is not limited to): forward operating bases (FOBs); general night-time military base surveillance; military ground vehicle operations for enhanced vision and SA during night-time and/or obscured vision conditions, as well as U.S. Border Patrol ground surveillance.

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[1] Biggs, K., Burris, M., Stanley, M. (2014). The Complete Guide to Night Vision, CreateSpace Independent Publishing Platform, p. 33-64

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[3] The EDU Photonics Handbook, available on online at http://www.photonics.com/EDU/Handbook.aspx?AID=25134

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KEYWORDS: Day/Night; All Condition Visibility; Augmented Reality; AR; Heads-Up Display; HUD; Infrared; SWIR; Night Vision