DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
15.C Small Business Technology Transfer (STTR)
Proposal Submission Instructions

Table of Contents

IMPORTANT NOTE REGARDING THESE INSTRUCTIONS

THESE INSTRUCTIONS ONLY APPLY TO PROPOSALS SUBMITTED IN RESPONSE TO DARPA 15.C PHASE I TOPICS.

Offerors responding to DARPA topics listed in Section 12.0 of this Solicitation must follow all the instructions provided in the DoD Program Solicitation AND the supplementary DARPA instructions contained in this section. The section/paragraph numbering in these instructions is intended to correspond with the section/paragraph numbering of the 15.C DoD Program Solicitation (http://www.acq.osd.mil/osbp/sbir/index.shtml).

1.0 INTRODUCTION

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA STTR 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 Technology Transfer (STTR) 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

System Requirements

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 15.C 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.

WARNING: The Corporate Official (CO) e-mail address (from the proposal coversheet) will be used to create a DARPA Extranet account. Updates to Corporate Official e-mail after proposal submission may cause significant delays to communication retrieval and contract negotiation (if selected). Additional information in section 4.0.

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 Program Solicitation.

4.0 PROPOSAL FUNDAMENTALS

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.

4.7/4.8 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 I award. See sections 4.7 and 4.8 of the DoD Program Solicitation for additional information.

4.10 Debriefing

DARPA will provide a debriefing to the offeror in accordance with Federal Acquisition Regulation (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 4.10 of the DoD Program Solicitation.

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.

Notification of 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 Program Solicitation.

4.11 Solicitation Protests

Interested parties may have the right to protest this solicitation by filing directly with the agency by serving the Contracting Officer (listed below) with the protest, or by filing with the Government Accountability Office (GAO). If the protest is filed with the GAO, a copy of the protest shall be received in the office designated below within one day of filing with the GAO. The protesting firm shall obtain written and dated acknowledgment of receipt of the protest.

Agency protests regarding the solicitation should be submitted to:
SBIR/STTR Solicitation Contracting Officer
WHS/Acquisition Directorate
1155 Defense Pentagon
Washington, DC 20301-1155
E-mail: E-mail: james.l.colachis.civ@mail.mil

Agency protests regarding the source 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

4.13 Phase I Award Information

a. Number of Phase I Awards. 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.

b. Type of Funding Agreement. DARPA Phase I awards will be Firm Fixed Price contracts.
c. Dollar Value. The maximum dollar value for a DARPA Phase I award shall not exceed $155,000.
d. Timing. The DoD goal for Phase I award is within 180 calendar days from the proposal receipt deadline. Phase I contract award may be delayed if the offeror fails to include sufficient documentation to support its cost proposal.

4.22 Discretionary Technical Assistance (DTA)

Offerors that are interested in proposing use of a vendor for technical assistance 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 20-page limit of the technical volume and will NOT be evaluated.
3. Enter the total proposed DTA cost, which shall not exceed $5,000, 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.

DTA requests must be explained in detail with the cost estimate. 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).

Approval of technical assistance is not guaranteed and is subject to review of the Contracting Officer. Please see section 4.22 of the DoD Program Solicitation 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.

5.4.c.(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 DoD 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

Complete proposals must contain the following elements. Incomplete proposals will be rejected.

____1. Volume 1: Completed Coversheet.
____ a. Completed and checked for accuracy.
____ b. Costs for the base and option (if proposed) are clearly separate and identified on the Proposal Cover Sheet.
____2. Volume 2: Technical Volume.
____ a. Numbered all pages of the proposal consecutively. The cover sheets are pages 1 and 2. The technical volume begins on page 3.
____ b. Font type is no smaller than 10-point on standard 8½" x 11" paper with one-inch margins. The header on each page of the technical proposal contains the company name, topic number and proposal number assigned by the DoD SBIR/STTR Electronic Submission Web site when the cover sheet was created. The header may be included in the one-inch margin.
____c. Include documentation required for Discretionary Technical Assistance (if proposed).
____d. The technical volume does not exceed twenty (20) pages. Any page beyond 20 will be redacted prior to evaluations.
____3. Volume 3: Cost Volume.
____a. Used the online cost proposal.
____b. Subcontractor, material and travel costs in detail. Used the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information, if necessary.
____c. Costs for the base and option (if proposed) are clearly separate and identified in the Cost Volume.
____d. Base effort does not exceed $100,000 or $105,000 if DTA services are proposed.
____e. Option (if proposed) does not exceed $50,000.
____f. If proposing DTA, cost submitted in accordance with instructions in section 4.22 and does not exceed $5,000.
____4. Volume 4: Company Commercialization Report
____a. Completed and checked for accuracy. Follow requirements specified in section 5.4(e).
____5. Submission
____a. Upload four completed volumes: 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 28, 2015.
____b. 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 (see section 4.15).
____c. Submit your proposal before 6:00 AM (ET) on October 28, 2015. DARPA will NOT accept proposals that have NOT been submitted by the solicitation deadline.

6.0 PHASE I EVALUATION CRITERIA

Phase I proposals will be evaluated in accordance with the criteria in section 6.0 of the DoD Program Solicitation.

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 Agreements 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".

Advocacy Letters

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. Phase I awards and options are subject to the availability of funds.

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.

11.0 CONTRACTUAL CONSIDERATIONS

11.1(r) 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 Program Solicitation 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 Program Solicitation 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 Program Solicitation.

DARPA STTR 15.C Topic Index

DARPA STTR 15.C Topic Descriptions

ST15C-001 TITLE: Real-time Tabletop X-ray Nanoscope

TECHNOLOGY AREA(S): Electronics, Materials/Processes

OBJECTIVE: Design and develop a tabletop-scale, real-time nanoscope for three-dimensional imaging with ~13 nanometer spatial resolution.

DESCRIPTION: There is a critical DoD need for the development of next generation microelectronics along with the supporting metrology infrastructure for their cost- effective fabrication. Maintaining state-of-the-art microelectronics is key to future DoD technology dominance. New sources of soft x-ray and extreme ultraviolet radiation are key to the development of nondestructive imaging technologies necessary for nanometrology in support of extreme ultraviolet photolithography and ultimately for an understanding of nanoscale phenomena in fields as diverse as next generation electronics and subcellular biological structure and function. Properties such as short wavelengths allowing for high spatial resolution, deep sample penetration depth, and elemental specificity deployed in nondestructive imaging modalities without invasive sample preparation have been exploited in laboratory proof-of-concept demonstrations. However, bright sources with imaging capabilities at or below ~13 nm are largely limited to user facility-scale synchrotrons and free electron lasers, limiting the wider impact of soft x-ray/extreme ultraviolet imaging and spectroscopy. Recent advances in efficient generation of laser-driven, high flux soft x-ray and extreme ultraviolet radiation [1,2] and efficient x-ray/extreme ultraviolet imaging modalities [3] demonstrate that the required performance specifications for a ~13 nm spatial resolution nanoscope with table-top form factor are now within reach.

PHASE I: Design a tabletop-scale nanoscope for real-time imaging at ~13 nm spatial resolution. Source wavelength should also be at or below 13 nm (i.e. for actinic mask inspection). Source design parameters, including soft x-ray/extreme ultraviolet flux, efficiencies, and imaging modality/acquisition should be driven by the requirements for:
1. Real-time three-dimensional image acquisition (including both data acquisition and image processing). Proposers should quantitatively define real-time image acquisition and update speed/frame rate in the context of the proposed design;
2. Adaptability for imaging a variety of specimens in multiple environments: i.e., the nanoscope technology should be agnostic to the imaged sample without requiring invasive sample preparation to the extent possible. Specific samples of interest include, but are not limited to, nanostructured electronics under test or cryogenically cooled, unsectioned biological samples, requiring large working distances of several centimeters and wide field of view, as well as the ability to image internal/buried structures in thick, >1 micron, samples. Proposers may identify additional applications and specimens for imaging.

Proposers may also identify applications beyond single wavelength imaging to exploit source coherence, spectral tunability (chemically selective/hyperspectral imaging and spectroscopy), and temporal resolution for ultrafast dynamics.

Phase I deliverables include a design review (soft x-ray/extreme ultraviolet source, sample staging/imaging apparatus, imaging modality and associated image acquisition electronics) including expected design performance and a report presenting Phase II plans. Experimental data demonstrating feasibility of the proposed device is favorable.

PHASE II: Fabricate and test a prototype device demonstrating the performance outlined in Phase I. The Phase II prototype must integrate all key subsystems and demonstrate performance in a tabletop-scale form factor at Technology Readiness Level 4: component/subsystem validation in a laboratory environment.

Phase II deliverables include validation of device performance by imaging a sample nanostructured semiconductor specimen provided by or arranged for by DARPA with spatial resolution and frame rate as defined in the Phase I

report. Selected teams will work with the DARPA program manager to arrange for delivery and test of validation samples.

PHASE III DUAL USE APPLICATIONS: Given the large demand for x-ray microscopy at x-ray free electron lasers and third generation synchrotrons, the proposed tabletop nanoscope will serve as a prototype for commercial systems to be installed directly into the user's laboratory or industrial facility. The application space for nanoscale microscopy includes fields as diverse as biology (subcellular imaging), electronics (semiconductor devices), and materials science (fracture and crack formation, engineered microstructures). The push for extreme ultraviolet photolithography, for example, has resulted in the installation of microscope beamlines for mask inspection at synchrotron sources (SEMATECH Berkeley Actinic Inspection Tool at the Advanced Light Source [4] and the EUV Microscope at NewSUBARU [5]).

The DoD will directly benefit from the new physical insights made possible by the development of tabletop-scale nanoscopes with 13 nanometer resolution, leading to next generation microelectronics along with the supporting metrology infrastructure for their cost- effective fabrication. The introduction of x-ray/extreme ultraviolet nanoscopes into biology and biochemistry laboratories will enable a better understanding of pathogens on the subcellular level.

REFERENCES:
1. D. Popmintchev, et al., "Bright high order harmonic generation in a multiply ionized plasma up to the water window," CLEO: 2014 Postdeadline Paper Digest, OSA Technical Digest (online), paper FTh5A.9 (2014).

2. B. Reagan, et al., "High average power, 100 Hz repetition rate, tabletop soft x-ray lasers at sub 15 nm wavelengths," Phys. Rev. A 89, 053820 (2014).

3. M. Seaberg, et al., "Ultrahigh 22 nm resolution coherent diffractive imaging using a desktop 13 nm harmonic source," Opt. Exp. 19, 22470 (2011).

4. http://ait.lbl.gov/

5. http://www.lasti.u-hyogo.ac.jp/NS-en/facility/bl03/

KEYWORDS: x-ray microscope, soft x-ray, extreme ultraviolet, x-ray imaging, x-ray laser, coherent diffractive imaging, nanoscope

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ST15C-002 TITLE: Analog Co-Processors for Complex System Simulation and Design

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

OBJECTIVE: Demonstrate that, in certain critical applications, analog processing architectures can significantly outperform the equivalent digital architectures and motivate the larger development and use of analog methods

broadly in defense systems.

DESCRIPTION: The efficient simulation of complex systems is of fundamental importance to the Department of Defense (DoD), the scientific community, and the commercial sector. However, today's digital computational architectures are in many cases ill-suited to the mathematical models that power these simulations. Recent research suggests that analog processors could be used in hybrid continuous-digital systems to accelerate computational problems that are intractable with current discrete variable encoding and serial processing.

The general purpose computer, conceived in the 1930's by Turing, was at first too large and slow to be practical in most applications. As late as the 1960's a mainstay of computation, particularly for controls and signal processing, was analog processing, first mechanical and then electrical. But by the 1970's the development of the digital integrated circuit, high capacity memory, and high level programming languages pushed analog computing into the background.

Nevertheless, because of analog computation's repertoire of rich primitives and its inherent parallel architecture, analog computation can still be far faster, more efficient, and more compact than digital computation for many applications. For example, an 8-bit multiplication of two currents in analog computation takes 4 to 8 transistors, whereas a parallel 8-bit multiply in digital computation takes approximately 3000 transistors. Furthermore, recent advances in op-amp performance (several Ghz) and re-configurability (introduction of the field programmable analog array) could commend analog processing for applications requiring high performance but constrained by low size, weight, and power.

Analog systems may have other important advantages over digital systems. First, as a natural solver of partial differential equations, the analog computer can be a much closer proxy to the actual physical processes that it is used to compute. This should mean that it is more effective at modeling "stiff" systems of equations (incompressible fluid flow, for instance) and should be much less affected by discretization errors. In addition, analog processing is immune to single event upsets, and may be less vulnerable to tampering.

This STTR seeks innovative approaches to demonstrate in actual hardware the ability of analog or hybrid-analog computation to outperform digital architecture employed in current applications. Such applications may include image processing, mathematical simulation of complex systems, parametric design exploration and optimization, etc. The demonstration may be as a standalone processor or as a coprocessor in a digital system and must be relevant to a national security problem.

PHASE I: Develop an analog architecture for efficient computation of partial differential equations. Identify the computational substrate and the physical dynamics of the structure that will encode or instantiate the analog representation. Describe how the analog processes will perform computation, and how the results will be measured. Define a target problem class informed by current computational and analytic limitations. Estimate the relative theoretical speedup versus best-in-class numerical or analytic alternatives, how the method scales to problem size/dimensionality, and any restrictions on the generalizability of the approach. Phase I deliverable is a final report documenting effort and results.

PHASE II: Demonstrate the key technical principles behind the proposed computational substrate. The demonstration should validate the predicted superior performance of the analog approach over a comparable digital approach and show the relevance of the demonstration to at least three real-world applications. The required deliverables for the end of Phase II include a prototype implementation of the techniques defined in Phase I and a final report that includes the demonstration system design and test results.

PHASE III DUAL USE APPLICATIONS: A successful Phase II demonstration will motivate a number of applications and insertions into commercial systems (natural language understanding, transportation optimization, power management, etc.).

A successful Phase II demonstration will enable a number of applications and insertions into defense systems (on-

board processing, space systems, automatic target recognition, etc.).

REFERENCES:
1. Sethumadhavan, S.; Roberts, R.; Tsividis, Y. "A Case for Hybrid Discrete-Continuous Architectures," Computer Architecture Letters, vol. 11, no. 1, pp. 1-4, 2012.

2. Rahul Sarpeshkar, “Analog Versus Digital: Extrapolating from Electronics to Neurobiology”, Neural Computation, vol. 10, no.7, pp.1601-1638, 1998.

KEYWORDS: analog, digital, array, massively parallel, optimization, signal processing

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