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

PHASE I Proposal Submission Instructions Pages 1-6
Phase II/Direct to Phase II Proposal Instructions Pages 7-22

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
(703) 526-4170
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 14.1SBIR 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.

2.0 SPECIFIC DARPA REQUIREMENTS

The solicitation has been EXTENSIVELY rewritten and follows the changes of the SBIR reauthorization. Please read the entire DoD solicitation and DARPA instructions carefully prior to submitting your proposal. **Please go to http://content.govdelivery.com/bulletins/gd/USSBA-4cada5# to read the SBIR Policy Directive issued by the Small Business Administration.**

3.0 DEFINITIONS

3.1 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 requirements.

3.2 Foreign National

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. Please note: A foreign national is anyone who is NOT a U.S. citizen. There are two primary sources of citizenship: birthright citizenship and naturalization. Additional information regarding U.S citizenship is available at http://travel.state.gov/law/citizenship/citizenship_782.html.

4.0 PROPOSAL FUNDAMENTALS

Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced. All communication from the DARPA will originate from the sbir@darpa.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

4.1 Classified Proposals

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

4.2 Debriefing

DARPA will provide a debriefing to the offeror in accordance with FAR Subpart 15.5. The notification letter referenced below (Information on Proposal Status) will provide instructions for requesting a proposal debriefing.

4.3 Notification of Proposal Receipt

After the solicitation closing date, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an e-mail with instructions for retrieving a proposal acknowledgement receipt from the DARPA SBIR/STTR Information Portal.

4.4 Information on Proposal Status

Once the source selection is complete, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an email with instructions for retrieving a letter of selection or non-selection from the DARPA SBIR/STTR Information Portal.

4.5 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 proposing firms will be notified of selection or non-selection status 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 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.

5.0 PHASE I PROPOSAL

5.1 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 ($150,000 maximum) must be submitted in detail online via the DoD SBIR/STTR submission system. Proposers that participate in this solicitation must complete the Phase I Cost Volume, not to exceed the maximum dollar amount of $100,000, 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).

5.2 Technical Assistance

In accordance with the Small Business Act (15 U.S.C. 632), DARPA will authorize the recipient of a Phase I SBIR award to purchase technical assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on-line data bases, for the purpose of assisting such concerns in—

A. making better technical decisions concerning such projects;
B. solving technical problems which arise during the conduct of such projects;
C. minimizing technical risks associated with such projects; and
D. developing and commercializing new commercial products and processes resulting from such projects.

If you are interested in proposing use of a vendor for technical assistance, you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one page description of the vendor you will use and the technical assistance you will receive. The proposed amount may not exceed $5,000 and the description should be included as the LAST page of the Technical Volume. This description will not count against the 20-page limit and will NOT be evaluated. Approval of technical assistance is not guaranteed and is subject to review of the contracting officer.

5.3 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.

5.4 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 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 January 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 proposers 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 for Phase I. 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 considered during the evaluation process.

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 upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

6.1 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 firms 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. Firms proposing a Direct to Phase II under the 14.1 Solicitation should continue to page 7 of these instructions.

8.0 CONTRACTUAL CONSIDERATIONS

8.1 Publication Approval (Public Release)

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. Visit http://dtsn.darpa.mil/fundamentalresearch/ to verify whether or not your award has a pre-publication review requirement.

8.2 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.

DIRECT TO PHASE II INSTRUCTIONS

(Phase I Instructions on Page 1)

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.

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Offerors responding to the DARPA topics listed in Section 12.0 of the DoD 14.1SBIR 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.

2.0 DEFINITIONS

2.1 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 requirements.**

2.2 Foreign National

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. Please note: A foreign national is anyone who is NOT a U.S. citizen. There are two primary sources of citizenship: birthright citizenship and naturalization. Additional information regarding U.S citizenship is available at http://travel.state.gov/law/citizenship/citizenship_782.html.

2.3 Human and/or Animal Use

Your topic may have been identified by the program manager as research involving Human and/or Animal Use. In accordance with DoD policy, human and/or animal subjects in research conducted or supported by DARPA shall be protected. Although these protocols were most likely not needed to carry out the Phase I, significant lead time is required to prepare the documentation and obtain approval in order to avoid delay of the Phase II award. Please visit http://www.darpa.mil/sbpo/docs/SBIR_STTRs_Human_Animal.pdf to review the Human and Animal Use PowerPoint presentation(s) to understand what is required to comply with human and/or animal protocols.

1. **Human Use:** All research involving human subjects, to include use of human biological specimens and human data, selected for funding must comply with the federal regulations for human subject protection. Further, research involving human subjects that is conducted or supported by the DoD must comply with 32 CFR 219, Protection of Human Subjects (http://www.access.gpo.gov/nara/cfr/waisidx_07/32cfr219_07.html) and DoD Directive 3216.02, *Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research* (http://www.dtic.mil/whs/directives/corres/pdf/321602p.pdf).
    - Institutions awarded funding for research involving human subjects must provide documentation of a current Assurance of Compliance with Federal regulations for human subject protection, for example a Department of Health and Human Services, Office of Human Research Protection Federal Wide Assurance (http://www.hhs.gov/ohrp). All institutions engaged in human subject research, to include subcontractors, must also have a valid Assurance. In addition, personnel involved in human subjects research must provide documentation of completing appropriate training for the protection of human subjects.
    - For all proposed research that will involve human subjects in the first year or phase of the project, the institution must provide evidence of or a plan for review by an Institutional Review Board (IRB) upon final proposal submission to DARPA. The IRB conducting the review must be the IRB identified on the institution's Assurance. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. Consult the designated IRB for guidance on writing the protocol. The informed consent document must comply with federal regulations (32 CFR 219.116). A valid Assurance along with evidence of appropriate training for all investigators should accompany the protocol for review by the IRB.
    - In addition to a local IRB approval, a headquarters-level human subjects regulatory review and approval is required for all research conducted or supported by the DoD. The Army, Navy or Air Force office responsible for managing the award can provide

guidance and information about their component's headquarters-level review process. Note that confirmation of a current Assurance and appropriate human subjects protection training is required before headquarters-level approval can be issued.

- The amount of time required to complete the IRB review/approval process may vary depending on the complexity of the research and/or the level of risk to study participants. Ample time should be allotted to complete the approval process. The IRB approval process can last between one to three months, followed by a DoD review that could last between three to six months. No DoD/DARPA funding can be used towards human subjects research until ALL approvals are granted.

2. **Animal Use:** Any Recipient performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling and use in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Act of 1966, as amended, (7 U.S.C. 2131-2159); (ii) the guidelines described in National Institutes of Health Publication No. 86-23, "Guide for the Care and Use of Laboratory Animals"; (iii) DoD Directive 3216.01, "Use of Laboratory Animals in DoD Program."
    - For submissions containing animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the PHS Policy on Humane Care and Use of Laboratory Animals, available at http://grants.nih.gov/grants/olaw/olaw.htm.
    - All Recipients must receive approval by a DoD certified veterinarian, in addition to an IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the USAMRMC Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the Recipient will be required to complete and submit an ACURO Animal Use Appendix, which may be found at: https://mrmc-www.army.mil/index.cfm?pageid=Research_Protections.acuro&rn=1.

3.0 PROPOSAL FUNDAMENTALS

Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced. All communication from the DARPA will originate from the mailto:sbir@darpa.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

3.1 Classified Proposals

DARPA topics are unclassified; however, the subject matter may be considered to be a "critical technology" and therefore subject to ITAR restrictions. See **Export Control** requirements above in Section 2.1.

3.2 Debriefing

DARPA will provide a debriefing to the offeror in accordance with FAR Subpart 15.5. The notification letter referenced below (Information on Proposal Status) will provide instructions for requesting a proposal debriefing.

3.3 Notification of Proposal Receipt

After the solicitation closing date, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an e-mail with instructions for retrieving a proposal acknowledgement receipt from the DARPA SBIR/STTR Information Portal.

3.4 Information on Proposal Status

Once the source selection is complete, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an email with instructions for retrieving a letter of selection or non-selection from the DARPA SBIR/STTR Information Portal.

3.5 Phase II Award Information

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. 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 II awards are typically Cost-Plus-Fixed-Fee contracts.
   - Offerors that choose to collaborate with a University must highlight the research activities that are being performed by the University and verify that the work is FUNDAMENTAL RESEARCH.
   - Offerors are strongly encouraged to implement a government acceptable cost accounting system during the Phase I project to avoid delay in receiving a Phase II award. Phase II contractors MUST have an acceptable system to record and control costs, including procedures for job costing and time record keeping. Items such as overhead and G&A rates WILL require logical supporting documentation during the DCAA review process. Visit www.dcaa.mil and download the "Information for Contractors" guide for more information.
   - Offerors that are unable to obtain a positive DCAA review of their accounting system, may on a case-by-case basis, at the discretion of the Contracting Officer, be awarded a Firm Fixed Price Phase II contract or an Other Transaction (OT). Visit http://www.darpa.mil/sbpo/ot/index.html for more information on Other Transactions.
c. Average Dollar Value. The table under section 4.7 (d) provides the applicable Phase II funding threshold for solicitations 12.3 through 14.B. If your Phase I award originated from a solicitation that is not listed, you may look up prior solicitations here: http://www.acq.osd.mil/osbp/sbir/solicitations/archives.shtml.
d. Timing. Across DoD, the median time between DoD's receipt of a Phase II proposal and the award of a Phase II contract is six months when the firm has an adequate accounting system.

4.0 PHASE II PROPOSAL

4.1 Introduction

The DoD electronic submission site (www.dodsbir.net/submission) is designed to reduce the time and cost required to prepare a formal proposal. Carefully review the guidance on allowable content.

A complete proposal consists of four volumes:

Volume 1: Proposal Cover Sheet

Volume 2: Technical Volume
Volume 3: Cost Volume
Volume 4: Company Commercialization Report

The electronic submission site provides a structure for providing these four sections but the offeror must begin entering its proposal by providing information for the Proposal Cover Sheet.

After the offeror saves the draft Proposal Cover Sheet, the system will assign a proposal number. Please make note of this proposal number and print it for future reference. Remember to click the "Submit" button when you are done preparing your proposal. It is the offeror's responsibility to verify that the Technical Volume does not exceed the page limit after upload to the DoD SBIR/STTR Submission site by clicking on the "Verify Technical Volume" icon.

4.2 Proposal Provisions

Submitting Identical/Similar Proposals

IMPORTANT -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies as early as possible. If a proposal submitted for a Phase II effort is substantially the same as another proposal that was funded, is now being funded, or is pending with another Federal Agency, or another or the same DoD Component, you must reveal this on the Cover Sheet and provide the information required in Section 4.7.c(9).

Awards by other Agencies

Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds, Head of Agency Determinations are now required before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact your original sponsoring agency before submitting a Phase II proposal to an agency other than the one who sponsored the original topic.

Transition from SBIR to STTR (or vice versa)

Section 4(b)(1)(i) of the SBIR and the STTR Policy Directives provide that, at the agency's discretion, projects awarded a Phase I under a FY13 solicitation (and beyond) for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact their designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. Agency disapproval of a request to change programs shall not be grounds for granting relief from any contractual performance requirement. All approved transitions between programs must be noted in the Phase II award or award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

Phase II Option

DARPA has implemented the use of a SBIR Phase II Option that may be exercised at the DARPA Program Manager's discretion to continue funding SBIR Phase II activities that will further mature the technology for insertion into a larger DARPA Program, DoD Acquisition Program, other Federal agency,

or commercialization into the private sector. The statement of work for the SBIR Phase II Option MUST be included with the Phase II technical volume and should describe Phase II activities, over a 12 month period, that may lead to the successful demonstration of a product or technology. The statement of work for the option counts toward the 40-page limit for the Phase II technical volume. If selected, the government may elect not to include the option in the negotiated contract.

Technical Assistance

In accordance with the Small Business Act (15 U.S.C. 632), DARPA will authorize the recipient of a Phase II SBIR (from 13.1 solicitation and beyond) or STTR award (from 13.A solicitation and beyond) to purchase technical assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on- line data bases, for the purpose of assisting such concerns in:

- making better technical decisions concerning such projects;
- solving technical problems which arise during the conduct of such projects;
- minimizing technical risks associated with such projects; and
- developing and commercializing new commercial products and processes resulting from such projects.

If you are interested in proposing use of a vendor for technical assistance, you must provide a cost breakdown under "Other Direct Costs (ODCs)" of the Cost Volume and provide a one page description of the vendor you will use and the technical assistance you will receive as the LAST page of the Technical Volume. This description will not count against the 20-page limit and will NOT be evaluated. The proposed amount may not exceed $5,000 per year and a total of $10,000 per Phase II contract. Approval of technical assistance is not guaranteed and is subject to review of the contracting officer.

4.3 How to Submit

Each Phase II proposal must be submitted through the DoD Electronic Submission Web site by the deadline specified in your notification letter (available on the DARPA SBIR/STTR Information Portal, SSIP). Direct to Phase II Proposals submitted in response to this solicitation must be submitted by January 22, 2014. Each proposal submission must contain a Proposal Cover Sheet, Technical Volume, Cost Volume, and a Company Commercialization Report (see Section 4.7.e).

4.4 Commercialization Strategy

At a minimum, your commercialization strategy must address the following five questions:

(1) What is the first product that this technology will go into?
(2) Who will be the customers, and what is the estimated market size?
(3) How much money will be needed to bring the technology to market, and how will that money be raised?
(4) Does the company contain marketing expertise and, if not, how will that expertise be brought into the company?
(5) Who are the proposing firm's competitors, and what is the price and/or quality advantage over those competitors?

The commercialization strategy must also include a schedule showing the anticipated quantitative commercialization results from the Phase II project at one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.). After Phase II award, the company is required to report actual sales and investment data in its Company Commercialization Report (see Section 4.7.e) at least annually.

In addition, each Phase II proposal must contain a five-page commercialization strategy as part of the technical proposal, addressing the following questions:

1. Product Description/System Application – Identify the Commercial product(s) and/or DoD system(s) or system(s) under development or potential new systems that this technology will be/or has the potential to be integrated into.
2. Advocacy Letters** – Feedback received from potential Commercial and/or DoD customers and other end-users regarding their interest in the technology to support their capability gaps.
3. Letters of Intent/Commitment** – Relationships established, feedback received, support and commitment for the technology with one or more of the following: Commercial customer, DoD PM/PEO, a Defense Prime, or vendor/supplier to the Primes and/or other vendors/suppliers identified as having a potential role in the integration of the technology into fielded systems/products or those under development.
4. Business Models/Procurement Mechanisms/Vehicles – Business models, procurement mechanisms, vehicles and, as relevant, commercial channels, and/or licensing/teaming agreements you plan to employ to sell into your targeted markets.
    a. What is the business model you plan to adopt to generate revenue from your innovation?
    b. Describe the procurement mechanisms, vehicles and channels you plan to employ to reach the targeted markets/customers.
    c. If you plan to pursue a licensing model, what is your plan to identify potential licensees?
5. Market/Customer Sets/Value Proposition – Describe the market and customer sets you propose to target, their size, and their key reasons they would consider procuring the technology.
6. What is the current size of the broad market you plan to enter and the "niche" market opportunity you are addressing?
7. What are the growth trends for the market and the key trends in the industry that you are planning to target?
    a. What features of your technology will allow you to provide a compelling value proposition?
    b. Have you validated the significance of these features and if not, how do you plan to validate?
8. Competition Assessment – Describe the competition in these markets/customer sets and your anticipated advantage (e.g., function, performance, price, quality, etc.)
9. Funding Requirements – List your targeted funding sources (e.g., federal, state and local, private (internal, loan, angel, venture capital, etc.) and your proposed plan and schedule to secure this funding. Provide anticipated funding requirements both during and after Phase II required to:
    - mature the technology
    - as required, mature the manufacturing processes
    - test and evaluate the technology
    - receive required certifications
    - secure patents, or other protections of intellectual property
    - manufacture the technology to bring the technology to market for use in operational environments
    - market/sell technology to targeted customers
10. Sales Projections – Provide a schedule that outlines your anticipated sales projections and indicate when you anticipate breaking even.
11. Expertise/Qualifications of Team/Company Readiness - Describe the expertise and qualifications of your management, marketing/business development and technical team that will support the

transition of the technology from the prototype to the commercial market and into operational environments. Has this team previously taken similar products/services to market? If the present team does not have this needed expertise, how do you intend to obtain it? What is the financial history and health of your company (e.g., availability of cash, profitability, revenue growth, etc.)?

The commercialization strategy must also include a schedule showing the quantitative commercialization results from the Phase II project that your company expects to report in its Company Commercialization Report Updates one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc.).

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

4.5 Marking Proprietary Proposal Information

Offerors that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall:

1. Mark the first page of each Volume of the Submission with the following legend: “This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used or disclosed - in whole or in part - for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this offeror as a result of - or in connection with -the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained in pages [insert numbers or other identification of sheets]"; and
2. Mark each sheet of data it wishes to restrict with the following legend: "Use or disclosure of data contained on this page is subject to the restriction on the first page of this volume."

The DoD assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

Restrictive notices notwithstanding, proposals and final reports submitted through the DoD electronic submission website may be handled, for administrative purposes only, by support contractors. All support contractors are bound by appropriate non-disclosure agreements.

4.6 Direct to Phase II

15 U.S.C. §638(cc), as amended by NDAA FY12 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 14.1SBIR 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. You must 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, follow instructions specified within the topic).
3. Offerors DO NOT upload a Phase I cost volume.
4. The Phase I coversheet and applicable documentation must be submitted to http://dodsbir.com/submission by 6:00 (ET) on January 22, 2014.

STEP 2:

1. Offerors must submit a Phase II proposal using the DARPA Phase II proposal instructions in section 4.0 (beginning on page 9).
2. The Phase II proposal must be submitted by 6AM (ET) on January 22, 2014.

NOTE: 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.**

4.7 Phase II Proposal Instructions

a. Proposal Cover Sheet (Volume One)

On the DoD Electronic Submission Web site, (www.dodsbir.net/submission/SignIn.asp), prepare the Proposal Cover Sheet. The cover sheet must include a brief technical abstract of no more than 200 words that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. Do not include proprietary or classified information in the Proposal Cover Sheet. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released on the Internet. Once the Cover Sheets is saved, the system will assign a proposal number. You may edit the cover sheet as often as necessary until the solicitation closes.

b. Format of Technical Volume (Volume Two)

1. **Type of file:** The Technical Volume must be a single Portable Document Format (PDF) file, including graphics. Perform a virus check before uploading the Technical Volume file. Do not lock or encrypt the uploaded file.

2. **Length:** The Technical Volume is limited to 40 pages (and appendices not to exceed 20 pages).

3. **Layout:** Number all pages of your proposal consecutively. If a virus is detected, it may cause rejection of the proposal. Offerors must submit a direct, concise, and informative research or research and development proposal of no more than 40 pages (no type smaller than 10-point on standard 8-1/2" x 11" paper with one inch margins). The header on each page of the technical proposal should contain your company name, topic number, and proposal number assigned by the

DoD Electronic Submission Web site when the cover sheet was created. The header may be included in the one-inch margin.

c. Content of the Technical Volume (Volume Two)

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

1. **Significance of the Problem and Results of Phase I work.** Define the specific technical problem or opportunity addressed and its importance. Discuss the objective of the Phase I effort, the type of research conducted, findings or results of this research and technical feasibility. (Begin on Page 3 of your proposal.)

2. **Phase II Technical Objectives.** Enumerate the specific objectives of the Phase II work, and describe the technical approach and methods to be used in meeting these objectives.
   a) Phase II Statement of Work. The statement of work should provide an explicit, detailed description of the Phase II approach, indicate what is planned, how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.
   b) Phase II OPTION Statement of Work. The statement of work should provide an explicit, detailed description of the activities planned during the Phase II option, if exercised. Include how and where the work will be carried out, a schedule of major events and the final product to be delivered. The methods planned to achieve each objective or task should be discussed explicitly and in detail.

3. **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state of the art in the specific topic. Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number) and (3) date of completion.

4. **Relationship with Future Research or Research and Development.**
   i. State the anticipated results of the proposed approach if the project is successful.
   ii. Discuss the significance of the Phase II effort in providing a foundation for Phase III research and development or commercialization effort.

5. **Commercialization Strategy.** Each Phase II proposal must contain a five-page commercialization strategy as part of the technical volume describing the proposing firm’s strategy for commercializing this technology in DoD, other Federal Agencies and/or private sector markets. Provide specific information on the market need the technology will address and the size of the market. See section 4.4 for additional information.

6. **Key Personnel.** Identify key personnel who will be involved in the Phase II effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included. All resumes count toward the page limitation. Identify any foreign nationals you expect to be involved on this project, country of origin and level of involvement.

7. **Facilities/Equipment**. Describe available instrumentation and physical facilities necessary to carry out the Phase II effort. Items of equipment to be purchased (as detailed in the cost proposal) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices and handling and storage of toxic and hazardous materials.

8. **Subcontractors/Consultants.** Involvement of a university or other subcontractors or consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in the cost proposal. A minimum of one-half of the research and/or analytical work in Phase II, as measured by direct and indirect costs, must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer. SBIR efforts may include subcontracts with Federal Laboratories and Federally Funded Research and Development Centers (FFRDCs). A waiver is no longer required for the use of federal laboratories and FFRDCs; however, proposers must certify their use of such facilities on the Cover Sheet of the proposal. Subcontracts with other federal organizations are not permitted.

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

d. Cost Volume

A Phase II Cost Volume ($1,000,000 maximum) must be submitted in detail online via the DoD SBIR/STTR submission system. Proposers that submit a Phase II proposal must complete the Phase II Cost Volume, not to exceed the maximum dollar amount of $1,000,000. Offerors proposing a SBIR Phase II option must also submit a Phase II Option Cost Volume, not to exceed the maximum dollar threshold stated in the solicitation from which your Phase I award originated – see table (below).

Solicitation		FY 12.3	FY 12.B	FY 13.1	FY 13.A	FY 13.2	FY 13.3	FY 14.1/2/3	FY 14.B
BASE	Max Amount	$1M	$1M	$1M	$1M	$1M	$1M	$1M	$1M
	Duration	24 Months	24 Months	24 Months	24 Months	24 Months	24 Months	24 Months	24 Months
OPTION	Max Amount	$500K	N/A	$500	$500K	$500	$500K	$500K	$500
	Duration	24 Months	N/A	12 Mon	12 Months	12 Mon	12 Months	12 Months	12 Mon

Complete the cost proposal in the format shown in the Cost Breakdown Guidance using the on-line cost volume form on the DoD Electronic Submission Web Site (with detailed backup included in the Technical Volume). Some items in the Cost Breakdown Guidance may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that

enough information be provided to allow DARPA to understand how the proposer plans to use the requested funds if the contract is awarded.

1. List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
2. Special tooling and test equipment and material cost may be included. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
3. Cost for travel funds must be justified and related to the needs of the project.
4. Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase II proposal.
5. A Phase II Option, if applicable, (SBIR ONLY) should be fully costed separately from the Phase II (base) approach. The on-line cost volume DOES NOT count against the 40 page limit.

Offerors are REQUIRED to use the online Cost Volume (available on the DoD SBIR/STTR submission site) for the Phase II and Phase II Option costs. Additional details and explanations regarding the Cost Volume may be uploaded as an appendix to the technical volume. The Cost Volume (and supporting documentation) DOES NOT count toward the 40-page limit of the Technical Volume. Phase II awards and options are subject to the availability of funds.

When a proposal is selected for award, the proposer should be prepared to submit further documentation to its DoD contracting officer to substantiate costs (e.g., a brief explanation of cost estimates for equipment, materials, and consultants or subcontractors). For more information about the Cost Volume and accounting standards, see the DCAA publication called "Information for Contractors" available at www.dcaa.mil.

e. Company Commercialization Report (CCR)

If your firm is submitting a Phase II proposal, it is required to prepare a CCR through the password-protected DoD Electronic Submission Web Site (www.dodsbir.net/submission). If you submit a proposal, you must submit a CCR whether or not you have previously received SBIR or STTR awards. As instructed on the Web Site, list in the Report the quantitative commercialization results of your firm's prior Phase II projects, including the items such as sales revenue, additional investment, as well as other information relative to your firm's commercialization track record. All prior Phase II projects must be reported, regardless of whether the project has any commercialization to date. The Web Site will then compare these results to the historical averages for the DoD SBIR Program to calculate a Commercialization Achievement Index (CAI) value. Only firms with four or more completed Phase II projects will receive a CAI score; otherwise the CAI is N/A. Firms with a CAI at the 20th percentile or below may receive no more than half of the evaluation points available for commercial potential criteria. This report need only be prepared once and submitted with all your proposals.

As noted on the Web Site, your firm may also, at its option, include at the end of the Report additional, explanatory material (no more than five pages) relating to the firm's record of commercializing its prior SBIR or STTR projects, such as: commercialization successes (in government and/or private sector markets) that are not fully captured in the quantitative results (e.g. commercialization resulting from your firm's prior Phase I projects); any mitigating factors that could account for low commercialization; and

recent changes in the firm's organization or personnel designed to increase the firm's commercialization success. The CCR and additional explanatory material (if any) will not be counted toward the page limit for Phase II proposals. A Report showing that a firm has received no prior Phase II awards will not affect the firm's ability to obtain a SBIR or STTR award.

4.8 Appendix Format

An Appendix contains information that is non-essential to understanding of the proposal, but may present information that further clarifies a point without burdening the body of the technical proposal. An appendix is optional. Each Appendix should be identified by a Roman numeral in sequence, e.g., Appendix I, Appendix II, etc. Each appendix should contain different material. The appendix footer should contain the page number (following the sequence used for the entire proposal) and the appendix label (ex. Appendix I). Please note, only that information provided in the technical proposal (pg. 1-40, including coversheets, cost volume and CCR) will be considered by the evaluator. Evaluator review of any appendix material is optional.

4.9 Modifications or Withdrawal of Proposals

Modification

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

Withdrawal

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

4.10 Phase II Proposal Checklist

The Offeror's proposal should be in accordance with section 4.0. A complete proposal consists of four volumes:

Volume 1: Proposal Cover Sheet
Volume 2: Technical Volume
Volume 3: Cost Volume
Volume 4: Company Commercialization Report

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

____1. Number all pages of your proposal consecutively. The cover sheets are pages 1 and 2. The technical volume begins on page 3. Use no type smaller than 10-point on standard 8½" x 11" paper with one-inch margins. The header on each page of the technical proposal should contain your company name, topic number and proposal number assigned by the DoD Electronic Submission Web site when the cover sheet was created. The header may be included in the one-inch margin.
____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 worksheet for this information, if necessary.
____4. The effort does not exceed $1,000,000 and 24 months.
____5. SBIR PROPOSALS ONLY - The option does not exceed the threshold and duration stated in under section 4.7(d). 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.

____6. The technical volume does not exceed twenty (40) pages. Any page beyond 40 will be redacted prior to evaluations.
____7. Appendices do not exceed twenty (20) pages. An Appendix contains information that is non-essential to understanding of the proposal, but may present information that further clarifies a point without burdening the body of the technical proposal. An appendix is optional. Each Appendix should be identified by a Roman numeral in sequence, e.g., Appendix I, Appendix II, etc. Each appendix should contain different material. The appendix footer should contain the page number (following the sequence used for the entire proposal) and the appendix label (ex. Appendix I). Please note, only that information provided in the technical proposal (pg. 1-40, including coversheets, cost proposal and CCR) will be considered by the evaluator***. Evaluator review of any appendix material is optional.***
____8. 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 the deadline in your Phase II Invitation or Notification letter or January 22, 2014 for Direct to Phase II Offerors responding to the 14.1 Solicitation.
____9. 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.

4.11 Notification of Proposal Receipt

After the solicitation closing date, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an e- mail with instructions for retrieving a proposal acknowledgement receipt from the DARPA SBIR/STTR Information Portal.

4.12 Information on Proposal Status

Once the source selection is complete, the person listed as the "Corporate Official" on the Proposal Coversheet will receive an email with instructions for retrieving a letter of selection or non-selection from the DARPA SBIR/STTR Information Portal.

4.13 Retrieval of DARPA SBPO Communication

DARPA SBPO will automatically create an account on the DARPA SBIR/STTR Information Portal (SSIP) for the "Corporate Official" (CO) listed on the Proposal Coversheet. After you receive an e-mail notification alerting you that you have a communication available, you must login to the SSIP following the instructions in the e-mail notification. At this time ONLY the CO listed on the Proposal Coversheet is authorized to have an account in the SSIP. The CO username is generally the e-mail address and forgotten passwords may be obtained from the authentication page.

5.0 PHASE II EVALUATION CRITERIA

Phase II proposals will be evaluated based on the criteria outlined below. Selections will be based on best value to the Government considering the following factors which are listed in descending order of importance:

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

Evaluators will base their conclusions only on information contained in the proposal. It cannot be assumed that evaluators are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal and will count toward the page limit. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

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

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 upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

5.1 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.

6.0 CONTRACTUAL CONSIDERATIONS

6.1 External Certification Authority (ECA)

Effective for the 12.3 SBIR and 12.A STTR solicitations and thereafter, DoD mission partners under contract with DARPA who are not eligible to receive a Common Access Card (CAC) are required to obtain a digital certificate from an approved External Certification Authority (ECA) vendor within 90 days of contract award. DoD Instruction 8520.02 (Public Key Infrastructure (PKI) and Public Key (PK) Enabling, May 24, 2011) requires DoD mission partners to use certificates issued by the DoD ECA

program or a DoD-approved Public Key Infrastructure (PKI) when interacting with the DoD in unclassified domains.

NOTE: Offerors must include, in the ODC line, the cost of each ECA proposed to be purchased in order to be reimbursed for the cost of ECAs. Reimbursement is limited to a maximum of three ECAs per company. Offerors should consider purchasing the ECA subscription to cover the Phase II period of performance, to include the option year. Offerors will only be reimbursed for ECA costs once per subscription. Offerors that previously obtained a DoD-approved ECA may not be reimbursed under any potential SBIR Phase II contract. Likewise, offerors that are reimbursed for ECAs obtained as a requirement under an SBIR Phase II contract, may not be reimbursed again for the same ECA purchase under any subsequent government contract.

6.2 Publication Approval (Public Release)

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. Visit http://dtsn.darpa.mil/fundamentalresearch/ to verify whether or not your award has a pre-publication review requirement.

6.3 Phase II Reports

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

DARPA SBIR 14.1 Topic Index

SB141-001	Superconducting Nanowire Single-Photon Detectors
SB141-002	Tools for Advancing Neural Modulation
SB141-003	Compact Cryogenic Generator for Electronic Applications
SB141-004	Portable Microwave Cold Atomic Clock
SB141-005	Feature Based Localization and Navigation for Miniature Underwater Vehicles

DARPA SBIR 14.1 Topic Descriptions

SB141-001 TITLE: Superconducting Nanowire Single-Photon Detectors

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: To develop nanowire single-photon detectors of shortwave infrared light with high system efficiency (>90%) and bandwidth (~1 GHz), high fabrication yield, and with compact (~5U) packaging and turnkey operation.

DESCRIPTION: Single photon sensitive detectors have many applications including active and passive imaging, traditional and upcoming quantum optical communications, and quantum information processing. For quantum key distribution in fibers, for instance, the noise properties of the detectors limit the distance over which one can establish a secure key. Similarly, for 3D imaging via LADAR, longitudinal resolution is limited by the detector jitter while the detector sensitivity dictates the trade-off between illumination power and maximum range. Therefore, a high-bandwidth, high-sensitivity, compact and readily available photon-counting detector is a key technology for many future scientific developments and improved DoD application capabilities.

Technologies for detecting single photons in the telecom band include semiconductor devices such as Geiger-mode InGaAs avalanche photodiodes (APDs) and superconducting devices like the transition edge sensor (TES). The InGaAs APDs can be operated at temperatures accessible via thermoelectric cooling, making them ideal for applications requiring compact photon-counting solutions. InGaAs APDs, however, are typically plagued by after-pulsing effects, making them ill-suited for applications requiring high duty-cycle and high-rate detection [1]. Extremely high efficiency and low dark counts can be achieved with superconducting TES detectors, but the rates are limited to less than 10 MHz and the systems must be operated in the 100 mK regime requiring an extensive cooling overhead [2]. New results in superconducting nanowire devices [3] have shown that high detection rates, low dark-count rates (DCRs), and high efficiency are all possible simultaneously with operating temperatures between 1 and 4 K. Despite these results, further performance improvements are needed. For example, detection efficiency (DE) above 90% and bandwidth (BW) approaching 1 GHz has yet to be achieved simultaneously. In addition, innovations leading to a reduction in the system footprint and improved operability will provide better accessibility of such technologies to the relevant scientific and engineering communities.

The goal of this SBIR project is to further improve upon the current state-of-the-art in nanowire single-photon detector performance while advancing the supporting technologies to allow for a compact, turn-key commercial system. The final system should provide multiple (>2), independent single-pixel detectors with performance superior to all current commercially available options (DE>90%, BW~1GHz, DCR< 1 Hz) in a ~5U 19™ rack-mount package. To achieve these goals, work under this SBIR may include the following: efforts to increase fabrication yields through the use of new materials or fabrication techniques, new device designs to improve bandwidth and sensitivity, efforts to reduce system SWaP through compact, application-specific cooling systems, electronics, and packaging.

PHASE I: Develop an initial concept design and model through computer simulations key elements of the proposed nanowire single-photon detection system. Demonstrate detector development capability by fabricating and testing system parts with performance indicative of a final system achieving the SBIR goals. Exhibit the feasibility of the approach through a laboratory demonstration of the critical system components. Phase I deliverables will include a design review including quantitative justification for the expected system performance and a report presenting the plans for Phase II.

PHASE II: Construct and demonstrate the operation of a prototype system validating the performance metrics outlined in Phase I. The final system should be near turn-key and demonstrate all relevant performance characteristics including the SWaP. The Transition Readiness Level to be reached is 5: Component and/or bread-board validation in relevant environment.

PHASE III: The detectors developed under this SBIR will have applications for the DoD which include secure communications and active stand-off imaging systems. The improved availability and SWaP will allow the use of these detectors in all relevant government labs and open the door to new fieldable systems. For example, low

power, portable optical communication links exceeding RF system bandwidths by 10-100x may be possible using the technology developed under this SBIR [4,5].

The technology developed as a consequence of this effort will have applications which span both DoD and non-DoD areas. One application particularly suited to the private sector is the analysis of integrated circuits (IC). Failure analysis via optical means is known to provide specific information about the operation of individual IC elements. Higher speed and sensitivity of detection leads to higher throughput for such diagnostic systems. Additionally, the technology developed under this SBIR may be integrated into commercially manufactured DoD products such as LADAR and optical communication systems.

REFERENCES:
1. A. Restelli et al., "Single-photon detection efficiency up to 50% at 1310 nm with an InGaAs/InP avalanche diode gated at 1.25 GHz," App. Phys. Lett. 102, 141104 (2013).

2. A. Lita et al., "Counting near-infrared single-photons with 95% efficiency," Opt. Exp. 16, 3032 (2008).

3. F. Marsili et al., "Detecting single infrared photons with 93% system efficiency," Nat. Phot. 7, 210 (2013).

4. M. L. Stevens et al., "High-data-rate photon-counting optical communications using a NbN-nanowire superconducting detector," CLEO/QELS (2006).

5. M. Shaw et al., "Tungsten Silicide Superconducting Nanowire Arrays for the Lunar Laser OCTL Terminal," CLEO/QELS (2013).

KEYWORDS: Detectors, Single photon detectors, Super conducting nanowire single photon detectors, WSi, NbN, LIDAR, LADAR, Optical communications, Photon counting

SB141-002 TITLE: Tools for Advancing Neural Modulation

TECHNOLOGY AREAS: Biomedical

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 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.

ACQUISITION PROGRAM: Regenerative & Restorative Medicine Management Team (RRMMT) U.S. Army Medical Materiel Development Activity (USAMMDA)

OBJECTIVE: Improve the ability to interrogate and ultimately modulate the neural influences of inflammation and immune function by enabling the design of new discovery tools that probe the bioelectrical states of human cells.

DESCRIPTION: Today’s warfighter is subject to a wide range of physical demands that include significant musculoskeletal stress and injury related to heavy equipment and gear, high physical exertion in tactical environments, and potential exposure to a variety of known and emerging pathogens and toxins. These external stressors typically elicit acute and/or chronic inflammatory responses as the body initiates the healing process. Advances at the interface of the nervous and immune systems are critical to understanding inflammation and ultimately optimizing human performance via the reduction of inflammation.

While the nervous and immune systems were previously thought to serve and act distinctly, a picture of an integrated communication and protective system is beginning to emerge (1). Recent developments in neurophysiology and immunology have begun to make the connection between neural reflexes and

inflammation/immunity (2). Better descriptions of the ways in which peripheral neurons interact with immune cells may enable a more comprehensive understanding of inflammation, leading to potential therapies or approaches to speed healing. Additionally, the development of techniques to track and functionally manipulate ion flows in cells has started to elucidate the possible roles of voltage gradients in the regulation of cell behaviors (3). Bioelectrical cell signaling studies are already providing insights in developmental and cancer biology (4, 5), and further technological advancements in the field would enable the characterization of the neural/immune interface.

Microelectrodes are powerful tools for quantitative, real-time, single- and multi-cell electrophysiology that require direct physical contact, which can limit their utility for various types of measurement. Additionally, they are limited in terms of spatial resolution and the ability to localize bioelectric activity and structure at the same time. Furthermore, electrical methods are often designed to measure events that exceed action potential thresholds, whilst important bioelectric activity can occur at voltage levels below action potential thresholds. Ideal tools for bioelectric measurements would offer sub-cellular resolution, high contrast, high dynamic range, and the ability to probe large fields of view with many cells in real-time. Current optical methods have advantages, yet also suffer in sensitivity (signal to noise) and require temporal averaging, thereby reducing temporal resolution. Thus, efforts to measure important bioelectric codes that guide cell fate and influence immunity still suffer from trade-offs in spatial, temporal, and voltage resolution, as well as the ability to record many cells and structures simultaneously.

This solicitation calls for the development of new voltage- and/or field-sensitive dyes designed to probe the bioelectrical states of cells in neural as well as non-neural systems. Commonly available voltage dyes focus on calcium signaling and provide insight into fast processes (millisecond timescale). Certain bioelectrical interrogations may benefit from different chemistries and timescales, as well as the ability to detect sub-threshold activation of neurons and other cells, thereby requiring a finer voltage (and/or electric field) resolution. Additional challenges with current state-of-the-art voltage dyes include high cost for the volume of dye typically required for in vivo studies, low contrast, and low signal-to-noise ratios.

Recent examples of methods with promise to improve performance for voltage and field sensing include fluorescence resonance energy transfer (FRET) probes, voltage-sensitive proteins, and other nanoparticles such as quantum dots and NV-diamonds. Combined with new optical imaging approaches that offer unprecedented fields of view at sub-cellular resolution, successful advancements in probe technology will enable transition to academic, government, and commercial researchers to propel the field by offering, for example, lower cost, better stability, greater brightness, a broader range of absorption and emission wavelengths, higher voltage/field resolution, calibration simplicity, and increased specificity in targeting of cell regions.

PHASE I: Design a new voltage-sensitive probe that addresses at least one of the following technical challenges for measuring bioelectrical states of cells in neural as well as non-neural systems:
a) Improvement of voltage and/or electric field resolution to detect sub-threshold activation of neurons and other cells (e.g., approach the ability to report differences of several mV).
b) Ability to probe at longer (seconds to minutes) or shorter (microseconds) timescales than currently available (milliseconds).
c) Extension to multiple cell types and/or specific cell regions not currently accessible.

Phase I deliverables will include a technical report detailing the experiments and results supporting the successful demonstration of a new voltage-sensitive probe that meets the selected technical challenge. Phase I deliverables will also include a Phase II transition plan for demonstrating sufficient reproducibility of the developed probe and potential research advancement to merit commercialization. The Phase II transition plan will include a description of the commercialization path, any barriers to market entry, and any identified early adoption partners.

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 4.0 of the DARPA Instructions.

PHASE II: Seek to finalize and validate the voltage-sensitive probe developed in Phase I and demonstrate the utility beyond currently available probes to address the selected technical challenge. Additionally, establish and describe

the market competitiveness of the new probe in the context of the combination of features that are desirable for a specific, defined application of the probe. This could include manufacture cost, probe stability, brightness, absorption and emission wavelength availability, sensitivity, and calibration simplicity.

If successful, Phase II deliverables will include a detailed technical profile of the new voltage-sensitive probe that fully illustrates the advanced capabilities for the selected challenge, establishes the desirable parameters that validates the probe as a viable tool, and describes the commercialization path.

PHASE III: The successful development of a new voltage-sensitive probe will enable a mechanistic understanding for modulating inflammation and immune function via neural interfaces. This capability is critical to understanding inflammation and its relation to human performance in order to address DoD challenges. The ultimate realization of the underlying technologies will advance healing and performance in the context of physical demands specific to the warfighter, including musculoskeletal stress and injury related to heavy equipment and gear, high physical exertion in tactical environments, and potential exposure to a variety of known and emerging pathogens and toxins.

The successful development of a new voltage-sensitive probe will propel advances in the biotechnology and pharmaceutical sectors with the end goal of understanding the bioelectrical underpinnings of inflammation and immunity to promote health and healing. Additionally, the ability to modulate the neural influences of inflammation and immune function has significant implications for a wide range of therapeutic and diagnostic applications in addition to healing and human performance. New probes are in demand that would have high impact for other areas of healthcare, including tumor detection, stem cell research, and regenerative medicine.

REFERENCES:
1. I. Chiu, C. von Hehn, and C. Woolf "Neurogenic inflammation and the peripheral nervous system in host defense and immunopathology," Nat Neuro 15(8), p.1063-7, 2012.

2. U. Andersson and K. Tracey. "Neural reflexes in inflammation and immunity," J Exp Med 209(6), p.1057-68, 2012.

3. A. Tseng and M. Levin. "Cracking the bioelectric code: Probing endogenous ionic controls of pattern formation," Comm & Int Bio 6(1), p.1-8, 2013.

4. L. Vandenberg, R. Morrie, and D. Adams. "V-ATPase-Dependent Ectodermal Voltage and pH Regionalization Are Required for Craniofacial Morphogenesis," Dev Dyn 240, p.1889-1904, 2011.

5. B. Chernet and M. Levin. "Transmembrane voltage potential is an essential cellular parameter for the detection and control of tumor development in a Xenopus model," Disease Mod & Mech 6, p. 595-607, 2013.

KEYWORDS: Biology, bioelectrical, inflammation, immunity, nervous system, voltage-sensitive probes, nanoparticles

SB141-003 TITLE: Compact Cryogenic Generator for Electronic Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 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.

OBJECTIVE: The objective of this SBIR is to develop and demonstrate a compact cryogenic generator capable of producing 1 L/hr of liquid nitrogen for use in electronics and optics cryogenic cooling applications. The entire

system should weigh no more than 5 kg, occupy no more than 0.1 m^3, require less than 0.75 kW to operate, and achieve a MTBF of at least 10^4 hours.

DESCRIPTION: Thermal management is a key barrier to enhanced performance of many defense electronic and optical systems and improvements in heat removal and temperature control are needed to realize the full potential of emerging electronics and optics technologies. Use of a cryogenic coolant could lead to dramatic improvements in performance through higher efficiency, switching speed, sensitivity, and/or output power for respective components. For example, CMOS transistor switching speeds at 80K are approximately twice the room temperature values and the efficiency of solid state laser diodes can be increased from 65% at room temperature to 85% at -50C.

The low liquid nitrogen production rate and large SWaP of current commercial cryogenic generators has prevented their broad use in defense electronic and optical systems. Yet, the delivery logistics and associated volume and weight limit the defense applications that can be met with stored liquid nitrogen. Thus, a compact, low SWaP cryogenic generator, capable of producing liquid nitrogen as needed in the field and/or on a mobile air, land, or sea platform, could find ready acceptance in the defense industry and in a broad range of commercial applications.

PHASE I: Design, build, and successfully demonstrate the operation of a laboratory prototype cryogenic generator capable of generating 1 L/hr of liquid nitrogen that weighs less than 10 kg and requires less than 1.5 kW of input power.

Required Phase I deliverables will include comprehensive device testing report, detailed design of the laboratory device, a description of the refrigeration cycle utilized in developing the generation capability and anticipated performance limits, and a comparison of the measured performance against the anticipated limits.

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 4.0 of the DARPA Instructions

PHASE II: Based on the performance achieved in the Phase I SBIR, design, build, and demonstrate the operation of a cryogenic generator capable of generating 1 L/hr of liquid nitrogen that weighs less than 5 kg, occupies less than 0.1 m^3, requires less than 0.75 kW of input power, has a predicted MTBF of 10^4 hours and is capable of being integrated into a selected platform. Conduct life-cycle and environmental testing, appropriate to a selected DoD platform and electronics application, including demonstration of at least 1000 hrs of continuous, failure-free operation in the appropriate pressure and temperature environment.

Required Phase II deliverables will include a working cryogenic generator at the TRL 6 level, a trade space analysis examining how the device can be scaled up or scaled down depending on future applications, and a comparison, along with analysis, of the predicted and measured performance characteristics.

PHASE III: The commercial/dual use applications would include utilizing this in high performance computer workstations, MRIs, SEMs, and other devices that require a steady supply of liquid nitrogen. For DoD purposes, this technology would be developed into the front end of a cryogenic cooling loop to be used for airborne, shipboard, or mobile electro-optics platforms, high performance computers, or other electronic or optical devices.

REFERENCES:
1. R.J. Krane, J.R. Parsons, and A. Bar-Cohen, “Design of a Candidate Thermal Control System for a Cryogenically Cooled Computer”, IEEE Transactions on Components, Hybrids, and Manufacturing Technology, vol. 11, no. 4, 545-556, 1988.

2. K. Linden, W. Neal, T. Ta, R. Feeler, and S. Ross, “Kilowatt CW cryogenic 940-nm laser diodes”, Photonics Technology Letters, vol. 22, 1452-1454, 2010.

KEYWORDS: Cryogenic cooler, liquid nitrogen, electronic cooling, laser cooling

SB141-004 TITLE: Portable Microwave Cold Atomic Clock

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 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.

OBJECTIVE: Develop a laser-cooled microwave atomic clock with small volume (< 1 L) and weight (< 1 kg), low power consumption (< 5 W), and the stability (10^-12 at 1 s) of a primary atomic frequency standard.

DESCRIPTION: Frequency and timing devices are essential components in modern military systems. The stability and accuracy of these devices impact the performance of communication, navigation, surveillance, and missile guidance systems. Atomic clocks are at the cores of many of these systems, either directly or via time-transfer from a master clock.

By employing techniques used in current laboratory atomic clocks, military clocks can be improved by orders-of-magnitude. Such clocks will enable secure data routing, communication systems that are insensitive to jamming, higher resolution coherent radar, and more reliable and robust global positioning.

Laser-cooled optical lattice atomic clocks are currently the world's most stable clocks, with stability below 10^-18 at 6 hours of averaging [1]. DARPA's QuASAR program aims to miniaturize and ruggedize such high-performance optical atomic clocks for deployment in the field [2]. While this work could enable widespread adoption of optical clock technology, many applications cannot tolerate the size, weight, and power (SWaP) of these first generation portable optical clocks (S > 50 L, W > 50 kg, P > 150 W). DARPA's Chip Scale Atomic Clock (CSAC) program has developed miniature microwave atomic clocks with extremely low SWaP values (S ~ 16 cm^3, W ~ 35 g, P ~ 125 mW) and good short-term stability (10^-10 at 1 sec) [3]. However these clocks drift over long timescales making them unsuitable for many applications.

The goal of this SBIR is to bridge the gap between these extremes by developing an atomic frequency standard with long term stability (< 5x10^-15 at 1 day), approaching that of laboratory frequency standards such as the NIST F1 microwave Cs fountain clock [4] but with reasonable SWaP values (S < 1 L, W < 1 kg, P < 5 W).

To achieve these goals, this SBIR will combine aspects of the two extreme clock architectures mentioned above: laser cooling (as used in QuASAR optical clocks) and microwave hyperfine transitions (as used in CSAC). Alternative strategies will also be considered if sufficiently justified. Special attention will need to be focused on reducing the power requirements of the requisite lasers, microwave sources, and local oscillators. Furthermore, the final device should be robust to environmental fluctuations (e.g. temperature, magnetic field, vibration) in a relevant operating environment.

PHASE I: Develop an initial design and model key elements of the proposed clock. The chosen work must be compatible with a fractional frequency stability of < 10^-12 at 1 second averaging and < 5x10^-15 for 1 day of averaging. It should have a size < 1 L, weight < 1 kg, and power consumption < 5 W. Develop a detailed analysis of the predicted performance in a relevant environment accounting for expected environmental fluctuations such as temperature, magnetic field, and vibration fluctuations. Exhibit the feasibility of the approach through a laboratory demonstration of critical components. Phase I deliverables will include a design review including expected device performance and a report presenting the plans for Phase II.

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 4.0 of the DARPA Instructions

PHASE II: Construct and demonstrate a prototype device validating the device performance outlined in Phase I. The Transition Readiness Level to be reached is 5: Component and/or bread-board validation in relevant environment.

PHASE III: The low SWaP of the clock developed in this program should enable widespread deployment of clocks with stability comparable to primary frequency standards. Such clocks could lead to more reliable and robust global positioning, synchronization and time-keeping in GPS-denied environments, secure data routing, communication systems that are insensitive to jamming, higher resolution coherent radar, and precision timekeeping. Potential commercial applications include precise synchronization of telecommunication networks for high-bandwidth communications, next-generation satellite atomic clocks for global positioning, and local clocks for very long-baseline interferometry.

REFERENCES:
1. Hinkley, N. et al. An atomic clock with 10^-18 instability. arXiv:1305.5869 (2013), http://arxiv.org/abs/1305.5869

2. QuASAR: Quantum Assisted Sensing and Readout: https://www.fbo.gov/index?s=opportunity&mode=form&id=9c912ae0743a9da465a18618bdc4d2a8&tab=core&_cview=0

3. Knappe, S. et al. A chip-scale atomic clock based on 87Rb with improved frequency stability. Opt. Express 13, 1249-1253 (2005).

4. NIST Primary Frequency Standards and the Realization of the SI Second. NCSL International Measure, Vol 2, No 4, 74 (2007) (http://tf.nist.gov/general/pdf/2039.pdf)

KEYWORDS: Clock, Atomic clock, Frequency standard, GPS, timekeeping, local oscillator, laser-cooling

SB141-005 TITLE: Feature Based Localization and Navigation for Miniature Underwater Vehicles

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Sensors

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 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.

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

OBJECTIVE: Develop reliable feature based localization capabilities for miniature underwater vehicles in shallow water environments. The system would combine accurate localization and mapping capabilities by utilizing miniaturized techniques such as onboard imagery sensors and inertial measurement sensors, e.g. sonar(s), lidars, enhanced cameras, and gyros. The system should allow a small undersea vehicle to perform an extended mission and return very close to the point of launch without surfacing. The system should be able to recognize naturally occurring features; optionally, man-made passive “features” could be emplaced along the path of the vehicle, but would need to be included in the overall system weight budget.

DESCRIPTION: One of the major challenges when deploying unmanned underwater vehicles (UUVs) is proper self-localization without available reference signals provided by, for example, Global Position System (GPS) or long baseline (LBL) acoustic positioning system. Present-day intelligence, surveillance and reconnaissance (ISR) missions often require the UUV to remain submerged for extended periods of time. Although ground velocity sensor systems such as Doppler Velocity Logs (DVLs) have been successfully designed and tested for large and medium scale vehicles, their deployment onboard small UUVs is often impractical for size, weight and power (SWaP) reasons.

One of the smallest, currently available DVLs on the market weighs 6+ lbs [1], and thus accounts for a large portion of the weight budget for a small UUV. Additionally, although the accuracy of velocity measurements has rapidly improved over the last decade, an error accumulation within the navigation solution is still unavoidable for long-endurance ISR missions due to the lack of true position feedback.

Recent advances in sonar technology have led to a significant reduction in hardware size and power consumption [2,3]. A trade- off for small sonar units exists in the relatively high frequency of the ping(s) leading to a limited maximum range of just a few hundred meters. However, for shallow water applications, sonar based navigation solutions may provide an alternative to and/or complement DVL technology by providing true position feedback. In particular, the detected range and bearing angle of features and/or landmarks within the field of view can be utilized to enhance the overall navigation solution via, for example, Simultaneous Localization and Mapping (SLAM) [4,5].

PHASE I: Develop a preliminary system design concept combining software and hardware components for a complete navigation solution. Study overall feasibility, derive the anticipated system performance metrics, and expose potential limitations. Conduct system level modeling and analysis to provide a proof of concept. Show improvement in SWaP and or navigational accuracy over existing approaches and equipment.

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 4.0 of the DARPA Instructions

PHASE II: Design, build and test the prototype navigation system and demonstrate performance metrics in a realistic underwater environment. Analyze the anticipated integration effort into existing and future UUV platforms.

PHASE III: Accurate navigation based on bottom features will minimize vehicle exposure on the surface and make the vehicle robust to GPS jamming. Accurate navigation is essential for a variety of unmanned undersea vehicle missions including ISR of harbors. A highly accurate underwater navigation system which is suitable for small UUVs would support a variety of commercial applications such as biological and chemical sampling, autonomous border or perimeter patrol, maintenance missions on underwater cables and pipelines, search and recovery operations, and natural resource surveys. Being able to go along the bottom and stay deep with a small affordable autonomous system would be a desirable commercial product.

REFERENCES:

1. LinkQuest Inc. NavQuest 600 Micro; The World's Smallest Doppler Velocity Log, 2009, see http://www.link-quest.com/html/NavQuest600M.pdf

2. Micron DST Sonar, see http://www.tritech.co.uk/product-category/imaging-sonars

3. Imagenex Ultra-Miniature Scanning Sonar, see http://www.imagenex.com/Downloads/What_s_New/852_Ultra-Miniature/852_ultra-miniature.html

4. Bailey, T and Durrant-Whyte, H, Simultaneous localization and mapping: part I,IEEE Robotics & Automation Magazine Vol: 13 Issue: 2 ISSN: 1070-9932. August 2006, Pages: 99-110

5. Bailey, T and Durrant-Whyte, H, Simultaneous localization and mapping: part II, IEEE Robotics & Automation Magazine Vol: 13 Issue: 3 ISSN: 1070-9932 Date: August 2006, Pages: 108-117

KEYWORDS: Undersea, unmanned, navigation, sonar, mapping, feature, localization