

**DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
16.1 Small Business Innovation Research (SBIR)
Proposal Submission Instructions**

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IMPORTANT NOTE REGARDING THESE INSTRUCTIONS

THESE INSTRUCTIONS ONLY APPLY TO PROPOSALS SUBMITTED IN RESPONSE TO DARPA 16.1 PHASE I TOPICS.

Offerors responding to DARPA topics listed in Section 12.0 of this Solicitation must follow all the instructions provided in the DoD Program Solicitation AND the supplementary DARPA instructions contained in this section. The section/paragraph numbering in these instructions is intended to correspond with the section/paragraph numbering of the 16.1 DoD Program Solicitation (<http://www.acq.osd.mil/osbp/sbir/index.shtml>).

1.0 INTRODUCTION

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

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

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Attention: DIRO/SBPO

675 North Randolph Street

Arlington, VA 22203-2114

sbir@darpa.mil

Home Page http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR.aspx

System Requirements

Use of the DARPA SBIR/STTR Information Portal (SSIP) is MANDATORY. Offerors will be required to authenticate into the SSIP (via the DARPA Extranet) to retrieve their source selection decision notice, to request debriefings, and to upload reports (awarded contracts only). DARPA SBPO will automatically create an extranet account for new users and send the SSIP URL, authentication credentials, and login instructions AFTER the 16.1 source selection period has closed. DARPA extranet accounts will ONLY be created for the individual named as the Corporate Official (CO) on the proposal cover sheet. Offerors may not request accounts for additional users at this time.

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

3.0 DEFINITIONS

3.4 Export Control

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

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

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

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

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

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

3.5 Foreign National

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

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

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

4.0 PROPOSAL FUNDAMENTALS

4.6 Classified Proposals

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

4.7/4.8 Human or Animal Subject Research

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

4.10 Debriefing

DARPA will provide a debriefing to the offeror in accordance with Federal Acquisition Regulation (FAR) 15.505. The source selection decision notice (reference 4.4 Information on Proposal Status) contains instructions for requesting a proposal debriefing. Please also refer to section 4.10 of the DoD Program Solicitation.

Notification of Proposal Receipt

Within 5 business days after the solicitation closing date, the individual named as the “Corporate Official” on the Proposal Cover Sheet will receive a separate e-mail from sbir@darpa.mil acknowledging receipt for each proposal received. Please make note of the topic number and proposal number for your records.

Notification of Proposal Status

The source selection decision notice will be available no later than **90 days after solicitation close**. The individual named as the “Corporate Official” on the Proposal Cover Sheet will receive an email for each proposal submitted, from sbir@darpa.mil with instructions for retrieving their official notification from the SSIP. Please read each notification carefully and note the proposal number and topic number referenced. The CO must retrieve the letter from the SSIP 30 days from the date the e-mail is sent. After 30 days the CO must make a written request to sbir@darpa.mil for source selection decision notice. The request must explain why the offeror was unable to retrieve the source selection decision notice from the SSIP within the original 30 day notification period. Please also refer to section 4.0 of the DoD Program Solicitation.

4.11 Solicitation Protests

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

Agency protests regarding the solicitation should be submitted to:

SBIR/STTR Solicitation Contracting Officer
WHS/Acquisition Directorate
1155 Defense Pentagon
Washington, DC 20301-1155
E-mail: james.l.colachis.civ@mail.mil

Agency protests regarding the source selection decision should be submitted to:

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

4.13 Phase I Award Information

- a. Number of Phase I Awards. DARPA reserves the right to select and fund only those proposals considered to be of superior quality and highly relevant to the DARPA mission. As a result,

DARPA may fund multiple proposals in a topic area, or it may not fund any proposals in a topic area.

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

4.22 Discretionary Technical Assistance (DTA)

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

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

Offerors proposing DTA must complete the following:

- 1. Indicate in question 17, of the proposal coversheets, that you request DTA and input proposed cost of DTA (in space provided).
- 2. Provide a one-page description of the vendor you will use and the technical assistance you will receive. The description should be included as the LAST page of the Technical Volume. This description will not count against the 20-page limit of the technical volume and will NOT be evaluated.
- 3. Enter the total proposed DTA cost, which shall not exceed \$5,000, under the "Discretionary Technical Assistance" line along with a detailed cost breakdown under "Explanatory material relating to the cost proposal" via the online cost proposal.

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

5.0 PHASE I PROPOSAL

Phase I Option

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

5.4.c.(6) Commercialization Strategy

DARPA is equally interested in dual use commercialization of SBIR project results to the U.S. military, the private sector market, or both, and expects explicit discussion of key activities to achieve this result in the commercialization strategy part of the proposal. The discussion should include identification of the problem, need, or requirement relevant to a DoD application and/or a private sector application that the SBIR project results would address; a description of how wide-spread and significant the problem, need, or requirement is; and identification of the potential DoD end-users, Federal customers, and/or private sector customers who would likely use the technology.

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

5.5 Phase I Proposal Checklist

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

- ___ 1. Volume 1: Completed Coversheet.
 - ___ a. Completed and checked for accuracy.
 - ___ b. Costs for the base and option (if proposed) are clearly separate and identified on the Proposal Cover Sheet.
- ___ 2. Volume 2: Technical Volume.
 - ___ a. Numbered all pages of the proposal consecutively. The cover sheets are pages 1 and 2. The technical volume begins on page 3.
 - ___ b. Font type is no smaller than 10-point on standard 8½” x 11” paper with one-inch margins. The header on each page of the technical proposal contains the company name, topic number and proposal number assigned by the DoD SBIR/STTR Electronic Submission Web site when the cover sheet was created. The header may be included in the one-inch margin.
 - ___ c. Include documentation required for Discretionary Technical Assistance (if proposed).
 - ___ d. The technical volume does not exceed twenty (20) pages. Any page beyond 20 will be redacted prior to evaluations.
- ___ 3. Volume 3: Cost Volume.
 - ___ a. Used the online cost proposal.
 - ___ b. Subcontractor, material and travel costs in detail. Used the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information, if necessary.
 - ___ c. Costs for the base and option (if proposed) are clearly separate and identified in the Cost Volume.
 - ___ d. Base effort does not exceed \$100,000 or \$105,000 if DTA services are proposed.
 - ___ e. Option (if proposed) does not exceed \$50,000.
 - ___ f. If proposing DTA, cost submitted in accordance with instructions in section 4.22 and does not exceed \$5,000.
- ___ 4. Volume 4: Company Commercialization Report
 - ___ a. Completed and checked for accuracy. Follow requirements specified in section 5.4(e).
- ___ 5. Submission

___ a. Upload four completed volumes: Volume 1: Proposal Cover Sheet; Volume 2: Technical Volume; Volume 3: Cost Volume; and Volume 4: Company Commercialization Report electronically through the DoD submission site by 6:00 AM (ET) on February 17, 2016.

___ b. Review your submission after upload to ensure that all pages have transferred correctly and do not contain unreadable characters. Contact the DoD Help Desk immediately with any problems (see section 4.15).

___ c. Submit your proposal before 6:00 AM (ET) on February 17, 2016. DARPA will NOT accept proposals that have NOT been submitted by the solicitation deadline.

6.0 PHASE I EVALUATION CRITERIA

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

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

Advocacy Letters

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

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

Limitations on Funding

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

7.0 PHASE II PROPOSAL

All offerors awarded a Phase I contract under this solicitation will receive a notification letter with instructions for preparing and submitting a Phase II Proposal and a deadline for submission. Visit

http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_Program.aspx for more information regarding the Phase II proposal process.

11.0 CONTRACTUAL CONSIDERATIONS

11.1(r) Publication Approval (Public Release)

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

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

11.4 Patents

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

11.5 Intellectual Property Representations

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

11.7 Phase I Reports

All DARPA Phase I awardees are required to submit reports in accordance with the Contract Data Requirements List – CDRL and any applicable Contract Line Item Number (CLIN) of the Phase I contract. Reports must be provided to the individuals identified in Exhibit A of the contract. Please also reference section 4.0 of the DoD Program Solicitation.

Direct to Phase II

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

award under Phase I of an SBIR Program with respect to such project.

DARPA is conducting a "Direct to Phase II" pilot implementation of this authority for this 16.1 SBIR solicitation only and does not guarantee the pilot will be offered in future solicitations.

Not all DARPA topics are eligible for a Direct to Phase II award. Potential offerors should read the topic requirements carefully. Topics may accept Phase I and Direct to Phase II proposals, Phase I proposals only, or Direct to Phase II proposals only – refer to the 16.1 Topic Index to review proposal types accepted against each 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 instructions in the DARPA Direct to Phase II Solicitation Instructions.

DARPA SBIR 16.1 Topic Index

*These instructions **ONLY** apply to Phase I Proposals. For Direct to Phase II, refer to the DARPA 16.1 Direct to Phase II (DP2) Topics and Proposal Instructions available at (<http://www.acq.osd.mil/osbp/sbir/index.shtml>).*

Proposals Types Accepted

Topic	Topic Title	Phase I	DP2
SB161-001	Rapid Assembly and Transfer Techniques for Large DNA Constructs	YES	NO
SB161-002	Miniaturized Wireless Microscope and Tissue Diagnostics	YES	YES
SB161-003	Rugged, chip scale, optical frequency combs for real-world applications	YES	NO
SB161-004	Building Trustworthy Software Systems using Big Code	YES	YES
SB161-005	High Dynamic Range Atomic Magnetic Gradiometer	YES	YES
SB161-006	Long Link Range Maritime Communications	YES	NO
SB161-007	Persistent Platform in Geosynchronous Orbit	YES	NO

DARPA SBIR 16.1 Topic Descriptions

SB161-001

TITLE: Rapid Assembly and Transfer Techniques for Large DNA Constructs

TECHNOLOGY AREA(S): Biomedical, Materials/Processes

OBJECTIVE: Develop a novel platform for DNA assembly, transfer, and transfection that uses synthetic DNA products to assemble DNA constructs at least 50 kbp or at least 100 kbp in length for prokaryotes and eukaryotes, respectively, and transfer these into cells with a transfection efficiency of at least 1%.

DESCRIPTION: The ability to engineer large and functional genetic elements de novo has been a foundational aim of synthetic biology. Whole genome engineering—for example, bacteria or yeast with extensively re-engineered genomes—offers exciting new possibilities for efficient biological manufacturing platforms and accelerated processes for optimizing engineered metabolic pathways.[1] However, current approaches to genome engineering fall short of this vision, with a state-of-the-art development cycle that remains prohibitively costly, time-consuming, and laborious. Examples include the first fully synthetic functional genome, based on a simple bacteria with a small genome (1.08 Mbp) that nevertheless required approximately 15 years and \$40 million to develop, as well as the first synthetic yeast chromosome, chromosome III of *S. cerevisiae*, which included only approximately 2.5% of the entire genome and required 5 years.[2] Additionally, few tools are available for genome engineering of species beyond these and other common model organisms, such as *E. coli*, *B. subtilis*, and *S. pombe*.

A critical challenge to advancing towards whole genome engineering is the ability to assemble and transfer large DNA constructs, which has not kept pace with rapid improvements in DNA synthesis technology. The commercial price for microgram-scale synthesis of large (for example, 4 kbp to 10 kbp) error-free DNA constructs is now less than \$0.22 per base pair with a turnaround time of less than 1 month,[3] and larger constructs may then be assembled from these DNA synthesis building blocks. However, as the availability, size, and sequence complexity of synthetic DNA constructs increase, so too do the technical challenges associated with handling and transfer into cells. For example, the simple act of pipetting can lead to truncated and/or recombined DNA products due to shear, which synthetic DNA affected significantly more than natively supercoiled chromatin. Increased size and linear topology also reduce DNA uptake into cells, such that successful transfers of large, functional, synthetic DNA constructs are extremely rare even in the most competent cells. With significant DNA fragmentation, failure rates for assembly can be substantial, and longer, more complex DNA sequences inherently require greater effort for validation. These and other limitations have left little room practically for the extensive pathway changes and rational genome engineering promised by synthetic biology.

This solicitation is focused on the development of a novel platform for DNA assembly, transfer, and transfection. DNA constructs will be assembled from synthesized DNA building blocks (for example, approximately 10 kbp to 20 kbp) manufactured at common commercial scales (for example, approximately 1 μ g) with acceptably low error rates. Assemblies directed towards prokaryotes must be at least 50 kbp, while assemblies directed towards eukaryotes must be at least 100 kbp. DNA transfection efficiency is generally measured using two scales, namely the number of cells transfected per μ g of DNA and the overall percentage of cells transfected. The final percentage of successfully transfected cells must be greater than 1% to facilitate downstream identification and characterization by end users. While necessary enrichment steps are not prohibited, increasing the apparent DNA transfer efficiency by flow cytometry sorting or extensive screening methods will be considered nonresponsive. The delivered platform should be applicable broadly, meeting suitable performance metrics in at least three phylogenetically dissimilar species. The demonstration of general methods to efficiently synthesize, assemble, and transfer functioning DNA into a broad range of organisms would represent a significant technological leap forward, opening new paths towards biotechnological solutions to problems of vital national importance. A successful platform could be transitioned readily to meet the needs of academic, government, and commercial researchers.

PHASE I: Determine the technical feasibility and projected cost of the new platform for DNA assembly, transfer, and transfection. This includes determining the appropriate methods and metrics for DNA assembly, transport, transfer into cells, and verification of successful transfection. Identify suitable metrics and perform appropriate analyses to determine efficiency and uncertainty at each step of the protocol. Determine the appropriate metrics and

analysis to identify full-length, sequence verified, functional DNA constructs in cells, as a measure of overall success. Establish the performance goals for minimum assembled construct length, transfection efficiency, phylogenetic generalizability, and overall success rate. Develop an initial concept design and model key elements to transition to commercial activity. While the initial platform may be based on any suitable technology, from microfluidics to conventional benchtop techniques, the platform should lend itself to automation with current lab automation technologies and methods. Phase I deliverables include: a technical report of experimental measurements supporting platform feasibility; defined milestones and metrics for cost per assembly and successful transfer, minimum number of DNA blocks assembled, minimum assembly length, transfection efficiency, phylogenetic flexibility, overall success rate, and stability and viability of the transfected cell; and, a detailed analysis of potential automation strategies with estimated throughput. Also included with the Phase I deliverables is a Phase II proposal that outlines plans for the further development and validation of the platform. This proposal should include a detailed assessment of the potential path to commercialization, barriers to market entry, and candidate collaborators or partners as early adopters for the new platform.

PHASE II: Finalize the design from Phase I and initiate construction of and production from the new platform. Establish performance through experimentation to determine: fidelity of constructs transferred into cells; failure rate and cost per successful transfer; maximum feasible construct length; limitations on sequence complexity; and the range of transfectable cell types and species. Develop, demonstrate, and validate DNA assembly, transfer, and transfection protocols that meet the key performance goals and metrics of full length, verified constructs of at least 50 kpb for prokaryotes and at least 100 kbp for eukaryotes, in at least three phylogenically dissimilar species, with an overall efficiency greater than 1% of cells transfected. Deliverables include a protocol and valid test data appropriate for a commercial production path.

PHASE III DUAL USE APPLICATIONS: A successful DNA assembly, transfer, and transfection platform that achieves the key metrics stated for Phase II has significant potential to transition rapidly to commercial use, enabling the development and biological production of new chemicals, enzymes, fuels, diagnostics, therapeutics, and industrial products, as well as new diagnostics services and custom organism synthesis. The ability to synthesize, modify, and test many new designs, at the genome scale, with a substantially reduced overhead in time and cost, will help realize the general biological design rules and tools needed for new products, devices, and services.

Platforms may support a number of current DoD challenges in the areas of novel therapeutics development, materials production, and diagnostics, as well as enabling new manufacturing capabilities and paradigms.

REFERENCES:

1. Kosuri, S. & Church, G. M. (2014). Large-scale de novo DNA synthesis: technologies and applications. *Nature Methods*, 11(5), 499–507. <http://doi.org/10.1038/nmeth.2918>
2. Callaway, E. (2014) First synthetic yeast chromosome revealed. *Nature News*, <http://doi.org/10.1038/nature.2014.14941>
3. <https://www.gen9bio.com/>

KEYWORDS: synthetic biology, genome editing, DNA, assembly, synthesis, transfection

SB161-002

TITLE: Miniaturized Wireless Microscope and Tissue Diagnostics

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.1 DoD Program Solicitation and the DARPA 16.1 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Biomedical, Human Systems

OBJECTIVE: Develop an injectable system no greater than one cubic-millimeter in size to identify and characterize tissue adjacent to the device at cellular resolution. Establish approaches to inject and remotely position this medical

device near internal trauma or tumors.

DESCRIPTION: Diagnosis of damaged tissue traditionally involves a biopsy or complex laproscopic techniques. While both of these approaches are relatively non-destructive and can produce an accurate diagnosis, they require a significant amount of training, expert knowledge and equipment to operate. In addition, due to the surgical nature of these procedures, they carry a small but not insignificant risk of infection and hemorrhage. Under battlefield conditions, combat medics do not have the time, hand-held equipment or antiseptic environment required to quickly and accurately identify a wounded service member's condition using these techniques. For example, the majority of potentially survivable combat deaths occur due to inadequate hemorrhage control.

Recent developments in hyperspectral imaging techniques have demonstrated a path to accurate and automated identification of tissue types and foreign objects. Furthermore, modern photonic design and integrated optics platforms can be used to construct complex imaging systems at the millimeter scale with micron resolution. This objective of this topic is to develop such an imaging system and demonstrate its safe and effective operation.

PHASE I: Design a concept for the millimeter-cube in vivo imaging and characterization system consistent with eventual use in humans for diagnosis of internal tissue. Perform modeling and simulation of the precision and imaging properties of the proposed system. Define key component technological milestones and metrics, such as spectral sensitivity and spatial resolution. Establish minimum performance goals necessary to achieve practical imaging and characterization of cellular tissue adjacent to the system. Included in the Phase I deliverables is a Phase II plan to construct, validate, and verify the performance of the system in vitro. This phase will demonstrate the feasibility of producing a demonstration of the proposed system and outline demonstration success criteria using integrated product and process design techniques.

PHASE II: Finalize the design from Phase I, produce prototype hardware, validate and verify the performance of the system to meet the key metrics. Establish performance parameters and the efficacy of tissue diagnosis using in vitro models or other relevant operational environments. It is expected that the imaging and characterization system will be manufactured using quality systems appropriate for eventual use in humans for medical applications. Select a target application and develop a credible translation pathway, and attain feedback from the Food and Drug Administration's Early Feasibility Study program. In addition, design and demonstrate at the benchtop level a method to control the position of the untethered wireless microscope in all three dimensions in an in vitro or cadaveric environment.

PHASE III DUAL USE APPLICATIONS: The successful development of this technology will provide a solution to diagnose internal tissue damage and thus potentially enable treatment. Such a capability would be translated to broad medical use through development of FDA-approved technology for use in civilian emergency rooms and cancer diagnosis.

The injectable system to characterize and image internal tissue will enable rapid diagnosis of internal trauma, tumors and other kinds of tissue damage. This new sub-millimeter imaging tool would not require a physical connection to the external world or require highly skilled doctors to operate, as with laproscopic equipment. The primary application for this technology would be in battlefield medicine.

REFERENCES:

1. Asimov, I., & Kleiner, H. (1966). *Fantastic voyage; a novel*. Boston: Houghton Mifflin.
2. Kim, M., D. Kang, T. Wu, N. Tabatabaei, R.W. Carruth, R.V. Martinez, G.M. Whitesides, Y. Nakajima, and G.J. Tearney, Miniature objective lens with variable focus for confocal endomicroscopy. *Biomed Opt Express*, 2014. 5(12): p. 4350-61. doi:10.1364/BOE.5.004350
3. Eisenberger U, Wüthrich RP, Bock A, et al. Medication Adherence Assessment: High Accuracy of the New Ingestible Sensor System in Kidney Transplants. *Transplantation*. 2013;96(3):245-250. doi:10.1097/TP.0b013e31829b7571

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KEYWORDS: nondestructive evaluation, design for manufacture, integrated product and process design, quality systems, in vivo imaging, untethered medical diagnostics

SB161-003 TITLE: Rugged, chip-scale, optical frequency combs for real-world applications

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

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

OBJECTIVE: Design, construct, test for reliability and deliver a ready-for-systems-integration or end-user use, ruggedized package, semiconductor laser-based optical frequency comb source.

DESCRIPTION: The mid-wave infrared, long-wave infrared, and longer spectral regions are scientifically and technologically important for numerous applications including communications, environmental and industrial monitoring, thermal imaging, and chemical sensing for defense and homeland security [1]. Despite the pressing physical motivations for extending such applications to the MWIR, LWIR, and beyond, the lack of suitable radiation sources in these spectral regions has resulted in technical applications being developed in the less favorable, near-infrared (NIR) spectral region where the telecom industry has driven the development of laser technology. These developments as well as the maturation of quantum cascade laser technology and packaging have demonstrated that such sources may be operated outside of the laboratory, in a broad range of spectral regions, and even in harsh environments. To fully exploit the application potential of semiconductor laser-based optical frequency combs [2,3,4] now under development [5], similar developments in packaging and characterization are required.

PHASE I: Design a fully integrated semiconductor laser-based optical frequency comb source, with output in the MWIR (3-6 microns), LWIR (6 -15) or longer (THz/submillimeter) spectral regions. The integrated device package should include all necessary hardware and stabilization components to realize a "ruggedized" broadband frequency comb in the targeted spectral region, including collimation micro-optics and coatings, and cooling and temperature stabilization.

Standardized package platforms (e.g., butterfly) are encouraged. However, other assembly designs may be submitted if all applicable interfaces (mechanical, optical and electrical) are clearly documented such that a systems integrator or end-user can interface with and operate the packaged device without modifications.

Phase I deliverables include delivery of the prototype optics package device to a laboratory of DARPA's specification along with all required documentation for an external party to operate the device. The Phase I device may use a semiconductor laser in place of the ultimate frequency comb source.

Phase I deliverables also include a design review of the proposed Phase II packaged comb source. Importantly, the Phase II design should include thorough plans for device reliability/lifetime testing (of individual sub-components and of the packaged device) and plans for ruggedness design and testing (see, for example, MIL-STD-810). The Phase II design should also include plans for all required electronics (e.g., cooling and temperature stabilization, comb feedback and stabilization, internal diagnostics, etc.) in a ruggedized package, subject to equivalent

environmental testing.

PHASE II: Fabricate the prototype packaged frequency combs source(s) designed in Phase I, and characterize sub-component and package reliability/lifetime and ruggedness in simulated or real operational environments. The Technology Readiness Level to be reached is 6: System/subsystem prototype demonstration in a relevant environment. Higher TRL levels are encouraged if feasible in the SBIR timeline.

At the completion of Phase II, the prototype device(s) (optics and electronics) will be delivered to a laboratory of DARPA's specification for characterization and systems integration with all required supporting documentation for end user operation.

Additional deliverables include:

1. a report with device efficiency (overall and sub-component: lasing material – single sided emission, cooling, electronics, etc.), power requirements, reliability and simulated and/or operational environment characterization results;
2. a “packaged selection matrix” of sub-component technologies identifying the required technologies (QCL or other semiconductor material systems, external cavity designs, optics and coatings, cooling technology, mounting/fabrication methods, incorporation of arrayed devices and any other topics deemed critical for inclusion) to engineer device specifications such as output spectral region and bandwidth (for the MWIR, LWIR, and THz/sub-mm spectral regions), output power, stability, and ruggedness beyond those targeted in the final Phase II device.

PHASE III DUAL USE APPLICATIONS: The same physical motivations underlying defense and security application of spectroscopic detection in the MWIR and LWIR spectral regions are true for numerous commercial applications of the same technology including environmental monitoring, toxic industrial chemical detection, and first responder safety and assessment. As for military applications, key specification for many commercial applications is the device, SWaP, ruggedness and reliability.

Spectroscopic detection in the MWIR and LWIR spectral regions, where fundamental molecular vibration transitions occur, combined with key atmospheric transmission windows, is critical for improved detection sensitivity of threat explosive and chemical warfare species. The whole variety of spectroscopic detection modalities and operational scenarios will become accessible to optical frequency comb technology, when properly and reliably packaged and deployed.

REFERENCES:

1. D Wasserman, et al, “Special issue on mid-infrared and THz photonics,” J. Opt., 16, 090201 (2014)
2. Hugi, et al, “Mid-infrared frequency comb based on a quantum cascade laser,” Nature, 492, 229 (2012).
3. J. Kurgin, et al, “Coherent frequency combs produced by self frequency modulation in quantum cascade lasers,” Appl. Phys. Lett., 104, 081118 (2014).
4. D. Burghoff, et al, “Terahertz laser frequency combs,” Nature Photonics, 8, 462 (2014).
5. <http://www.darpa.mil/program/spectral-combs-uv-to-thz>

KEYWORDS: optical frequency comb, quantum cascade laser, semiconductor laser, ruggedized, MIL-STD-810, micro-optics, laser packaging

SB161-004

TITLE: Building Trustworthy Software Systems using Big Code

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.1 DoD Program Solicitation and the DARPA 16.1 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Create tools and techniques that use Big Code for developing trustworthy software systems.

DESCRIPTION: As computing devices become more pervasive in our daily lives, the software systems that control them have become increasingly more complex and sophisticated. Consequently, ensuring that programs are correct, especially at scale, remains a difficult and challenging endeavor. Poorly designed or incorrectly implemented software can lead to unwitting ingestion of malware that can result in potentially crippling security violations, which can in turn have profound negative consequences on the reliability of mission-critical systems, and the correct operation of important and sensitive cyber-infrastructure. Identifying flawed software structure necessary for malware infiltration is critical to ensuring the trustworthiness of modern-day DoD software systems.

Trying to ascertain whether a given piece of software contains vulnerabilities that make it an attractive malware target is problematic in isolation, however, given the large number of malware variants, and the well-known limitations of static and dynamic program analyses, with respect to their high false negative and false positive rates, resp. Indeed, security specialists AV-Test [1] recently reported that new malware was up 72 percent in 2014 from the previous year, despite tremendous investment in software security, suggesting that it is easy to create and sustain diverse malware variants resistant to existing analysis and patching techniques.

Rather than examining a single program in isolation, we posit that a potentially more fruitful approach would be to leverage the results of mining a large corpus of programs for common semantic patterns that can be used to assess the trustworthiness of software components. Limitations in existing analysis techniques can be thus mitigated using statistical methods and machine learning approaches, i.e., “Big Code”. To explore this thesis in the context of automated repair and program synthesis, DARPA’s Mining and Understanding Software Enclaves (MUSE) program [2] has already produced a large publically available corpus of open source software, currently containing over 200K projects, reflecting over 600GBs of source code.

By extending and labeling this corpus with known malware (source and binary) artifacts, along with a precise representation of their attack vectors, we envision the construction of an evolving semantic database that effectively relates these artifacts with potentially vulnerable software components. New programs can now be compared against these components to gauge the likelihood they are vulnerable to a specific malware attack.

PHASE I: Develop a plan for creating tools and techniques that leverage Big Code to create trustworthy software systems. Required Phase I deliverable includes a final report that details the proposed techniques, how the technology would leverage the MUSE corpus, and the anticipated amount of software development required.

PHASE II: Demonstrate that the techniques from Phase I can be practically and effectively applied to a DoD relevant system. Required Phase II deliverables include all documentation and software for the techniques and a proof-of-concept demonstration of the techniques on a DoD relevant system.

PHASE III DUAL USE APPLICATIONS: Phase III Commercial App: SCADA systems, medical devices, computer peripherals, communication devices, and vehicles.

Phase III DoD/Military App: Unmanned ground, air and underwater vehicles, weapons systems, satellites, and command and control devices.

REFERENCES:

1. <https://www.av-test.org/en/statistics/malware/>
2. <http://www.darpa.mil/program/mining-and-understanding-software-enclaves>

KEYWORDS: Big code, trustworthy software systems, malware, program analysis, software mining, big data analytics

SB161-005

TITLE: High Dynamic Range Atomic Magnetic Gradiometer

PROPOSALS ACCEPTED: Phase I and DP2. Please see the 16.1 DoD Program Solicitation and the DARPA 16.1 Phase I Instructions for Phase I requirements and proposal instructions.

TECHNOLOGY AREA(S): Biomedical, Sensors

OBJECTIVE: Develop atomic magnetometers capable of high-sensitivity magnetic field gradient detection in unshielded environments.

DESCRIPTION: State-of-the-art magnetometers are utilized for diverse civilian and DoD applications, ranging from biomedical imaging to navigation and North-finding, unexploded ordnance detection, and underwater and underground anomaly detection. Commercially-available magnetometers range from inexpensive Hall probes, to highly sensitive Fluxgate and atomic magnetometers, to high precision SQUIDs and SERF atomic magnetometers. In general, however, all of these devices have limited dynamic range; the lower-performing devices operate comfortably in the background ambient field of the earth, while the highest performing sensors only operate in highly-shielded special purpose laboratory facilities. Emerging applications require highly sensitive detection of magnetic fields in non-laboratory environments. As many of these applications require cancelling of the background field in order to isolate the signal of interest, it is expected that significant application gain will be realized through gradient detection.

The objective of this SBIR is to develop a high dynamic range atomic magnetic gradiometer (HDRAMG), with sensitivity below 10 femtoTesla/cm/sqrt(Hz) in background fields exceeding 100 microTesla. Possible geometries include a dual sensor, with some displacement between the atomic vapor cells but with common laser sources and electronics, which will enable simplification of design and enhancement of sensitivity, due to common-mode cancellation of noise sources.

A HDRAMG meeting the objectives of this solicitation has potential to revolutionize diagnostics and research of brain injuries and seizures by enabling diagnostic magnetoencephalography outside of costly dedicated facilities, as well as field and emergency diagnostics.

PHASE I: Perform modelling and experiments to validate predicted performance of the proposed technology. Develop an architecture and model of the final product and evaluate component technologies for performance and availability, particularly laser sources, vapor cells, and other unique components. The Phase I final report shall include a detailed design and performance specifications for a sensor to be fabricated and tested in Phase II.

PHASE II: Develop and test prototype fully-integrated sensors, suitable for subsequent transfer to manufacturing. Phase-II prototypes will initialize and operate autonomously and be compactly packaged in a form factor suitable for commercial sale. At the conclusion of the Phase-II base period, a minimum of three sensors will be tested, across a relevant operating temperature range, in a laboratory environment. If proposed, a Phase-2 option period should include the fabrication and test of a minimum of ten additional sensors as well as demonstration in an operationally relevant system application.

PHASE III DUAL USE APPLICATIONS: Phase III Commercial App: Unshielded magnetoencephalography and/or magnetocardiology for medical diagnostic applications. Non-invasive direct brain control of prosthetics.

Phase III DoD/Military App: Perimeter monitoring/detection. Underground cave/tunnel detection. Submarine detection. Navigation aiding. Hands-free command and control.

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3. Hassanien, Aboul Ella, Azar, Ahmad Taher , "Noninvasive Electromagnetic Methods for Brain Monitoring: A Technical Review", in Brain-Computer Interfaces,74, 10.1007/978-3-319-10978-7_3, Springer International Publishing, p. 51-95.
4. Pradhan, S. and Mishra, S. and Behera, R. and Poornima and Dasgupta, K., "An atomic magnetometer with autonomous frequency stabilization and large dynamic range," Review of Scientific Instruments, 86, 063104 (2015), DOI:http://dx.doi.org/10.1063/1.4921901
5. Belfi J, Bevilacqua G, Biancalana V, Cartaleva S, Dancheva Y and Moi L 2007 Cesium coherent population trapping magnetometer for cardiosignal detection in an unshielded environment J. Opt. Soc. Am. B 24 2357–62.
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KEYWORDS: Atomic Magnetometer, Magnetometer, magnetoencephalography, magnetocardiology, magnetic navigation, north-finding, perimeter monitoring, anti-submarine warfare

SB161-006 TITLE: Long Link Range Maritime Communications

TECHNOLOGY AREA(S): Electronics, Information Systems

OBJECTIVE: Develop and demonstrate innovative methods to increase the distance and predictability of maritime surface-to-surface and air-to-surface communications.

DESCRIPTION: Maritime link distances (100s of km to 1,000s of km) are very challenging for RF transceivers operating at practical power levels and with feasible antenna apertures. Link range losses can be partially overcome by reducing data rates, but useful links need to have capacities of 100s of bits per second to 10,000s of bits per second. Approaches using relays (surface, satellite, and airborne) have drawbacks related to deployment logistics, force protection, and covertness.

What is needed are new radio technologies to extend RF link ranges in a maritime environment, including novel combinations of antennas, wide tuning range front-ends, signal processing, inter-platform coordination, and other techniques as required. The radio system packaging would support multiple platforms such as autonomous vehicles as well as manned aircraft and surface ships. Power, antenna size, and weight consistent with small unmanned vehicles in maritime scenarios are important factors.

Link range predictability is also important. It is likely that this new technology may often be unable to meet the required link ranges over some time periods. Being able to predict at the network level what connections are possible ahead of time is critical because it enables assets to coordinate their activities ahead of time to make use of communications when available (i.e. when the UUV is submerged). Predictive algorithms and software are needed to enable use of the new technologies in a networked maritime environment.

PHASE I: Develop a system concept for the proposed technology solution and a specific radio and packaging design. Perform technology risk reducing experiments and demonstrations if possible. Develop algorithmic approaches that enable prediction of maritime RF link range given the proposed system, and evaluate versus measurement data if possible. Phase I deliverables shall include a final report that describes radio and packaging designs, algorithms, and experiment and demonstration data.

PHASE II: Develop, demonstrate, and validate a prototype radio and packaging solution. The prototype should focus on basic physical tradeoffs in a maritime environment, such as link range versus size, weight, and power, particularly antenna size and system packaging. Develop software to predict RF link range for the proposed system, and evaluate versus system performance if possible. Conduct tests with a small network to show multi-node connectivity and long-term (hours to days) coverage and data rate predictability. Phase II deliverables shall include a final report that contains the final system design and packaging design, a prototype that has been tested in a maritime environment with a written performance evaluation, and test and measurement data.

PHASE III DUAL USE APPLICATIONS: Phase III Commercial App: Remote environmental monitoring and the associated networking to enable information transfer from remote sensors to monitoring applications.

Phase III DoD/Military App: Enabling information transfer between all platforms within a mission.

REFERENCES:

1. A Cooperative Strategy for 21st Century Seapower, <http://www.navy.mil/local/maritime/150227-CS21R-Final.pdf>

2. Navy Unveils New UUV Master Plan, http://www.navy.mil/navydata/cno/n87/usw/issue_26/uuv.html

KEYWORDS: communications, maritime, electromagnetic spectrum, jamming, electronic warfare

SB161-007 TITLE: Persistent Platform in Geosynchronous Earth Orbit

TECHNOLOGY AREA(S): Materials/Processes, Space Platforms

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: Define a persistent platform for geosynchronous Earth orbit (GEO) that would provide structural and support infrastructure for multiple payloads with diverse missions, and could accept the integration of payloads delivered to orbit after the platform is established in its orbital slot.

DESCRIPTION: DARPA envisions a new space technology ecosystem that would create opportunities for developing assembled systems much larger than those in orbit today and, eventually, systems that could be reconfigured and improved after they have reached orbit. These sorts of systems would combine long-lived structural and support infrastructure components with shorter-lived, higher-value electronics and payloads. Regular replacement of payloads would allow space systems to take advantage of technological improvements as soon as they are available, similarly to ground-based systems.

The envisioned platform would enable payload owners to send just payloads—and not all the equipment to support them—that could be delivered and assembled onto the platform as needed. Such a capability could enable a new market approach to leasing support infrastructure on orbit, which could help multiple commercial and government organizations place payloads over specific geographic locations. This scenario would allow system costs to be amortized across multiple customers over many years.

PHASE I:

- Determine the technical feasibility of the persistent platform in GEO, the key enabling technologies or processes, and the technology limitations to be overcome.
- Determine potential payloads to be integrated to the persistent platform.
- Define system and requirements design for the persistent platform in GEO, including services provided to payloads and interface requirements (hardware and software) between the platform and the payloads.

- Develop analysis and mitigation strategies to ensure each payload's specific mission needs are met (e.g. If multiple payloads require precise pointing, how could pointing services be provided to each payload as needed?)
- Phase 1 deliverables will include a final report with the details described in this solicitation.

For launch, delivery and ejection into GEO, the platform (or atomic units that could be assembled into a platform) should be able to fit within the size, weight and power constraints of the DARPA Payload Orbital Delivery (POD) system (standard or extended size). Mass allocation for a standard POD is up to 90 kg; mass allocation for an extended POD is up to 150 kg. Standard POD volume allocation is 1m by 0.5m by 0.4m. Extended POD volume allocation is 1m by 1m by 0.6m. Power available for a POD from its host spacecraft during launch and orbit raising is 150W average, 300W peak at 28-31V. (After ejection, this power would no longer be available and the platform would need to collect and distribute its own power.) Proposers should assume the existence of a robotic or other system in orbit and available to effect the integration of newly launched payloads to the persistent platform.

PHASE II:

- Continue to develop a system design for the persistent platform, with a preliminary design review (PDR)-level design to be delivered by the end of Phase 2.
- Provide a practical implementation for requirements developed in Phase 1.
- Construct and demonstrate the operation of a prototype of enabling hardware (and any enabling software).
- Validate key performance parameters for the prototype.

Phase 2 would entail a prototype delivery of any enabling mechanism, structure or other hardware for the concept developed in Phase 1.

PHASE III DUAL USE APPLICATIONS: DARPA's Payload Orbital Delivery (POD) system is scheduled for testing in orbit in 2017. If successful and adopted by the space community, PODs could provide opportunities for rideshare and ejection from a host spacecraft in GEO between six and eight times per year. A Phase 3 application for this enabling technology for the persistent platform would include the development, integration, test and delivery to orbit of the flight platform developed under this SBIR topic.

Because the robotic or other system required to integrate newly launched payloads to this platform might lag behind the launch of the platform or platform unit itself, the first demonstration of the platform could be launched with one or two payloads to demonstrate feasibility of hosting and providing the required resources to multiple representative GEO payloads. The platform should include, however, some number of open interfaces to allow for the future integration of payloads as the on-orbit payload integrator becomes available.

This demonstrator platform could be purely military or purely commercial, or the platform could host payloads for both military and commercial applications simultaneously. The latter path may prove difficult due to regulatory and policy issues related to differing spectrum allocation, information assurance requirements, mission prioritization, etc., but it would likely be the preferred instantiation for the persistent platform to host government, commercial and international payloads alike.

REFERENCES:

1. On the DARPA Phoenix Payload Orbital Delivery (POD) system: Sullivan, B., Barnhart, D., Hill, L., Oppenheimer, P., Benedict, B., van Ommering, G., Chappell, L., Ratti, J., and Will, P. "DARPA Phoenix Payload Orbital Delivery (POD) System: 'FedExTM to GEO.'" Proceedings of the AIAA SPACE 2013 Conference and Exposition, San Diego, CA, September 2013.
2. On the concept of a robotic spacecraft in GEO: DARPA SN-14-51 GEO Robotic Servicer RFI, https://www.fbo.gov/index?s=opportunity&mode=form&id=a5ba9b924872fe7f6b2169e4e2a73bcc&tab=core&_cvi=0
3. On a robotic spacecraft servicing concept: Roesler, G., Sullivan, B. R., Kelm, B., Henshaw, C. G. "Robotic Satellite Servicer Concept: On-Demand Capabilities in GEO." Proceedings of the AIAA SPACE 2015 Conference and Exposition, Pasadena, CA, September 2015.

KEYWORDS: Payload Orbital Delivery (POD) system; geosynchronous Earth orbit; geostationary orbit; space; persistent; platform; host