AIR FORCE
16.2 Small Business Innovation Research (SBIR)
Phase I Proposal Submission Instructions

INTRODUCTION

The Air Force (AF) proposal submission instructions are intended to clarify the Department of Defense (DoD) instructions as they apply to AF requirements.

Please note that there have been changes made to these instructions. Firms must ensure their proposal meets all requirements of the solicitation currently posted on the DoD website at the time the solicitation closes. Incomplete proposals will be rejected.

The Air Force Research Laboratory (AFRL), Wright-Patterson Air Force Base, Ohio, is responsible for the implementation and management of the AF Small Business Innovation Research (SBIR) Program.

The AF Program Manager is Mr. David Shahady. The AF SBIR/STTR Program Office can be contacted at 1-800-222-0336. For general inquiries or problems with the electronic submission, contact the DoD SBIR/STTR Help Desk at [1-800-348-0787] or Help Desk email at [sbirhelp@bytecubed.com] (9:00 a.m. to 6:00 p.m. ET Monday through Friday). For technical questions about the topics during the pre-solicitation period (22 April 2016 through 22 May 2016), contact the Topic Authors listed for each topic on the Web site. For information on obtaining answers to your technical questions during the formal solicitation period (23 May through 22 June 2016), go to https://sbir.defensebusiness.org/.

General information related to the AF Small Business Program can be found at the AF Small Business website, http://www.airforcesmallbiz.org. The site contains information related to contracting opportunities within the AF, as well as business information, and upcoming outreach/conference events. Other informative sites include those for the Small Business Administration (SBA), www.sba.gov, and the Procurement Technical Assistance Centers, www.aptacus.org/new/Govt_Contracting/index.php. These centers provide Government contracting assistance and guidance to small businesses, generally at no cost.

The AF SBIR Program is a mission-oriented program that integrates the needs and requirements of the AF through R&D topics that have military and/or commercial potential.

Efforts under the SBIR program are expected to fall within the scope of fundamental research. The Under Secretary of Defense (Acquisition, Technology, & Logistics) defines fundamental research as "basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community," which is 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. However, the research shall not be considered fundamental where the funded effort presents a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. See DFARS 252.227-7018 for a description of your SBIR/STTR rights.

PHASE I PROPOSAL SUBMISSION

The Air Force SBIR/STTR Program Office is instituting new requirements in an initiative to combat fraud in the SBIR/STTR program. As a result, each Small Business is required to visit the

AF SBIR Program website:
http://www.afsbirsttr.com/Firm/downloads/SBIRSTTR%20Program%20Rules.pdf and read through the "Compliance with Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Program Rules" training. The Certificate of Training Completion at the end of the training presentation and/or as pg. AF-11 of this document, MUST be signed by an official of your company, AND ATTACHED to your proposal. Failure to do this will result in your proposal being removed from consideration. This form will not count against the 20-page limitation.

Read the DoD program solicitation at https://sbir.defensebusiness.org/ for program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. For the AF, the contract period of performance for Phase I shall be nine (9) months, and the award shall not exceed $150,000. We will accept only one Cost Volume per Topic Proposal and it must address the entire nine-month contract period of performance.

The Phase I award winners must accomplish the majority of their primary research during the first six months of the contract with the additional three months of effort to be used for generating final reports. Each AF organization may request Phase II proposals prior to the completion of the first six months of the contract based upon an evaluation of the contractor's technical progress and review by the AF technical point of contact utilizing the criteria in section 6.0 of the DoD solicitation. The last three months of the nine-month Phase I contract will provide project continuity for all Phase II award winners so no modification to the Phase I contract should be necessary.

The Phase I Technical Volume has a 20-page-limit (excluding the Cover Sheet, Cost Volume, Cost Volume Itemized Listing (a-j), Company Commercialization Report, Non-Disclosure Agreement Form and Certificate of Training Completion Form).

Limitations on Length of Proposal

The Technical Volume must be no more than 20 pages (no type smaller than 10-point on standard 8-1/2" x 11" paper with one (1) inch margins. The Cover Sheet, Cost Volume, Cost Volume Itemized Listing (a-j), and Company Commercialization Report, Non-Disclosure Agreement Form and Certificate of Training Completion Form are excluded from the 20-page limit. Only the Technical Volume and any enclosures or attachments count toward the 20-page limit. In the interest of equity, pages in excess of the 20-page limitation (including attachments, appendices, or references, but excluding the Cover Sheet, Cost Volume, Cost Volume Itemized Listing (a-j), Company Commercialization Report, Non-Disclosure Agreement Form and Certificate of Training Completion Form will not be considered for review or award.

Phase I Proposal Format

Proposal Cover Sheet: The Cover Sheet does NOT count toward the 20-page total limit. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released on the Internet; therefore, do not include proprietary information in these sections.

Technical Volume: The Technical Volume should include all graphics and attachments but should not include the Cover Sheet or Company Commercialization Report (as these items are completed separately). Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission to avoid complications or delays in submitting your Technical Volume. To verify that your

proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your uploaded file will be virus checked. However, if your proposal does not appear after an hour, please contact the DoD SBIR/STTR Help Desk at [1-800-348-0787] or Help Desk email at sbirhelp@bytecubed.com (9:00 am to 6:00 pm ET Monday through Friday).

Key Personnel: Identify in the Technical Volume all key personnel who will be involved in this project; include information on directly related education, experience, and citizenship. A technical resume of the principle investigator, including a list of publications, if any, must be part of that information. Concise technical resumes for subcontractors and consultants, if any, are also useful. You must identify all U.S. permanent residents to be involved in the project as direct employees, subcontractors, or consultants. You must also identify all non-U.S. citizens expected to be involved in the project as direct employees, subcontractors, or consultants. For all non-U.S. citizens, in addition to technical resumes, please provide countries of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project, as appropriate. You may be asked to provide additional information during negotiations in order to verify the foreign citizen's eligibility to participate on a contract issued as a result of this solicitation.

Voluntary Protection Program (VPP): VPP promotes effective worksite-based safety and health. In the VPP, management, labor, and the Occupational Safety and Health Agency (OSHA) establish cooperative relationships at workplaces that have implemented a comprehensive safety and health management system. Approval into the VPP is OSHA's official recognition of the outstanding efforts of employers and employees who have achieved exemplary occupational safety and health. An "Applicable Contractor" under the VPP is defined as a construction or services contractor with employees working at least 1,000 hours at the site in any calendar quarter within the last 12 months that is NOT directly supervised by the applicant (installation). The definition flows down to affected subcontractors. Applicable contractors will be required to submit Days Away, Restricted, and Transfer (DART) and Total Case Incident (TCIR) rates for the past three years as part of the proposal. Pages associated with this information will NOT contribute to the overall Technical Volume page count. NOTE: If award of your firm's proposal does NOT create a situation wherein performance on one Government installation will exceed 1,000 hours in one calendar quarter, **SUBMISSION OF TCIR/DART DATA IS NOT REQUIRED.**

Phase I Work Plan Outline

NOTE: THE AF USES THE WORK PLAN OUTLINE AS THE INITIAL DRAFT OF THE PHASE I STATEMENT OF WORK (SOW). THEREFORE, DO NOT INCLUDE PROPRIETARY INFORMATION IN THE WORK PLAN OUTLINE. TO DO SO WILL NECESSITATE A REQUEST FOR REVISION AND MAY DELAY CONTRACT AWARD.

At the beginning of your proposal work plan section, include an outline of the work plan in the following format:

Scope
List the major requirements and specifications of the effort.
Task Outline
Provide a brief outline of the work to be accomplished over the span of the Phase I effort.
Milestone Schedule
Deliverables
Kickoff meeting within 30 days of contract start
Progress reports

Technical review within 6 months
Final report with SF 298

Cost Volume

Cost Volume information should be provided by completing the on-line Cost Volume form and including the Cost Volume Itemized Listing (a-j) specified below. The Cost Volume detail must be adequate to enable Air Force personnel to determine the purpose, necessity and reasonability of each cost element. Provide sufficient information (a-j below) on how funds will be used if the contract is awarded. The on-line Cost Volume and Itemized Cost Volume Information (a-j) will not count against the 20-page limit. The itemized listing may be placed in the "Explanatory Material" section of the on-line Cost Volume form (if enough room), or as the last page(s) of the Technical Volume Upload. (Note: Only one file can be uploaded to the DoD Submission Site). Ensure that this file includes your complete Technical Volume and the Cost Volume Itemized Listing (a-j) information.

a. Special Tooling and Test Equipment and Material: The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness of 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 relate directly to the specific effort. They may include such items as innovative instrumentation and/or automatic test equipment.

b. Direct Cost Materials: Justify costs for materials, parts, and supplies with an itemized list containing types, quantities, and price and where appropriate, purposes.

c. Other Direct Costs: This category of costs includes specialized services such as machining or milling, special testing or analysis, costs incurred in obtaining temporary use of specialized equipment. Proposals, which include leased hardware, must provide an adequate lease vs. purchase justification or rational.

d. Direct Labor: Identify key personnel by name if possible or by labor category if specific names are not available. The number of hours, labor overhead and/or fringe benefits and actual hourly rates for each individual are also necessary.

e. Travel: Travel costs must relate to the needs of the project. Break out travel cost by trip, with the number of travelers, airfare, per diem, lodging, etc. The number of trips required, as well as the destination and purpose of each trip should be reflected. Recommend budgeting at least one (1) trip to the Air Force location managing the contract.

f. Cost Sharing: Cost sharing is permitted. However, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal. Please note that cost share contracts do not allow fees. If proposing cost share arrangements, please note each Phase I contract total value may not exceed $150K total, while Phase II contracts shall have an initial Not to Exceed value of $750K NOTE: Subcontract arrangements involving provision of Independent Research and Development (IR&D) support are prohibited in accordance with Under Secretary of Defense (USD) memorandum "Contractor Cost Share", dated 16 May 2001, as implemented by SAF/AQ memorandum, same title, dated 11 July 2001.

g. Subcontracts: Involvement of university or other consultants in the planning and/or research stages of the project may be appropriate. If the offeror intends such involvement, describe in detail and include information in the Cost Volume. The proposed total of all consultant fees, facility leases or usage fees, and other subcontract or purchase agreements may not exceed one-third of the total contract price or cost,

unless otherwise approved in writing by the Contracting Officer. Support subcontract costs with copies of the subcontract agreements. The supporting agreement documents must adequately describe the work to be performed (i.e., Cost Volume). At a minimum, an offeror must include a Statement of Work (SOW) with a corresponding detailed Cost Volume for each planned subcontract.

h. Consultants: Provide a separate agreement letter for each consultant. The letter should briefly state what service or assistance will be provided, the number of hours required and hourly rate.

i. Any exceptions to the model Phase I purchase order (P.O.) found at http://www.afsbirsttr.com/Proposals/Default.aspx (see "NOTE" below).

NOTE: If no exceptions are taken to an offeror's proposal, the Government may award a contract without discussions (except clarifications as described in FAR 15.306(a)). Therefore, the offeror's initial proposal should contain the offeror's best terms from a cost or price and technical standpoint. In addition, please review the model Phase I P.O. found at https://www.afsbirsttr.com/Proposals/Default.aspx and provide any exception to the clauses found therein with your cost proposal Full text for the clauses included in the P.O. may be found at http://farsite.hill.af.mil. **If selected for award, the award contract or P.O. document received by your firm may vary in format/content from the model P.O. reviewed. If there are questions regarding the award document, contact the Phase I Contracting Officer listed on the selection notification.** (See item g under the "Cost Volume" section, p. AF-4.) The Government reserves the right to conduct discussions if the Contracting Officer later determines them to be necessary.

j. DD Form 2345: For proposals submitted under export-controlled topics (either International Traffic in Arms (ITAR) or Export Administration Regulations (EAR)), a copy of the certified DD Form 2345, Militarily Critical Technical Data Agreement, or evidence of application submission must be included. The form, instructions, and FAQs may be found at the United States/Canada Joint Certification Program website, http://www.dlis.dla.mil/jcp/. Approval of the DD Form 2345 will be verified if proposal is chosen for award.

NOTE: Only Government employees and technical personnel from Federally Funded Research and Development Centers (FFRDCs) Mitre and Aerospace Corporations, working under contract to provide technical support to AF Life Cycle Management Center and Space and Missiles Centers may evaluate proposals. All FFRDC employees have executed non-disclosure agreement (NDAs) as a requirement of their contracts. Additionally, AF support contractors may be used to administratively or technically support the Government's SBIR Program execution. DFARS 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends (Mar 2011), allows Government support contractors to do so without company-to-company NDAs only AFTER the support contractor notifies the SBIR firm of its access to the SBIR data AND the SBIR firm agrees in writing no NDA is necessary. If the SBIR firm does not agree, a company-to-company NDA is required. The attached "NDA Requirements Form" must be completed, signed, and included, with your proposal indicating your firm's determination regarding company-to-company NDAs for access to SBIR data by AF support contractors. Proposal packages that do not contain an Non Disclosure Agreement (NDA) Requirements Form (pg AF-10) will be considered incomplete, and will NOT be considered for award. This form will not count against the 20-page limitation.

k. The Air Force does not participate in the Discretionary Technical Assistance Program. Contractors should not submit proposals that include Discretionary Technical Assistance.

PHASE I PROPOSAL SUBMISSION CHECKLIST

Failure to meet any of the criteria or to submit all required documents will result in your proposal being REJECTED and the Air Force will not evaluate your proposal. NOTE: If you are not registered in the System for Award Management, https://www.sam.gov/, you will not be eligible for an award.

1) The Air Force Phase I proposal shall be a nine-month effort and the cost shall not exceed $150,000.

2) The Air Force will accept only those proposals submitted electronically via the DoD SBIR Web site (https://sbir.defensebusiness.org/).

3) You must submit your Company Commercialization Report electronically via the DoD SBIR Web site (https://sbir.defensebusiness.org/).

4) **Complete proposals must include all of the following**:
a. Cover Sheet
b. Technical Volume
c. A signed Non-Disclosure Agreement and inserted at the end of the Technical Volume
d. A signed Certificate of Training inserted at the end of the Technical Volume
e. Cost Volume
f. DD2345 if applicable
g. Commercialization Report

It is mandatory that the complete proposal submission -- DoD Proposal Cover Sheet, Technical Volume with any appendices, Cost Volume, Itemized Cost Volume Information, and the Company Commercialization Report, Non-disclosure Agreement (NDA) Requirements Form, (pg AF-10) and Certificate of Training Completion Form -- be submitted electronically through the DoD SBIR Web site at https://sbir.defensebusiness.org/. Each of these documents is to be submitted separately through the Web site. Your complete proposal **must** be submitted via the submissions site on or before the **6:00 am ET, 22 June 2016 deadline.** A hardcopy **will not** be accepted.

The AF recommends that you complete your submission early, as computer traffic gets heavy near the solicitation closing and could slow down the system. **Do not wait until the last minute.** The AF will not be responsible for proposals being denied due to servers being "down" or inaccessible. Please assure that your e-mail address listed in your proposal is current and accurate. Byearly August, you will receive an e-mail serving as our acknowledgement that we have received your proposal. **The AF is not responsible for ensuring notifications are received by firms changing mailing address/e-mail address/company points of contact after proposal submission without proper notification to the AF. Changes of this nature that occur after proposal submission or award (if selected) for Phase I and II shall be sent to the Air Force SBIR/STTR site address, afprogram@afsbirsttr.net.**

AIR FORCE SBIR/STTR SITE

As a means of drawing greater attention to SBIR accomplishments, the AF has developed a SBIR/STTR site at http://www.afsbirsttr.com. Along with being an information resource concerning SBIR policies and procedures, the SBIR/STTR site is designed to help facilitate the Phase III transition process. To this end, the SBIR/STTR site contains SBIR/STTR Success Stories written by the Air Force and Phase II summary reports written and submitted by SBIR companies. Since summary reports are intended for public viewing via the Internet, they should not contain classified, sensitive, or proprietary information.

AIR FORCE PROPOSAL EVALUATIONS

The AF will utilize the Phase I proposal evaluation criteria in section 6.0 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications of the principal investigator (and team), and followed by Commercialization Plan. The AF will utilize Phase II evaluation criteria in section 8.0 of the DoD solicitation; however, the order of importance will differ. The AF will evaluate proposals in descending order of importance with technical merit being most important, followed by the Commercialization Plan, and then qualifications of the principal investigator (and team). Please note that where technical evaluations are essentially equal in merit, and as cost and/or price is a substantial factor, cost to the Government will be considered in determining the successful offeror. The next tie-breaker on essentially equal proposals will be the inclusion of manufacturing technology considerations.

The proposer's record of commercializing its prior SBIR and STTR projects, as shown in its Company Commercialization Report, will be used as a portion of the Commercialization Plan evaluation. If the "Commercialization Achievement Index (CAI)", shown on the first page of the report, is at the 20th percentile or below, the proposer will receive no more than half of the evaluation points available under evaluation criterion (c) in Section 6 of the DoD 16.2 SBIR instructions. This information supersedes Paragraph 4, Section 5.4e, of the DoD 16.2 SBIR instructions.

A Company Commercialization Report showing the proposing firm has no prior Phase II awards will not affect the firm's ability to win an award. Such a firm's proposal will be evaluated for commercial potential based on its commercialization strategy.

On-Line Proposal Status and Debriefings

The AF has implemented on-line proposal status updates for small businesses submitting proposals against AF topics. At the close of the Phase I Solicitation – and following the submission of a Phase II via the DoD SBIR/STTR Submission Site (https://sbir.defensebusiness.org/) – small business can track the progress of their proposal submission by logging into the Small Business Area of the AF SBIR/STTR site (http://www.afsbirstr.com). The Small Business Area (http://www.afsbirsttr.com/Firm/login.aspx) is password protected and firms can view their information only.

To receive a status update of a proposal submission, click the "Proposal Status" link at the top of the page in the Small Business Area (after logging in). A listing of proposal submissions to the AF within the last 12 months is displayed. Status update intervals are: Proposal Received, Evaluation Started, Evaluation Completed, Selection Started, and Selection Completed. A date will be displayed in the appropriate column indicating when this stage has been completed. If no date is present, the proposal submission has not completed this stage. Small businesses are encouraged to check this site often as it is updated in real-time and provides the most up-to-date information available for all proposal submissions**. Once the "Selection Completed" date is visible, it could still be a few weeks (or more) before you are contacted by the AF with a notification of selection or non-selection.** The AF receives thousands of proposals during each solicitation and the notification process requires specific steps to be completed prior to a Contracting Officer distributing this information to small businesses.

The Principal Investigator (PI) and Corporate Official (CO) indicated on the Proposal Cover Sheet will be notified by e-mail regarding proposal selection or non-selection. The e-mail will include a link to a secure Internet page containing specific selection/non-selection information. Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the Proposal Number and Topic Number referenced. **Again, if changes occur to the company mail or email address(es) or company points of contact after proposal submission, the information shall be provided to the AF at afprogram@afsbirsttr.net.**

A debriefing may be received by written request. As is consistent with the DoD SBIR/STTR solicitation, the request must be received within 30 days after receipt of notification of non-selection. Written requests for debrief must be uploaded to the Small Business Area of the AF SBIR/STTR site (http://www.afsbirsttr.com). Requests for debrief should include the company name and the telephone number/e-mail address for a specific point of contract, as well as an alternate. Also include the topic number under which the proposal(s) was submitted, and the proposal number(s). Further instructions regarding debrief request preparation/submission will be provided within the Small Business Area of the AF SBIR/STTR site. Debrief requests received more than 30 days after receipt of notification of non-selection will be fulfilled at the Contracting Officers' discretion. Unsuccessful offerors are entitled to no more than one debriefing for each proposal.

IMPORTANT: Proposals submitted to the AF are received and evaluated by different offices within the Air Force and handled on a Topic-by-Topic basis. Each office operates within their own schedule for proposal evaluation and selection**. Updates and notification timeframes will vary by office and Topic. If your company is contacted regarding a proposal submission, it is not necessary to contact the AF to inquire about additional submissions.** Check the Small Business Area of the AF SBIR/STTR site for a current update. Additional notifications regarding your other submissions will be forthcoming.

We anticipate having all the proposals evaluated and our Phase I contract decisions within approximately three months of proposal receipt. **All questions concerning the status of a proposal, or debriefing, should be directed to the local awarding organization SBIR Program Manager.** Organizations and their Topic Numbers are listed later in this section (before the Air Force Topic descriptions).

PHASE II PROPOSAL SUBMISSIONS

Phase II is the demonstration of the technology that was found feasible in Phase I. Only Phase I awardees are eligible to submit a Phase II proposal, unless a topic is being solicited under the Direct to Phase II Program. All Phase I awardees will be sent a notification with the Phase II proposal submittal date and a link to detailed Phase II proposal preparation instructions. If the mail or email address(es) or firm points of contact havechanged since submission of the Phase I proposal, correct information shall be sent to the AF at afprogram@afsbirsttr.net. Please note that it is solely the responsibility of the Phase I awardee to contact this individual. Phase II efforts are typically two (2) years in duration with an initial value not to exceed $750,000.

NOTE: Phase II awardees should have a Defense Contract Audit Agency (DCAA) approved accounting system. It is strongly urged that an approved accounting system be in place prior to the AF Phase II award timeframe. If you have questions regarding this matter, please discuss with your Phase I Contracting Officer.

All proposals must be submitted electronically at https://sbir.defensebusiness.org/. The complete proposal – Department of Defense (DoD) Cover Sheet, entire Technical Volume with appendices, Cost Volume and the Company Commercialization Report – must be submitted by the date indicated in the invitation. The Technical Volume is **limited to 50 pages** (unless a different number is specified in the invitation). The Commercialization Report, any advocacy letters, SBIR Environment Safety and Occupational Health (ESOH) Questionnaire, and Cost Volume Itemized Listing (a-i) will not count against the 50 page limitation and should be placed as the last pages of the Technical Volume file that is uploaded. (Note: Only one file can be uploaded to the DoD Submission Site. Ensure that this single file includes your complete Technical Volume and the additional Cost Volume information.) The preferred format for submission of proposals is Portable Document Format (.pdf). Graphics must be distinguishable in black and white. **Please virus-check your submissions**.

AIR FORCE PHASE II ENHANCEMENT PROGRAM

On active Phase II awards, the Air Force may request a Phase II enhancement application package from a limited number of Phase II awardees. In the Air Force program, the outside investment funding must be from a Government source, usually the Air Force or other military service. The selected enhancements will extend the existing Phase II contract awards for up to one year. The Air Force will provide matching SBIR funds, up to a maximum of $750,000, to non-SBIR Government funds. If requested to submit a Phase II enhancement application package, it must be submitted through the DoD Submission Web site at https://sbir.defensebusiness.org/. Contact the local awarding organization SBIR Program Manager (see Air Force SBIR Organization Listing) for more information.

AIR FORCE SBIR PROGRAM MANAGEMENT IMPROVEMENTS

The AF reserves the right to modify the Phase II submission requirements. Should the requirements change, all Phase I awardees will be notified. The AF also reserves the right to change any administrative procedures at any time that will improve management of the AF SBIR Program.

AIR FORCE SUBMISSION OF FINAL REPORTS

All Final Reports will be submitted to the awarding AF organization in accordance with the Contract. Companies **will not** submit Final Reports directly to the Defense Technical Information Center (DTIC).

AIR FORCE
16.2 Small Business Innovation Research (SBIR)
Non-Disclosure Agreement (NDA) Requirements

DFARS 252.227-7018(b)(8), Rights in Noncommercial Technical Data and Computer Software – Small Business Innovation Research (SBIR) Program (May 2013), allows Government support contractors access to SBIR data without company-to-company NDAs only AFTER the support contractor notifies the SBIR firm of its access to the SBIR data AND the SBIR firm agrees in writing no NDA is necessary. If the SBIR firm does not agree, a company-to-company NDA is required.

"Covered Government support contractor" is defined in 252.227-7018(a)(6) as "a contractor under a contract, the primary purpose of which is *to furnish independent and impartial advice or technical assistance directly to the Government in support of the Government's management and oversight of a program or effort* (rather than to directly furnish an end item or service to accomplish a program or effort), provided that the contractor—

(i) Is not affiliated with the prime contractor or a first-tier subcontractor on the program or effort, or with any direct competitor of such prime contractor or any such first-tier subcontractor in furnishing end items or services of the type developed or produced on the program or effort; and

(ii) Receives access to the technical data or computer software for performance of a Government contract that contains the clause at 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends."

USE OF SUPPORT CONTRACTORS:

Support contractors may be used to administratively process SBIR documentation or provide technical support related to SBIR contractual efforts to Government Program Offices.

Below, please provide your firm's determination regarding the requirement for company-to-company NDAs to enable access to SBIR documentation by Air Force support contractors. This agreement must be signed and included in your Phase I/II proposal package

☐ YES ☐ NO Non-Disclosure Agreement Required
(If Yes, include your firm's NDA requirements in your proposal)

Company: _____ Proposal Number: _____

Address: _____ City/State/Zip: _____

Proposal Title: _____

Name _____ Date: _____

Title/Position _____

AIR FORCE SMALL BUSINESS INNOVATION RESEARCH (SBIR)/
SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAMS
"COMPLIANCE WITH SBIR/STTR PROGRAM RULES"

The undersigned has fully and completely reviewed this training on behalf of the proposer/awardee, understands the information presented, and has the authority to make this certification on behalf of the proposer/awardee. The undersigned understands providing false or misleading information during any part of the proposal, award, or performance phase of a SBIR or STTR contract or grant may result in criminal, civil or administrative sanctions, including but not limited to: fines, restitution, and/or imprisonment under 18 USC 1001; treble damages and civil penalties under the False Claims Act, 31 USC 3729 et seq.; double damages and civil penalties under the Program Fraud Civil Remedies Act, 31 USC 3801 et seq.; civil recovery of award funds; suspension and/or debarment from all federal procurement and non-procurement transactions, FAR Part 9.4 or 2 CFR Part 180; and other administrative remedies including termination of active SBIR/STTR awards.

_____	_____
Signature	Date
_____	
Name	
_____	_____
Firm Name and Position Title	Proposal Number

AIR FORCE SBIR 16.2 Phase I Topic Index

AF162-001	Deployable Electronically Steered Apertures (ESAs) for Future Space Platforms
AF162-002	Instrumentation for passive sensing of diffusely modulated signatures
AF162-003	Standardized Interface for Satellite Ground System Integration Technologies
AF162-004	Index, Export and Search Archived Data for Enterprise Ground Satellite Command and Control Systems from Multiple Sources
AF162-005	User Defined Operational Picture (UDOP) for Enterprise Ground Satellite Command and Control Systems from Multiple Sources
AF162-006	Autonomous Satellite Ground Operations
AF162-007	High-Efficiency Radiation-Hard Solar Array Interface to Spacecraft Power System
AF162-008	Spacecraft Propellant Storage and Feed Systems
AF162-009	Electric Propulsion for Dual Launch
AF162-010	Flexible Electric Propulsion for Resilient Spacecraft

AIR FORCE SBIR 16.2 Phase I Topic Descriptions

AF162-001 TITLE: Deployable Electronically Steered Apertures (ESAs) for Future Space Platforms

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: The objective of this work is to develop a low-cost, compactly folded aperture approach to replace traditional active phased array antennas for future satellite architectures.

DESCRIPTION: Multibeam steerable antennas are currently used to provide secure communications for a variety of protected and unprotected missions. Improved coverage and capacity is needed. Phased array antennas are desired because more beams can be transmitted and rapidly repositioned arbitrarily for a large number of users. The problem is that high performing phased array antennas are complex and expensive requiring extensive parts list and specialized NRE for each iteration on a given platform. With the limited procurement volumes seen in the space sector, new antenna options are needed that can be procured for less than $1M/m^2 and that can be reconfigured or modularized to meet a variety of RF parameters. Additionally, these antennas need to function as the same aperture for both transmit and receive frequencies for their respective platform. Frequencies used on heritage AF space systems, such as AEHF, Milstar, WGS, etc. are available in open literature. While one single aperture solution may not be able to handle all frequencies for future versions of these systems, it is of interest to capture as much of the spectrum as possible (TX: 7.3, 20, and 73 GHz; RX: 8, 30, 44 and 83 GHz; Cross-link 60 GHz). This may be achievable, for example, using wideband antenna elements combined with RF MEMS or other reconfigurable approaches. Regardless of the approach proposed, authors should plan to explain the appropriateness of a given technology for a space environment consisting of thermal cycle extremes, launch loads, and space radiation induced effects. Thermally induced deformations and the effect on antenna performance must also be addressed.

Phased array antenna technologies are needed with reduced complexity feeds, simpler tuning and phase shifting architectures, reduced overall size and mass, and reduced touch labor required to assemble and integrate. Single feed solutions, similar in principle to a reconfigurable reflectarray, are desired that are capable of both transmit and receive across all the frequency bands of interest, where the reconfiguration of the reflector can be done with low power phase shifting solutions such that all the sensitive, high-powered feed requirements may be limited to the single feed element rather than an array of coupled amplifiers and phase shifters to tune individual or grouped elements. Proposers should not focus solely on approaches limited to a reflectarray approach, which is only offered as one example of a reduced feed Electronically Steered Array.

Future space architectures may disaggregate or augment these communications functions across multiple satellites, either as free-flyers or as hosted payloads on commercial satellites. In order to provide options for smaller spacecraft platforms and hosted payloads in LEO, HEO, and GEO orbits, apertures are additionally desired that can be folded or packaged in some stowed fashion for launch and deployed once on-orbit. Deployable structures are desirable but only if proposed as an antenna system solution. The desire is to fit as large of an aperture as possible onto a 10 kg to 100 kg class spacecraft.

PHASE I: Design, simulate, and build antenna hardware components with focus on proving the antenna critical function. Solution should be producible such that AFRL can verify performance with traditional network analyzer and waveguide setups. Proposers should also begin to form partnerships with payload or prime contractors that have potential to transition into military satellite communications systems.

PHASE II: Fabricate and produce a sub/full aperture brassboard antenna with focus on ground test and evaluation. Include flight qualifiable aspects to the antenna design where possible. Form stronger partnerships with payload or prime contractors that have potential to transition into military satellite communications systems.

PHASE III DUAL USE APPLICATIONS: Build full-scale flight qualifiable antenna that may be tested in a relevant ground or space environment.

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KEYWORDS: Milsatcom, Phased Array, Reflector, Beam Steering, Electronically Steered Antenna, Space Antenna, Deployable Antenna

AF162-002 TITLE: Instrumentation for passive sensing of diffusely modulated signatures

TECHNOLOGY AREA(S): Battlespace

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the AF SBIR/STTR Contracting Officer, Ms. Gail Nyikon, gail.nyikon@us.af.mil.

OBJECTIVE: Develop hardware to advance imaging techniques for remotely sensing low level earth surface vibrations via detection of diffusely modulated light; enhance survivability from lab to field, improve ranges to hundreds of kilometers.

DESCRIPTION: Recent work in the laboratory [1-3, 5-7] has demonstrated that detection of dim signals that indicate the presence of surface vibrations via diffuse light modulation can be conducted under controlled conditions, with results sufficient to provide initial proof of concept for the viability of diffuse light modulation-based methods.

The underlying scientific utility of diffuse light modulation has been understood for years [9], and development of specific applications is ongoing. However some technological gaps remain. Long-range detection on the ground is a key step on the path to detection from low Earth orbit or geosynchronous (GEO) orbit [8], and one of the limitations is the lack of an appropriately sensitive advanced sensor capable of high dynamic range that can tolerate field conditions, sense light very precisely (ideally at or near the photon shot noise limit), and remain portable and flexible for ongoing field work. Achieving this goal places significant demands on the imaging sensor, requiring a focal plane with a deep well capacity and low noise. Sensors that can function at spectral bandwidths that provide improved or even optimal chances of vibration detection would also be desirable. Spectral bandwidths for better detection probability may include subsets of the visible spectrum, or the non-visible spectra, depending on the phenomenology.

Accordingly, the goal of this topic is to produce sensor hardware that can make passive detection of surface vibrations via diffuse light modulation methodology at ranges in the regime of tens to hundreds of kilometers, perform in the field reliably, and/or provide a good probability of detection at these ranges. Active sensing devices such as vibrometers are not desirable. This hardware should be able to be field-deployed on the ground or in airplanes to demonstrate viability, that is, used in assorted environmental conditions, without requiring onerous amounts of supporting equipment (e.g., cryocooling hardware, extensive maintenance kits, heavy shock absorption

systems, heavy power-generation systems) to be co-deployed.

In addition to the field deployment requirements, support for a path ahead is desirable. Evidence of a clear and graduated path to space from the field is a strong plus, as is availability of field support capability, to enable government users to conduct additional field data collection for later efforts. The capability to deliver multiple units may also be a factor worth considering, as will the ability to work on classified data if the effort begins to generate products at higher levels of classification.

PHASE I: Construct a prototype field deployable hardware system. Demonstrate the prototype under field-similar conditions, and identify major technical obstacles to field deployment, including such factors as sensitivity, data handling/storage, compatibility with other systems, and expected field lifetime.

PHASE II: Extend the field-deployable hardware system to airborne platforms and verify its performance under a set of varied environmental conditions, collecting data from a set of varied targets and in varied locations. Demonstrate ability to extract known vibration signals from collected data amidst clutter.

PHASE III DUAL USE APPLICATIONS: Package the field-deployable system for use by other government and commercial customers, e.g. passive detection of vibrations due to faults in bridges within the Department of Transportation. Demonstrate collection of data from very dim and unknown vibration sources, with an emphasis on demonstration from space, thereby implicitly extending the airborne theme referred to in Phase II.

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KEYWORDS: BRDF, field packaging, photon counting, dim signal detection, shot noise limit

AF162-003 TITLE: Standardized Interface for Satellite Ground System Integration Technologies

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Develop a system/capability to make satellite ground system development/ integration easier and reusable across satellite programs.

DESCRIPTION: This effort will develop and demonstrate design concepts for a standardized interface suite to improve satellite ground system development and integration capabilities. A requirement for this system capability is to simplify ground system development and integration as well as reducing the required time to perform the task. This improved capability should have the ability to facilitate one of a kind research, development, test, and evaluation (RDT&E) satellites and ground system interfaces. Traditionally ground system development is expensive and time consuming for several reasons which include the failure to integrate the development efforts for Integration and Test (I&T) support and operations hardware and software, and the lack of common interfaces and standards. The ability to perform commanding and telemetry processing is a critical component of I&T and a workstation that can perform this functionality is developed accordingly. In almost all cases for DoD satellite systems the telemetry, tracking, and commanding (TT&C) workstation used in operations is developed separately and with minimal, if any, reuse from the workstation developed during I&T. Significant time and cost savings can be achieved by incorporating a test like you fly philosophy and developing a TT&C console that can be used for both I&T and for Operations.

AFSPC has had some success with standardized space trainer architectures. It is likely that this successful architecture could be leveraged for greater operational/applications/use. In addition to workstation reuse, savings can be achieved by developing standards for: command and telemetry database formats; naming conventions for commands and telemetry parameters; graphical user interfaces; and data transfer protocols. The objective of this topic is to investigate methods which can lower the cost and development time of satellite ground stations through incorporation of the test like you fly philosophy and by employing ground system standards which will enable optimal reuse of resources.

PHASE I: The objective of phase I is to develop a ground architecture that promotes ground system reuse between I&T and Operations, and from program to program. To demonstrate the validity of the proposed concept and architecture a limited demonstration is highly desirable. Emphasis on scalability and reusability is required.

PHASE II: The objective of phase II is to implement the system defined in phase I on a demonstration platform. The developed system should be capable of handling all TT&C functionality. As one outcome of the effort a detailed analysis of the results which quantifies the time and cost savings is also required.

PHASE III DUAL USE APPLICATIONS: This proposed research and development effort has equal applicability to the commercial satellite domain. NASA GSFC and JPL have multiple spacecraft programs that could directly benefit from this research.

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http://www.spacedaily.com/reports/Multi_Mission_Satellite_Operations_Center_Goes_Live_999.html, Jan 2011.

KEYWORDS: Satellite Ground System Technologies, Ground Automation, Satellite Autonomy, Ground Segment Reuse, Satellite Ground Standards

AF162-004 TITLE: Index, Export and Search Archived Data for Enterprise Ground Satellite Command and Control Systems from Multiple Sources

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Develop techniques to index, export and search large volumes of archived data, across streams of telemetry and mission data and other data sources from multiple satellite missions in order to produce deep forensic analytics

DESCRIPTION: Technology breakthroughs have drastically increased the complexity of today's satellites, with some satellites having more than of 10,000 satellite telemetry points for just a single satellite, updating at a cadence of once or more per second. In addition, communication technology has increased the data throughput capability across satellite links. The US alone has placed billions of dollars' worth of assets into space and collecting, searching and extrapolating meaningful information from these assets quickly is a significantly important need. The net effect is that the amount of satellite data that must be downlinked to the ground has increased drastically. These amounts of data are overwhelming at the human level and searching them for patterns or actionable information becomes a challenge. The problem is compounded when applied across multiple satellite missions and beyond to the space enterprise, which results in streams of big amounts of data to search. Innovative software approaches which enable searching these large amounts of data in a fast and efficient way are therefore needed.

To be effective in a normal operational environment, the solution should be designed from the start with human centered computing in mind. The solution space should then have multiple automated processes that run in the background to ease big data workload. Big data storage and quick retrieval are also important. Indexing has proven to be a challenge for big data applications, but plays an integral role in ability to produce a timely and efficient search result. Solutions which reduce the time for index creation are desired. Detection and reporting processes both for real-time and after-the-fact analysis should be running in the background and not require substantial human interaction. It should be possible to conduct search queries in parallel and include ability to conduct multi-variable queries as combining results multiple mission areas. This will allow for powerful pattern matching and pattern discovery across missions. For example, such queries may be able to quickly identify problems in a particular ground area by searching multiple missions that fly over a particular location. The detection and reporting processes need to be self-sustaining, meaning that human management of these processes has been minimized. Satellite and payload state classification, indexing, and archival needs to be accomplished. Many processes should be running in the background including correlation between satellite and payload states with other data sources as well as attribution assessment. Humans should be able to monitor processes and set thresholds for human interaction in real time. Detection and reporting of events to humans with supporting correlations, likely attribution, and potential courses of action are the main real-time processes for human space system operators.

Innovative extensible and scalable low-cost software solutions are sought that will enable high performance searching and pattern and anomaly recognition. These software solutions should enable deep forensic analytics of large volumes of multiple satellite mission data from across the space enterprise. One approach could be a software application that indexes and searches large amounts of archived data from multiple satellite mission areas.

PHASE I: Conduct feasibility studies/technical analysis/simulation/proof-of-concept. The system should demonstrate the ability to work on a single satellite mission, but must scale support multiple missions. It is a requirement that if a software application approach is proposed, the software must be modular/opensource to allow for easy modifications in future increments. Demo prototype highly desirable.

PHASE II: Using the results from Phase I, construct, demonstrate and test tool with actual or properly simulated spacecraft data and other source data. Using simulated or actual data demonstrate a key finding through search of data across multiple missions. Recommend standards for representing satellite data for faster indexing.

PHASE III DUAL USE APPLICATIONS: Military Application: Transition to the RSC/MMSOC platform and then subsequently to the Enterprise Ground Service Framework.

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KEYWORDS: Big Data; indexing; searching big data; multiple mission satellite operations center; MMSOC; Satellite Command and Control (C2)

AF162-005 TITLE: User Defined Operational Picture (UDOP) for Enterprise Ground Satellite Command and Control Systems from Multiple Sources

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Develop a UDOP that brings multiple dissimilar operational systems into a common presentation level, for ease of use and reduction of training for the operators, in addition to a set of guidelines governing the implementation strategy of the UDOP.

DESCRIPTION: In the satellite community, there is a large variety of different ground systems that requires multiple, unique, independent systems that currently serve each individual satellite mission. In addition, all of the operational screens for each satellite mission have very different screen pictures, and command naming nomenclature. As a result, each satellite mission requires specialists for each type of ground system. Operators are required to be trained in detail for each different system before they can perform their duties which results in higher training time and operational costs for satellites.

A commonality is that each of the ground systems has similar commanding options, satellite state of health information, and contact planning and scheduling options. By integrating the different ground systems into one overarching common presentation level for the ground sites, operators can more easily transition from one ground system to the next with minimal training. The goal is to develop a common user interface that allows a user to follow the same general procedures for basic processes. The interface should be accompanied by a standardized guideline for potential new systems to build to. The interface should also establish a standardized method of focusing on individual aspects of the satellite, for example opening a new tab or selecting a data point. These interface definitions should be specific enough to standardize where specific data is found, but should be broad enough to accommodate a wide variety of missions with different payloads and significant telemetry points. This will promote a common chain of reasoning for satellite control to allow simpler transition between operating different missions.

The design of this interface should also include details accessibility and configuration control. Due to the numerous different programs that will use the interface, details must be established such as user permissions and satellite

configuration management. Other important points include establishing how asset capability statuses are determined and displayed.

Another large part of this development will be to determine how the interface will access the data it will display. The goal is to create a common user interface, not a common ground system, so the interface should be capable of supporting a vast variety of different ground systems. It should also be able to support not only Trade, Telemetry & Communications (TT&C), but mission planning, data analysis, and any other significant satellite processes or procedures.

PHASE I: Conduct feasibility studies/technical analysis/simulation/proof-of-concept demonstration of the multi mission area UDOP and an outlined of it's associated standardized guideline. To demonstrate the validity of the proposed concept and architecture, a demonstration is highly desirable.

PHASE II: The objective of phase II is to implement the system defined in phase I on a demonstration platform. The developed system should be capable of handling all operational functionality. As one outcome of the effort a detailed analysis of the results which quantifies the time and cost savings is also required.

PHASE III DUAL USE APPLICATIONS: Transition to the RDT&E Support Complex/Multi Mission Space Operations Center (RSC/MMSOC) platform and then subsequently to the Enterprise Ground Service Framework.

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KEYWORDS: UDOP, Satellite Command and Control (C2), ground systems, common presentation level

AF162-006 TITLE: Autonomous Satellite Ground Operations

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Develop prototype for Next Generation Air Force Enterprise Ground System to support autonomous satellite operations.

DESCRIPTION: In order to transition the AFSCN's Space Operations Centers (SOC's) to an autonomous operational mode the methods for handling and processing data (command, health and status monitoring, mission planning) needed by SOC's needs to be redesigned. In addition technologies are needed which will enable performing automated command and control and specifically to handle complex non-deterministic scenarios. The research and analysis needs to account not only the current data carried by the SOCs, but also the data needed to control or future satellite systems. One area of immediate improvement would be the ability to autonomously reset the telemetry limit checking software to enable more agile on orbit adjustments to account for natural anomalies, aging of the spacecraft, natural drift in on orbit measurements and anomalies which are long lived. Additionally, in order to reduce costs and create more responsive ground control systems technologies are needed which will automate functionality that is currently largely performed by human operators. Over the last several years the use of intelligent systems technologies have made advances in several domains and have shown the ability to not only reduce manpower costs but also to provide the ability to detect and respond to anomalous conditions in a more timely fashion. The time is ripe to develop and develop intelligent system technologies and apply these towards Air Force satellite operations.

To affect autonomy within Air Force SOC's an overall understanding of SOC mission requirements in terms of control and data needs has to be developed. The research and analysis needs not only cover normal operations with the SOC's but also provide the ability to detect and respond to anomalous conditions. These systems need to operate within the larger Air Force Satellite Control Network (AFSCN) and its network of antennas. Technologies such as

expert systems, machine learning, and model based systems need to be developed and implemented within a modular extensible framework. From the above analysis a robust and extensible network architecture and toolset capable of supporting autonomous operations will be developed and prototyped. One approach could be software applications that monitor and processes health and status (H&S), and satellite telemetry. This particular application would need to be able to process H&S and telemetry from multiple satellite missions (PNT, SSA, Imaging) and have a near-real time indication/warning system that would inform the multiple mission area satellite operators of anomalous behavior (via pop-up dialog boxes or other means) and recommend new telemetry limit points.

The Phase I portion should: 1) conduct analysis of SOC autonomous needs for all modes of operations with an emphasis on dynamic resetting of satellite limit checking, considering both current and future systems as described above. 2)Conduct simulations and loading studies to identify average and peak loads the autonomous systems would need to manage. 3) Develop basic architecture in terms of functions and capabilities for autonomous systems.4) Emphasize scaling to SOC operation of worldwide set of AFSCN antennas and identify initial architectural design components. 5) Emphasize modular and open approach for incremental upgrades. 6) Detailed analysis of the results which quantifies cost and time savings is also required.

PHASE I: Deliver: analysis of SOC autonomous needs for all modes of operations w an emphasis on dynamic resetting of satellite limit checking, simulations & loading studies to identify average & peak loads the autonomous systems, develop basic architecture in terms of functions & capabilities for autonomous systems & detailed analysis of the results which quantifies cost and time savings is also required.

PHASE II: Prototype net-centric compliant architecture that meets the data volume and requirements for autonomous operations. Generate architectural development strategy that will ensure an extensible framework to support future acquisitions. Simulate operations, including both predefined and new events, under relevant conditions using the modeling and simulation and architectural design components identified in Phase 1. Deliver the executable model.

PHASE III DUAL USE APPLICATIONS: Apply the results of phase two to prototype a basic modular Air Force automated ground operations center. Validate performance and scalability of prototype architecture to entire set of Air Force satellite systems.

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KEYWORDS: Network Architecture, Open architecture, Automated satellite operations, Status and Monitoring Data, Automated satellite command and control

AF162-007 TITLE: High-Efficiency Radiation-Hard Solar Array Interface to Spacecraft Power System

TECHNOLOGY AREA(S): Space Platforms

OBJECTIVE: Develop concepts for a high efficiency, compact radiation hard interface between the solar array and the spacecraft power system

DESCRIPTION: Present state of the art power processing of electric power from spacecraft solar arrays utilizes a partial shunt strategy, string switching, or both to control the output of a solar array. The spacecraft solar array can degrade from 20% to 50% in power producing capability over a 15-year mission depending upon the specific orbit it

must operate in. These schemes have worked well for solar arrays, which are sized for end of spacecraft life conditions.

However, these designs make it impossible to access the full power available from the solar array. The reason for this is that the solar array must be designed to deliver full power at end of life while being connected to a regulated spacecraft power system bus or a spacecraft battery with an unregulated spacecraft power system bus. In either case the solar array operation cannot be optimized to operate at peak power conditions. To date there have not been many spacecraft with loads which require power above end of life conditions.

However, with the advent of the use of electric propulsion for orbit raising the additional power that the solar array could deliver could reduce trip time from low earth orbit to the operational orbit of the satellite.

To solve this problem the solar array interface must be capable of delivering all of solar array power at the spacecraft bus voltage at beginning of life and end of life conditions. Potential methods for addressing this challenge include, but are not limited to; higher efficiency cell designs, alternate cellular arrangements, dynamic topology adjustment, high-efficiency reconfigurable charge management circuitry, concepts in soft-defined power-aware and degradation-aware distribution architecture possibilities.

The solar array interface should be capable of operation in a Low Earth Orbit (LEO) for 5 years and in a Geosynchronous Earth Orbit (GEO) or Medium Earth Orbit (MEO) for 15 years after storage on the ground for 5 years. It should function after 500 kRad (Si) total dose, be immune to dose rate and single event latchup, and not upset at a single event LET lower than 20 Mev/mg/cm2.

PHASE I: Perform preliminary analysis and conduct trade studies to validate performance for the solar array interface. Using breadboard hardware verify related performance information in support payoff estimates.

PHASE II: Fabricate and deliver engineering demonstration unit. Show the flexibility of delivering reliable power with the solar array at various load points. Identify radiation impacts upon components of the string converter.

PHASE III DUAL USE APPLICATIONS: Technology developed will be applicable to all military and commercial space platforms. Expected benefits include 20% to 50% increase in beginning of life solar array power.

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KEYWORDS: Peak Power Tracker, Solar Array, Parallel Power Conversion, Distribution and Control, Solar Array Regulation

AF162-008 TITLE: Spacecraft Propellant Storage and Feed Systems

TECHNOLOGY AREA(S): Space Platforms

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the AF SBIR/STTR Contracting Officer, Ms. Gail Nyikon, gail.nyikon@us.af.mil.

OBJECTIVE: Develop and demonstrate decreased mass, volume and power requirements for spacecraft liquid chemical propellant storage and feed hardware.

DESCRIPTION: Typical propellant storage and feed systems for spacecraft using liquid chemical propulsion comprise compressed helium or nitrogen driving the propellant from the storage tank. Mission requirements will drive the choice of blow down or regulated pressure feed, likewise, the choice of feed will further drive the type of propellant management device. Also common for hydrazine monopropellant systems, the driving pressure gas and propellant will be within the same tank separated by an elastomeric diaphragm. Also, it is frequently necessary to provide some sort of environmental control for the propellant storage tank to ensure the propellants do not freeze or fall to sub-nominal temperature for thruster operation. These systems are proven for reliability and have long flight legacies, however, they are not free of concerns and there remains opportunity for improvement of the design.

Pressurized tankage presents a significant logistical and cost footprint in the regards to component qualification or verification, acquisition lead time, and spacecraft processing operations. Where monopropellant thrusters are used, catalyst poisoning is always of concern. Though standards for the purity of hydrazine as well as for preparation of the elastomer diaphragm materials, such as AFE-332, that the hydrazine would be continuously contacting within a diaphragm tank are well established, introduction of contaminating substances acquired from the hydrazine or diaphragm leaching may have potential to alter thruster delivered performance due to catalytic poisoning. Similar concerns are also present for emerging advanced green monopropellant formulations.

Other limitations faced with liquid propulsion systems on board spacecraft relate to impulse variability and determination of propellant remaining. In blow down systems, the change in delivered performance of the thruster due to decreasing feed pressure must be mapped in order to be able to determine thrust commands to accomplish desired maneuvers. For missions with large delta-V requirements, significant amounts of propellant will be required driving need of large compressed gas tanks reducing mass and volume available for payload. Liquid chemical thrusters that can deliver variable thrust from a compact configuration, such as combined functionality of low thrust monopropellant and high thrust bipropellant modes, for different mission phases have been developed and are commercially available.

Of interest is a liquid propellant storage and feed system that does not grow in volume and component manufacturing risk with propellant throughput (such as state of the art compressed gas approaches) that also mitigates typical concerns associated with reliability, repeatability, and contamination. Envisioned applications are for thrusters in the range of ~0.25 lbf to ~5.0 lbf, with design knowledge to scale up and be able to support to the 100 lbf level. Minimum impulse bit performance repeatability and predictability that is superior or, as a minimum, equivalent to the state of the art is desired.

Performance and capability advantages to all type of spacecraft platforms from extremely volume limited applications such as Cubesats up to large scale, long life systems such as GPS should be assessed and presented.

Developmental effort should include a physics based understanding in terms of a mathematical expression; capturing details of power requirements, geometry, material make-up, duty cycle, and propellant throughput range as a function of relevant parameters.

Energy requirements should be bounded within today's nominal satellite bus architecture capabilities.

Additional considerations should include streamlined manufacturing process with high yield and minimal quality assurance required. Estimates of storage life and guidance to maximize storage should also be considered, minimal storage requirements are desired. Approaches with applicability to both state of the art and emerging green propellant formulations are encouraged.

The thruster technology should be capable of supporting a 15-year mission in GEO or Medium Earth Orbit (MEO) and 5 years in Low Earth Orbit (LEO) after ground storage of 5 years.

PHASE I: Demonstrate a feasibility concept and accompanying base model approach that shows path to meet manufacturability and performance metrics stated. The effort should clearly address and estimate propulsion system inert weight and overall flight system impacts as well as model and manufacturing technical challenges.

PHASE II: Demonstrate proof of concept with flight scaled components in relevant environment. Propulsion system inert weight and flight system impacts shall be optimized from those estimated in Phase I. Leading model and manufacturing technical challenges shall be retired or have a clearly defined path to mitigation.

PHASE III DUAL USE APPLICATIONS: The Offeror shall develop viable demonstration cases in collaboration with the government or the private sector. Follow-on activities are to be sought aggressively throughout all mission applications within DoD, NASA, and commercial space platforms by Offeror.

REFERENCES:
1. Ballinger, I.A.; Lay, W.D.; Tam, W.H., "Review and History of PSI Elastomeric Diaphragm Tanks", AIAA 95-2534, 31st AIAA/ASME/SAE/ASEE Joint Propulsion Conference, San Diego, CA, July, 1995.

2. Ballinger, A.; Sims, D., "Development of an EPDM Elastomeric Material for use in Hydrazine Propulsion Systems", AIAA 2003-4611, 39th AIAA Propulsion Conference, Huntsville, AL July 21, 2003.

3. Honse, J.P.; Bangasser, C.T.; Wilson, M.J., "Delta-Qualification Test of Aerojet 6 and 9 lbf MR-106 Monopropellant Hydrazine Thrusters for Use on the Atlas Centaur Upper Stage during the Lunar Reconnaissance Orbiter (LRO) and Lunar Crater Observation and Sensing Satellite (LCROSS) Missions", AIAA 2009-5481, 45th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Denver, CO August, 2009.

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5. United States Patent 5,417,049.

KEYWORDS: Spacecraft Propulsion, Chemical Propulsion, Propellant Storage, Propellant Feed system, Pump, Blow Down, Thruster

AF162-009 TITLE: Electric Propulsion for Dual Launch

TECHNOLOGY AREA(S): Space Platforms

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation and within the AF Component-specific instructions. Offerors

are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the AF SBIR/STTR Contracting Officer, Ms. Gail Nyikon, gail.nyikon@us.af.mil.

OBJECTIVE: Develop high-thrust solar electric propulsion technologies that enable/enhance mission capabilities and dual manifest launch opportunities for national security space assets.

DESCRIPTION: Pervasive electric propulsion (EP) technologies greatly enhance in-space maneuverability and spacecraft payload capacity for many DoD missions, such as transfer to Geostationary Earth Orbit (GEO), when compared to liquid chemical propulsion [1]. Satellites with EP as primary propulsion have lower propellant mass requirements, which provide cost and schedule advantages with launch vehicle step-down, dual launch, or mixed manifest capability on existing launch vehicles to reduce the number of satellite launches. This has significant benefits for DoD and commercial applications [2,3,4]. State-of-the-art EP on the Air Force Advanced Extremely High Frequency (AEHF) satellites have demonstrated orbit transfer from geosynchronous transfer orbit (GTO) to GEO, however this required multiple months of thruster firing time due to low thrust levels, which are limited by the available on-board power. Thus, maximizing thruster efficiency and thrust to power (T/P) levels are necessary to reduce orbit transfer time, specifically to minimize duration through the Van Allen radiation belts [5]. Existing technologies, such as high-power Hall thrusters, have demonstrated reduced efficiency when operating at peak T/P and must operate at a de-rated power, further reducing overall thrust [1].

This solicitation seeks research on EP system technologies capable of greater than 70% efficiency over the range of 1400 to 2000 seconds specific impulse (Isp), corresponding to T/P levels of 109 to 76 millinewtons per kilowatt (mN/kW), respectively. This efficiency includes power processing and ancillary losses, such as cathode flow or electromagnet power requirements. Proposal solutions may be either ideas for advancing existing thruster technologies or the development of new concepts, such as high-power electrospray propulsion. Specific power of the thruster and power processing should be less than 6 kg/kW. A representative power level for this technology is 3-10 kW, though subscale demonstrations may be conducted at lower power levels to accommodate cost-effective research activities. The full propulsion system (thruster, power processing unit & propellant feed) should define a clear path for transition to national security space applications in the proposal.

The thruster technology should be capable of supporting a 15-year mission in GEO or Medium Earth Orbit (MEO) and 5 years in Low Earth Orbit (LEO) after ground storage of 5 years.

PHASE I: Perform proof-of-concept analysis and experiments that demonstrate the feasibility of the high performance electric propulsion concept. End TRL 2 to TRL 4.

PHASE II: Measure performance and plume characteristics of breadboard hardware to demonstrate program goals for the high performance electric propulsion concept. Breadboard hardware will be evaluated on thrust stands at AFRL, and achieve TRL 5 at the end of Phase II activities. Deliverables include breadboard hardware, preliminary cost analyses, and full performance analysis with comparison to state-of-the-art EP.

PHASE III DUAL USE APPLICATIONS: Transition of a mature high performance electric thruster will reduce satellite orbit transfer time and enable/enhance dual launch or mixed manifest capabilities. Additional transition partners may include NASA and U.S. manufactured large GEO communications satellites.

REFERENCES:
1. Brown, D. L., Beal, B E., Haas, J. M., "Air Force Research Laboratory High Power Electric Propulsion Technology Development," IEEEAC Paper #1549, Presented at the IEEE Aerospace Conference, Big Sky, MT, March 3-7, 2009.

2. "Commercial Space Transportation Forecasts," Report, Federal Aviation Administration, Office of Commercial Space Transportation and the Commercial Space Transportation Advisory Committee, May 2013.

3. Sargent, Anne-Wainscott, "SpaceX Effect Fuels Efficiency Push in Launch Services Market," Via Satellite, July 17, 2014 (www.satellitetoday.com).

4. Feuerborn, S. A., Neary, D. A., Perkins, J. M., "Finding a Way: Boeing's All Electric Propulsion Satellite," AIAA-2013-4126, 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, July 14-17, 2013.

5. Observations of the Earth and Its Environment: Survey of Missions and Sensors, 4th Edition, Herbert J. Kramer, Springer Science & Business Media, 2002.

KEYWORDS: Electric Propulsion, Dual Launch, Dual Manifest, Thrust to Power, Orbit Transfer

AF162-010 TITLE: Flexible Electric Propulsion for Resilient Spacecraft

TECHNOLOGY AREA(S): Space Platforms

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the solicitation and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the AF SBIR/STTR Contracting Officer, Ms. Gail Nyikon, gail.nyikon@us.af.mil.

OBJECTIVE: Develop low-cost, flexible solar electric propulsion technologies that enable/enhance resilient mission capabilities and disaggregated satellite architectures.

DESCRIPTION: Electric propulsion (EP) is a pervasive space technology that greatly enhances in-space maneuverability compared to liquid chemical propulsion [1]. Satellites with EP have lower propellant mass requirements for the same maneuver, which reduces the overall satellite wet mass, enables more on-board propellant for additional maneuvers or extended lifetime, or increased payload mass capability [1, 2]. These capabilities enable numerous advantages for satellite resiliency, including dual launch or mixed manifest for functional disaggregation [3], and flexible positioning to enhance satellite options for multi-orbit disaggregation. To this end, a high efficiency EP technology compatible with chemical propellants could be paired with a chemical thruster to produce highly flexible and efficient multi-mode propulsion (MMP) system. An agile MMP system with shared propellant and tanks reduces system complexity and increases risk mitigation redundancy by enabling flexible and optimal utilization of propellant between the EP and chemical thruster system for in-space maneuvers, including orbit transfer, repositioning, station-keeping, attitude control, and disposal. Realizing these advantages requires innovative solar electric propulsion technologies with high efficiency and high thrust when operated with lightweight, molecular propellants used in chemical propulsion, such as hydrazine or advanced "green" energetic monopropellant formulations [4]. To date, EP technologies have not met the performance and lifetime requirements needed for agile MMP capabilities [5, 6].

This solicitation seeks research on electric thruster technologies capable of greater than 110 mN/kW over a specific impulse from 1000-1500 seconds. Proposal solutions may be either ideas for improving existing thruster technology or the development of new concepts. Specific power of the thruster and power processing electronics should be less than 6 kg/kW. A representative power level for this technology is 1-5 kW per thruster, though demonstrations may be conducted at different power levels or with simulated propellant to accommodate cost-effective research activities. The full propulsion system (thruster, power processing unit & propellant feed) should define a clear path for transition to national security space applications in the proposal.

The thruster technology should be capable of supporting a 15-year mission in GEO or Medium Earth Orbit (MEO)

and 5 years in Low Earth Orbit (LEO) after ground storage of 5 years.

PHASE I: Perform proof-of-concept analysis and experiments that demonstrate the feasibility of the high performance electric propulsion concept.

PHASE II: Measure performance and plume characteristics of breadboard hardware to demonstrate program goals for the high performance electric propulsion concept. Breadboard hardware will be evaluated on thrust stands at AFRL, and achieve TRL 5 at the end of Phase II activities. Deliverables include breadboard hardware, preliminary cost analyses, and full performance analysis with comparison to state-of-the-art EP.

PHASE III DUAL USE APPLICATIONS: Transition of flexible electric propulsion will enhance satellite resiliency with increased in-space maneuverability and reduced propellant mass. Transition may include NASA and the U.S. commercial large GEO communications satellites.

REFERENCES:
1. Brown, D. L., Beal, B E., Haas, J. M., "Air Force Research Laboratory High Power Electric Propulsion Technology Development," IEEEAC Paper #1549, Presented at the IEEE Aerospace Conference, Big Sky, MT, March 3-7, 2009.

2. Feuerborn, S. A., Neary, D. A., Perkins, J. M., "Finding a Way: Boeing's All Electric Propulsion Satellite," AIAA-2013-4126, 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, July 14-17, 2013.

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5. Frisbee, R. H., "Evaluation of High-Power Solar Electric Propulsion Using Advanced Ion, Hall, MPD, and PIT Thrusters for Lunar and Mars Cargo Missions," AIAA-2006-4465, 42nd AIAA Joint Propulsion Conference, Sacramento, CA, 9-12 July, 2006.

KEYWORDS: Electric Propulsion, Resiliency, Flexible, Disaggregation, Orbit Transfer