ARMY
16.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The US Army Research, Development, and Engineering Command (RDECOM) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Website: https://www.armysbir.army.mil/.

Solicitation, topic, and general questions regarding the SBIR Program should be addressed according to the DoD Program Solicitation. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit https://sbir.defensebusiness.org/. Specific questions pertaining to the Army SBIR Program should be submitted to:

John Smith
Program Manager, Army SBIR
usarmy.apg.rdecom-ac.mbx.sbir-program-managers-helpdesk@mail.mil
US Army Research, Development and Engineering Command (RDECOM)
6200 Guardian Gateway
Suite 145
Aberdeen Proving Ground, MD 21005-1322
TEL: (866) 570-7247
FAX: (443) 360-4082

The Army participates in three DoD SBIR Solicitations each year. Proposals not conforming to the terms of this Solicitation will not be considered. Only Government personnel will evaluate proposals.

PHASE I PROPOSAL SUBMISSION

SBIR Phase I proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments. Small businesses submitting a Phase I Proposal must use the DoD SBIR electronic proposal submission system (https://sbir.defensebusiness.org/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

The small business will also need to register at the Army SBIR website: https://portal.armysbir.army.mil/Portal/SmallBusinessPortal/Default.aspx in order to receive information regarding proposal status/debriefings, summary reports, impact/transition stories, and Phase III plans.

Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent,in other sections of the proposal as these will count toward the 20-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool. **Army Phase I proposals submitted containing a Technical Volume over 20 pages will be deemed NON-COMPLIANT and will not be evaluated. It is the responsibility of the Small Business to ensure that once the proposal is submitted and uploaded into the system it complies to the 20-page limit.**

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DoD Program Solicitation.

16.2 Phase I Key Dates

Solicitation closes, proposals due	22 Jun 2016, 6:00 am ET
Phase I Evaluations	24 Jun – 8 Sep 2016
Phase I Selections	12 Sep 2016
Phase I Award Goal	20 Oct 2016

**Subject to the Congressional Budget process*

PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL

The Army implements 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 efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume such as descriptions of capability or intent, in other sections of the proposal as these will count toward the 20-page limit.

PHASE I COST VOLUME

A firm fixed price or cost plus fixed fee Phase I Cost Volume ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete a Phase I Cost Volume not to exceed a maximum dollar amount of $100,000 and six months and a Phase I Option Cost Volume not to exceed a maximum dollar amount of $50,000 and four months. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Volume. The Cost Volume DOES NOT count toward the 20-page Phase I proposal limitation. When submitting the Cost Volume, complete the Cost Volume form on the DoD Submission site, versus submitting it within the body of the uploaded proposal.

PHASE II PROPOSAL SUBMISSION

Commencing with Phase II's resulting from a 13.1 Phase I, invitations are no longer required. Small businesses submitting a Phase II Proposal must use the DoD SBIR electronic proposal submission system (https://sbir.defensebusiness.org/). This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

Army SBIR has four cycles in each FY for phase II submission. A single Phase II proposal can be submitted by a Phase I awardee within one, and only one, of four submission cycles and must be submitted between 4 to 17 months after the Phase I contract award date. Any proposals that are not submitted within these four submission cycles and before 4 months or after 17 months from the contract award will not be evaluated. The submission window opens at 0001hrs (12:01 AM) eastern time on the first day and closes at 2359hrs (11:59 PM) eastern time on the last day. Any subsequent Phase II proposal (i.e., a second Phase II subsequent to the initial Phase II effort) shall be initiated by the Government Technical Point of Contact for the initial Phase II effort and must be approved by Army SBIR PM in advance.

The four Phase II submission cycles following the announcement of selections for the 16.2 solicitation are:

2017(a) 17 October to 16 November 2016
2017(b) 1 March to 31 March 2017
2017(c) 15 June to 14 July 2017
2017(d) 1 August to 30 August 2017

For other submission cycles, see the schedule below and always check with the Army SBIR Program Manager's office help desk for the exact dates.

SUBMISSION CYCLES	TIMEFRAME
Cycle One	30 calendar days starting on or about 15 October*
Cycle Two	30 calendar days starting on or about 1 March*
Cycle Three	30 calendar days starting on or about 15 June*
Cycle Four	30 calendar days starting on or about 1 August*

*Submission cycles will open on the date listed unless it falls on a weekend or a Federal Holiday. In those cases, it will open on the next available business day.

Army SBIR Phase II Proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes), data assertions and any attachments. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 38-page limit. As with Phase I proposals, it is the proposing firm's responsibility to verify that the Technical Volume does not exceed the page limit after upload to the DoD SBIR/STTR Submission site by clicking on the "Verify Technical Volume" icon.

Only the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 38-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool.

Army Phase II Proposals submitted containing a Technical Volume over 38 pages will be deemed NON-COMPLIANT and will not be evaluated.

Army Phase II Cost Volumes must contain a budget for the entire 24-month Phase II period not to exceed the maximum dollar amount of $1,000,000. During contract negotiation, the contracting officer may require a Cost Volume for a base year and an option year. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Small businesses submitting a proposal are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal.

DoD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DoD Program Solicitation very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the solicitation.

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.5 of this solicitation for definitions of “lawful permanent resident” and “protected individual”] as key personnel, they must be clearly identified. **For foreign nationals, you must provide country 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. Please ensure no Privacy Act information is included in this submittal.**

OZONE CHEMICALS

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase I ($100,000 maximum), Phase I Option ($50,000 maximum), and Phase II ($1,000,000 maximum), under "CMRA Compliance" in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://cmra.army.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

  (1) Contract number, including task and delivery order number;
  (2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
  (3) Estimated direct labor hours (including sub-contractors);
  (4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
  (5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
  (6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
  (7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual

entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

DISCRETIONARY TECHNICAL ASSISTANCE

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed nine Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

For more information, go to: https://www.armysbir.army.mil, then click the "SBIR" tab, and then click on Transition Assistance/Technical Assistance.

As noted in Section 4.22 of this solicitation, firms may request technical assistance from sources other than those provided by the Army. All such requests must be made in accordance with the instructions in Section 4.22. It should also be noted that if approved for discretionary technical assistance from an outside source, the firm will not be eligible for the Army's Technical Assistance Advocate support. All details of the DTA agency and what services they will provide must be listed in the technical proposal under "consultants". The request for DTA must include details on what qualifies the DTA firm to provide the services that you are requesting, the firm name, a point of contact for the firm, and a web site for the firm. List all services that the firm will provide and why they are uniquely qualified to provide these services. The award of DTA funds is not automatic and must be approved by the Army SBIR Program Manager.

COMMERCIALIZATION READINESS PROGRAM (CRP)

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DoD and/or non-DoD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at https://portal.armysbir.army.mil/Portal/SmallBusinessPortal/Default.aspx and is due within 30 days of the contract end date.

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) Submit two copies of the approved scientific or technical report delivered under the contract to the Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

ARMY SBIR PROGRAM COORDINATORS (PC) and Army SBIR 16.2 Topic Index

Participating Organizations	PC	Phone
Aviation and Missile RD&E Center (AMRDEC-A) (AMRDEC-M)	Dawn Gratz	256-842-8769
Army Research Lab (ARL)	Francis Rush Sabrina Hill	301-394-4961 301-394-3665
U.S. Army Test & Evaluation Command (ATEC)	Jessica Knight Anthony Ham	443-861-9339 443-861-9340
Communication-Electronics Research, Development and Engineering Center (CERDEC)	Joanne McBride	443-861-7654
PEO Intelligence, Electronic Warfare & Sensors (PEO IEW&S)	Hari Bezwada Michael Muller	703-806-4595 703-806-3631

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DoD requirements specified in the solicitation. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase I effort (up to **$100,000** with up to a six-month duration) AND an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

2. The proposal is limited to only **ONE** Army Solicitation topic.

3. The technical content of the proposal, including the Option, includes the items identified in Section 5.4 of the Solicitation.

4. SBIR Phase I Proposals have four (4) sections: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal submission as THESE WILL COUNT AGAINST THE 20-PAGE LIMIT. Any information that details work involved that should be in the technical volume but is inserted into other sections of the proposal will count against the page count. ONLY the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 5.4.e of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the "Company Commercialization Report" tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

5. The Cost Volume has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army prefers that small businesses complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

10. If applicable, Foreign Nationals are identified in the proposal. An employee must have an H-1B Visa to work on a DoD contract.

ARMY SBIR 16.2 Topic Index

A16-090	Flexible Integrated Intelligent Network (FIIN) for Prognostics Health Management (PHM) Systems
A16-091	Cost Effective Aerodynamic Missile Domes
A16-092	Low Cost, High Performance, Elastomeric Case Insulation for Solid Rocket Motors
A16-093	Multisensing Target Discrimination System
A16-094	Development of longwave infrared tunable laserline rejection filters
A16-095	High Speed Low Loss Quantum Optical Switch for 1550nm band
A16-096	Indoor GPS Satellite Constellation Antenna Array
A16-097	Expendable Active RF Technology for Helicopters (EARTH)
A16-098	Developing A Robust Software Assurance Tools for Cyber Security
A16-099	High Power MWIR Laser with Coherently Combined Emitters
A16-100	Third Generation Sensor Anti-reflecting Surface Textures for Maximum Transmission through Infrared Optical Surfaces

ARMY SBIR 16.2 Topic Descriptions

A16-090 TITLE: Flexible Integrated Intelligent Network (FIIN) for Prognostics Health Management (PHM) Systems

TECHNOLOGY AREA(S): Information Systems

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: The objective of this effort is to develop and demonstrate an integrated, robust, flexible, and intelligent PHM network for Army aviation applications.

DESCRIPTION: A FIIN would allow for advanced PHM capabilities that would increase aircraft safety and significantly impact O&S costs associated with aircraft maintenance. This network will provide prognostic and diagnostic capabilities to maintainers and crew members over a reliable and integrated network that enables automated inspections, damage detection, real-time component health, and physical state data for near real-time trend analyses and determination of remaining useful life. The goal is to develop a high bandwidth capacity, low cost network that allows for insertion of future PHM capabilities. The FIIN will be implemented into future Army aircraft, with possible insertion into legacy Army rotorcraft where cost effective. The FIIN should incorporate into Army aircraft without requiring any special installation equipment. In order to transition to Army aviation platforms, the FIIN should have minimal size, weight, and power requirements. The FIIN will be required to meet all current military specifications and future specification should be considered in its development. The rotorcraft of the future, the Future Vertical Lift (FVL) family of systems and beyond, will require significant improvements above current levels in operational availability, reliability, durability, maintainability, maintenance down time, and operating and support (O&S) costs. A key element of achieving the sustainment vision is an integrated, robust, flexible, and intelligent PHM network. The FVL will operate on an integrated mission system structure. The Joint Common Architecture (JCA) and Future Airborne Capability Environment (FACE) are being considered for this system structure; developers should consider this when developing their solution. The FIIN will be required to interface with the FVL system structure to enable the sharing of system health information to the aircrew members, the Adaptive Vehicle Management System (AVMS) for flight loads and mission capability data, and to transmit in-flight aircraft health and diagnostic information to ground crews to allow for the prepositioning of assets and maintenance execution when required. To meet these challenges the FIIN will require robustness, flexibility, the ability to reconfigure/self-heal if necessary, network integrity, accuracy and reliability. It will require a machine intelligence and a high degree of automation to ensure that the system continuously provides the physical state and health data for components connected to the FIIN and the ability to determine the proper route for distributing, storing and/or transmitting the data.

PHASE I: The Contractor shall develop and conduct a feasibility and trade-off assessment of a FIIN. The assessment should consider design options for the FIIN architecture. It should address the requirements and technical challenges indicated in the Topic's description above as well as data types, network composition (copper, fiber-optic and wireless); interface protocols; data transport/distribution; data management; and operational environment, to include vibration, humidity, temperature, and pressure extremes. The product of the Phase I will be a final report that recommends a FIIN architecture to be fully developed and demonstrated on a prototype system.

PHASE II: The Contractor shall design, fabricate, assemble, and demonstrate key elements of the FIIN chosen from the Phase I assessment in a Systems Integration Laboratory (SIL) environment. The FIIN will be evaluated on the level of integration, robustness, flexibility, intelligence, and ability to reconfigure/self-heal to meet future aircraft health assessment requirements and the technical challenges indicated in the topic's description. The degree of machine intelligence and automation that enables the system to continuously provide the physical state and health data for components connected to the network is of particular importance. The FIIN will also be assessed for its

ability to determine the appropriate route for distributing, storing and/or transmitting the data.

PHASE III DUAL USE APPLICATIONS: The Contractor shall develop a fully operational prototype FIIN for SIL and full-scale rotorcraft ground demonstrations. Transition of this technology could be integrated in a broad range of military/civilian aircraft including future and legacy aircraft.

The resulting technology will facilitate reliable health management of the LRUs connected to it. The health management technology could also apply to components in commercial rotorcraft, to include aeromedical, off-shore & exploration, and general civil aviation.

REFERENCES:
1. ADS -79D- HDBK, Aeronautical Design Standard Handbook, Condition Based Maintenance System for US Army Aircraft, 7 March 2013.

2. Technical Standard, Future Airborne Capability Environment (FACE), Edition 2.1, May 2014.

3. Steven Harrigan, "A Condition-Based Maintenance Solution for Army Helicopters", The AMMTIAC Quarterly, Volume 4, Number 2(http://ammtiac.alionscience.com/quarterly).

4. DuBois, Thomas; Kinahan, William and Dones, Fernado, Joint Common Architecture (JCA) Recommendations, American Helicopoter Society International, Forum 70 Proceedings, May 2014 (https://vtol.org/store/product/joint-common-architecture-jca-recommendations-9467.cfm).

5. Boydston, Alex; Feller, Peter; Vestal, Steve and Lewis, Bruce; Joint Common Architecture (JCA) Demonstration Architecture Centric Virtual Integration Process (ACVIP) Shadow Effort, AHS international Forum 71 Proceedings, May 2015 (https://vtol.org/store/product/joint-common-architecture-jca-demonstration-architecture-centric-virtual-integration-process-acvip-shadow-effort-10125.cfm)

KEYWORDS: Rotorcraft, Aviation, Health Management, Autonomous Control, Reliability, Sustainment, Network, Prognostics, Diagnostics, Joint Common Architecture (JCA), Airborne Capability Environment (FACE)

A16-091 TITLE: Cost Effective Aerodynamic Missile Domes

TECHNOLOGY AREA(S): Weapons

OBJECTIVE: Develop optical materials and novel methodology to produce an infrared-transmitting dome with high optical quality and enough design flexibility to simultaneously minimize cost and aerodynamic drag for missile seeker applications. Produce a low-drag dome for demonstration in an imaging missile seeker to prove the design and manufacturing technology developed in this effort.

DESCRIPTION: Executive Summary Statements:
1.) The US Army desires the ability to operate imaging sensors behind a non-spherical dome at the front of a missile.
2.) This effort shall develop novel materials, fabrication processes, and assembly methods which shall allow for the production of transparent domes for missiles at a minimized cost which is favorably compared to the cost of current, traditional, spherical domes.
3.) Exterior dome shape must remain variable in order to allow for tailoring of aerodynamic characteristics to fit various missile platforms.
4.) Dome materials must simultaneously transmit 1.06-micron laser radiation and either mid-wave infrared (MWIR) or long-wave infrared (LWIR), while not significantly affecting transmission of Ka-band radar. A solution for each infrared band is preferred.
5.) This effort shall consider dome maximum base diameters of 2.75, 5, and 7 inches.

The US Army employs imaging and non-imaging sensors on a variety of missile platforms to provide precision guidance to targets. The Army now places a strong emphasis on decreasing cost in its missiles, while simultaneously increasing the effective range of those missiles. Aerodynamic drag must be reduced on current missile platforms in order to extend the range of the missiles in an efficient manner. A key drag component of a missile with an imaging seeker is the front-end dome.

Aerodynamic drag varies with missile speed. Therefore, the shape of minimal-drag domes must be tailorable to suit different missile platforms.

Domes must also be resistant to abrasions and other environmental effects typically seen by missiles in tactical environments. The Army requires novel research of highly-transparent and robust optical materials. Novel dome materials must allow favorable transmission and wavefront quality for imaging missile seekers. Dome material research must couple with fabrication and alignment innovation in order to realize the cost minimization desired under this effort.

Platforms of interest to the Army are those with outside missile diameters of 2.75-inches, 5-inches, and 7-inches. Transparent dome base diameters are typically slightly smaller than the missile outside diameter. This effort shall expect length to diameter ratios of the aerodynamic domes to be greater than 0.5 (spherical), but likely less than 1.5. The smallest platform of interest (2.75-inch diameter) is likely to have a stationary, non-gimbaled sensor operating behind the dome. The larger platforms (5 and 7 inch diameters) are more likely to be gimbaled. These gimbaled sensors will rotate behind the dome as much as 10-degrees in angle from the longitudinal axis of the missile and dome. This motion significantly complicates dome wavefront quality metrics.

Larger diameter missile platforms may also be required to operate while transmitting both 1.06-micron laser radiation as well as Ka-band radar through the dome. The Army consequently prefers dome materials which might allow for such transmission. The Army shall regard this as lower in priority for this effort than the goal of infrared wavefront transmission and low cost.

Past efforts have developed techniques for both optical correction [1], [2], and dome fabrication and measurement [3], [4], [5], [6], for gimbaled seekers. These techniques have either not considered gimbaled imaging quality, or have proven to be prohibitively expensive for current missile programs.

Relatively recent work in chalcogenide materials [7] and molding technology [8] imply that more unique lower-cost infrared materials and novel approaches to dome technology may exist. The Army also recognizes that fresh approaches to older concepts, like plastics [9] [10], might now be made feasible.

Consider missile speeds for this effort to be subsonic. Dome abrasion is likely due to external mounting on aircraft. The Army may entertain the idea of hardened coatings, possibly even shielding the dome until launch if it is necessary, or any other novel concept to improve the lifetime of any domes developed in this effort.

The Army is primarily interested in domes which are transparent in the mid-wave infrared (MWIR) and long-wave infrared (LWIR). Of secondary interest is the near-infrared (NIR). These correspond to wavelengths 3 to 5 microns, 7 to 13 microns, and 0.7 to 1.5 microns, respectively. The dome materials in this study only have to transmit one waveband at a time. However, the Army prefers the ability to operate seekers on these missile platforms in a dual-mode configuration with a 1.06 micron laser designator sensor. Therefore, preference will be given to dome materials which exhibit simultaneous transmission in one of the aforementioned wavebands as well as at 1.06 microns.

Minimized materials and production costs are just as important to the Army as the ability to tailor domes to aerodynamic shapes with high-quality optical performance. This SBIR effort exists in order to produce domes which cost less than ones currently produced with traditional materials and methods. The Army's goal for this effort shall be to produce domes at 25% or less than the total cost of a missile seeker. An example production cost goal would be $3,000 for a dome on a large (7-inch diameter) missile platform. Smaller platform dome cost goals would be significantly less than this example.

Phase I proposals will be technically evaluated on the perceived ability of the technology to meet the previously-

stated desired system performance goals as well as achieve future cost goals.

PHASE I: Deliverable Summary:
Prior to conclusion of Phase I, the Army requires:
1.) Documented optical materials and fabrication process research to prove feasibility and quantify the likelihood to successfully achieve a dome prototype exhibiting previously-described qualities.
2.) Formulaic descriptions of dome shapes which are achievable by the proposed materials and methods, and which prove adaptability of the novel technology to the range of previously-described dome shapes.
3.) Analysis of expected transmitted wavefront quality with consideration for the novel materials and methods and dome shapes.
4.) Demonstration of feasible operation and scalability of any key technology components which must be achieved to prove feasibility of the proposed technology.
5.) A defined and documented incremental research plan to reduce technical risk as well as achieve cost goals.

Detailed Description of the expected Phase I effort:
The goal of the Phase I effort is to demonstrate the feasibility of a missile seeker dome with the desired properties as described in the previously stated description.

The Phase I effort shall demonstrate concept feasibility through optical design and process fabrication design, proven with calculations, references of direct experience, and component technology prototyping and/or lab experimentation. The Phase I effort shall be formulated to significantly reduce the risk to the success of future research to occur in Phase II and beyond.

A successful Phase I shall demonstrate a good understanding of manufacturing tolerances and alignment procedures which may be required to produce a seeker using such a dome.

Dome cost is often the most costly single component in a missile seeker. This SBIR effort exists primarily to solve this problem. A well-designed Phase I effort will show a clear path to low cost of fabricated, mounted, and aligned domes in quantities of several hundred to only a few thousand per year. Phase I shall define an incremental path of research to develop the technology and achieve the cost goals.

A successful Phase I shall demonstrate dome technology intended for domes exhibiting length-to-diameter ratios in the range described in the solicitation, but show some variability such that small design changes for aerodynamic reasons might be possible in the future.

Transmitted optical wavefront is a key consideration for this effort. Phase I shall examine transmitted wavefronts for proposed dome designs and produce a metric and limiting parameters by which dome optical quality can be assessed.

A well-received Phase I proposal will declare the missile diameters and wavebands which will be investigated in the SBIR effort. The Army will favor a well-formulated proposal which shows technology that might address several or all of the platforms of interest. A Phase I effort may also be formulated to demonstrate a scaled-down version of the novel dome technology, provided that the effort also establishes a well-designed incremental path to a full-scale prototype in later phases.

PHASE II: The Phase II effort shall produce and deliver prototypes of cost-efficient, aerodynamic missile domes. A successful Phase II will develop the technology that was proven to be feasible in Phase I. Detailed optical designs and manufacturing tooling designs shall occur in Phase II. Detailed fabrication and alignment processes shall be developed in Phase II. The Phase II effort shall also investigate and develop methods by which the dome will be held in place on a missile body. Phase II shall produce a functioning imaging seeker optical assembly which can be integrated with a camera to record video and test. The Phase II effort shall allow the Army to make a make a full assessment of the ability of the technology to be developed to a point where it can be integrated onto a missile platform.

In Phase II, the investigating firm shall deliver to the Army no less than two (2) prototype domes, integrated with imaging lenses. The domes shall have different shapes in order to demonstrate the design versatility of the novel

technology. Measured data on dome optical and mechanical quality shall be delivered, and shall use any novel quality metrics developed as a part of this effort. Materials discoveries and novel process steps shall be documented and reported. Any early parts which illustrate manufacturing process development shall also be delivered to the Army in order to provide evidence of low-cost production methods. The Phase II shall provide well-justified cost estimates for producing domes in production quantities.

A Phase II effort should also include marketing of the technology to missile prime contractors, and establishing relationships for potential integration of the dome technology into real missile platforms.

PHASE III DUAL USE APPLICATIONS: Simultaneously develop technology for integration into a specific missile platform as well as develop spin-off commercial applications for any materials, fabrication methods and processes, or novel design processes which were developed through the SBIR effort.
Potential commercial technology areas might be in commercial optics fabrication or software for design, assessment and/or fabrication of similar commercial optical components.

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KEYWORDS: dome, seeker, optics, infrared, missile, optical materials, molding, assembly

A16-092 TITLE: Low Cost, High Performance, Elastomeric Case Insulation for Solid Rocket Motors

TECHNOLOGY AREA(S): Materials/Processes

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

OBJECTIVE: Develop a low cost, domestically sustainable, elastomeric material for use as internal solid rocket motor case insulation, and demonstrate improved performance over state-of-the-art materials through increased stable char yield, reduced erosion, and low thermal conductivity of material up to maximum internal case temperatures.

DESCRIPTION: Traditional solid rocket motors require internal case insulation to prevent overheating of the motor case and subsequent failure of the motor. As newer designs utilizing composite materials begin to replace metal rocket motor cases to provide improved structural and Insensitive Munitions (IM) performance, internal insulation remains critical to keep the case wall well below the glass transition temperature of the matrix. Another essential function of the insulator when used in composite motor cases is to serve as the pressure seal. In addition to providing the necessary insulation for the motor case wall, these materials can also be tailored for use in thermal barriers, supporting multi-mission and extended range goals for tactical missiles.

Conventional motor case insulation materials are easily eroded when confronted with high heat flux and particle impingement. While some of this material ablation contributes to heat removal, increased insulation thickness is required to account for the material loss and maintain a positive thermal margin at the case wall. As a result, the thicker insulation consumes critical volume within the rocket motor and adds unwanted mass.

The intent of this topic is to develop novel, improved performance insulation materials through the use of commercially available constituent materials (additives, modifiers, fillers, reinforcements, etc.) that enable the production of a thick, tenacious, low thermal conductivity char. Balance between heat removal via mass loss and char stability is desired.

A focus on low cost materials and processes is essential, as is the long term domestic viability of the new material. Processability of the new material is critical for ease of insertion into typical solid rocket motor case manufacturing processes. In addition, special consideration must be given to the interface of the insulation material with the propellant. The insulator must have stable properties across the operating temperature range of the missile (typically -45 °F to +145 °F).

PHASE I: Identify and evaluate candidate materials to satisfy the performance objectives: thermal conductivity of the virgin material < 0.21 BTU/hr-ft-°F, and thermal conductivity of the charred material < 126.0 (BTU/ft-sec-°R) x 10^-6 at 6460 °R. Develop processing methods to ensure and demonstrate scalable processability. Characterize candidate filled-elastomer material systems through thermal, mechanical, and physical property testing. Perform propellant interface & bond line characterization with typical high performance propellants. Compare performance of candidate systems with state-of-the-art elastomeric insulation baseline through analyses of the physical properties and thermomechanical performance. Reference 5 provides typical physical properties for state-of-the-art Kevlar/EPDM insulation materials in Table 1, as well as thermal and erosion data for the Kevlar/EPDM designation ARI-2727. This reference (or another relevant reference for state-of-the-art solid rocket motor internal insulation material properties) may be used for comparison with new materials to determine the relative improvements in performance. Offerors should include a cost analysis of candidate materials for comparison with state-of-the-art materials.

PHASE II: Fabricate and test novel insulation material systems to verify improvements in thermo-mechanical properties. Perform relevant coupon level laboratory testing (e.g., plasma or oxyacetylene torch testing) to compare performance with state-of-the-art baseline insulation and down-select candidate(s). Perform sub-scale motor testing with down-selected candidate(s) to demonstrate performance. Provide evidence of process viability for large scale production while focusing on low cost, efficiency, and minimizing environmental impacts while maintaining the necessary material performance.

PHASE III DUAL USE APPLICATIONS: Demonstrate the new insulation material's thermo-mechanical capability in a relevant environment. Anticipated benefits for tactical rocket motors include improved motor efficiency, supporting multi-mission and extended range goals, reduced system mass and parasitic volume, and materials and processing techniques for low cost, sustainable, domestically-manufactured critical materials. Phase III applications for integration exist across the portfolio of current tactical Army systems and Technology Efforts through the replacement of thicker internal rocket motor insulation. Programs that would benefit from this innovation are not limited to Army systems, but extend throughout the Department of Defense and to the National Aeronautics and Space Administration. Commercial applications for this type of low cost, high performance elastomeric insulation material may exist in the private space industry and other commercial areas as well.

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KEYWORDS: Thermostructural composites, ablation, erosion, solid rocket motor insulation, filled elastomers

A16-093 TITLE: Multisensing Target Discrimination System

TECHNOLOGY AREA(S): 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: Develop an autonomous capability for missile systems to perform real time discrimination between targets, such as Rolled Homogeneous Armor and MOUT. Increase missile system lethality by rapidly and accurately identifying the target and automatically configuring the warhead.

DESCRIPTION: There is a need to develop an autonomous capability for missiles and munitions to discriminate between Rolled Homogeneous Armor (RHA) and various other softer targets on impact in real-time. Given the hardness of some targets, especially stone masonry, there needs to be a mechanism in place to identify an armor target from a MOUT target. In the absence of gunner input or a magnetometer, this task is not currently possible. Previous research focused on developing target signatures from impact sensors. This program will fuse data from multiple sensors to provide input to a configurable warhead for increased lethality effects. The sensors must be rugged and durable to survive high impact velocities greater than 200mps. Total system volume should not exceed 3 cubic inches.

RHA was chosen to represent very hard targets/materials such as tanks and heavily armored vehicles. Softer targets could include, but are not limited to brick, sand and thin steel. These materials represent targets such as cars, non-armored vehicles, bunkers, etc... The overall system should provide a discrimination result in less than 100 microseconds, with a 95% efficiency and reliability rating.

PHASE I: Determine the feasibility of integrating multiple sensors to discriminate between RHA and softer materials. Document and provide target classification data from the individual sensors. Measure, analyze and document the effect of impact angle and velocity on the sensor system response. Document potential improved resilience against false triggering on brush, branches, etc. Provide a conceptual graphical depiction of the end system, detailing the inputs to an advanced fuzing system for multi-purpose, multi-mode anti-armor warheads. Laboratory demonstration of the concept technology would be beneficial and useful for data collection and entry to the Phase II process.

PHASE II: Fabricate the electronics and data acquisition system for the Phase I sensor system. Integrate the multiple sensors with the electronics and data acquisition system. Test integrated device amongst complete target set (hard and soft targets). Demonstrate accuracy and reliability of target discrimination system.

PHASE III DUAL USE APPLICATIONS: The technology can be integrated with an advanced seeker and has a direct, fully supported transition path into the next generation close combat missile or munition. The advanced electronics and sensing capabilities can be transitioned to commercial applications.

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5. Patent US4019440. “Impact discriminating apparatus for missiles and the like, and method for impact discrimination.” https://www.google.com/patents/US4019440.

KEYWORDS: acoustic sensors, impact sensors, magnetometers, advanced optical sources, broadband optics, data fusion, target discrimination

A16-094 TITLE: Development of longwave infrared tunable laserline rejection filters

TECHNOLOGY AREA(S): 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: To develop longwave infrared tunable laserline rejection filters for uninterrupted enhanced force protection and situational awareness.

DESCRIPTION: There is a need to develop tunable notch or laserline rejection transmission filters operating in the longwave infrared (LWIR) spectral region to protect and allow uninterrupted operation of the LWIR sensors. Such a filter will efficiently block a single or multiple discrete wavelength band(s), while transmitting light in the rest of the spectral region. Currently, there are a number of optical filters: bandpass, high-pass, low-pass, etc., available for various applications in optics, imaging, spectroscopy, etc. Such tunable filters include acousto-optic tunable filters (AOTFs), liquid crystal tunable filters (LCTFs), Fabry-Perot filters, etc. that operate over many spectral regions. Existing filter technology is inadequate for notch filtering application since these filters transmit only a narrow band of light and reject the rest of the light in the spectral region. Therefore, novel compact notch filters need to be developed which will be useful in applications where a tunable intense light source or laser is used for a specific task and the operator and the environment need to be protected from the intense radiation.

The primary goal of the current SBIR is to develop a tunable LWIR notch filter capable of rejecting greater than 90% of IR light at the notch, while maintaining a greater than 90% transmission in the rest of the LWIR spectral region. A filter linewidth of less than 200 nm is preferred with an optical power handling of 200-500 mW with an acceptance angle close to ± 27 degree over less than an inch clear aperture. Proposed notch filter designs should clearly include an efficient mechanism for dissipating the absorbed or reflected optical energy at the notch wavelength. An electrical or optoelectronic tuning mechanism should be preferred. Materials should not be limited to traditional optical materials; instead exploitation of compatible material platforms suitable for operation in the LWIR spectral range is encouraged. Ability of the chosen material to dissipate the required optical power and operate under standard military specification should be addressed. The proposed designs should be both polarization and vibration insensitive with no-moving-parts. Fabrication techniques needed to realize proposed filter designs should be clearly defined in the Phase I effort. The device size should be less than one cubic inch and per unit cost should be close to $500.00.

PHASE I: Feasibility study for design and analysis of a tunable LWIR notch filter capable of rejecting greater than 90% of IR light at the notch, while maintaining a greater than 90% transmission in the rest of the 8-12 µm LWIR spectral region. A filter linewidth of 200 nm or smaller is preferable with an optical power handling of 200-500 mW with an acceptance angle of ± 27 degree over less than an inch clear aperture. These filters should be both polarization and vibration insensitive. The deliverables shall include a detailed design and simulation results for a tunable optical notch filter along with preliminary experimental characterization results for an early prototype filter.

PHASE II: Fabrication and demonstration of prototype tunable LWIR notch transmission filters which are polarization insensitive with close to an inch clear aperture with an acceptance angle of ± 27 degree and continuous electronic tuning of optical notch across the LWIR spectral region (8 – 12 micron). Tuning of the notch across the optical spectrum must be achieved at greater than 60 Hz with the smallest possible size. The filter should be capable of rejecting greater than 90% of IR light at the notch, while maintaining a greater than 90%transmission in the rest of the 8-12 µm spectral region. The expected deliverables are at least two fully operational prototype tunable LWIR notch transmission filters. Also, potential commercial and military transition partners for a Phase III effort shall be identified.

PHASE III DUAL USE APPLICATIONS: Further research and development during Phase III efforts will be directed towards a final deployable design, incorporating design modifications based on results from tests conducted during Phase II, and improving engineering/form-factors, equipment hardening, and manufacturability designs to meet the U.S. Army CONOPS and end-user requirements. Manufactured LWIR tunable laserline rejection filters shall be integrated into military systems utilizing LWIR sensor technologies. Such LWIR tunable laserline rejection filters are useful for commercial applications that use the LWIR lasers for manufacturing and other industrial applications where protection of the operator and the environment is required to avoid damage from high intensity laser radiation. The LWIR tunable laserline rejection filters will provide uninterrupted enhanced force protection and day/night situational awareness. Military applications for this technology include laser safety devices for Mounted/Dismounted Ground System thermal sensors, and for thermal imaging systems on manned aircraft, unmanned aerial vehicles and unattended ground sensors. Potential commercial applications include laser protection of thermal security cameras for use in Homeland Security applications (perimeter security at airports, coastal ports, nuclear power installations) or other remote viewing scenarios where an intense laser could be used by criminals/terrorists to defeat security at range.

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KEYWORDS: longwave infrared, LWIR, tunable, transmission filter, notch filter, laserline rejection filter

A16-095 TITLE: High Speed Low Loss Quantum Optical Switch for 1550nm band

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop and demonstrate a high speed low loss optical switch enabling high capacity quantum entanglement routing in fiber-based quantum networks.

DESCRIPTION: The Army is actively developing novel networks based on quantum phenomena, which will provide unprecedented degree of security and performance in challenging contested environments. Quantum mechanics permits nontrivial special connection between two or more physically separated systems that is called quantum entanglement. In quantum networks numerous pairs of entangled photons propagate over optical fibers to entangle remote network nodes. The resulting quantum entanglement between the nodes allows them to act in accord without explicitly exchanging any information. This in turn offers a number of novel functionalities, extending beyond those available to classical networks such as byzantine general agreement, multi-party function evaluations, quantum finger printing, and anonymous quantum communications. Testing and demonstrating these functionalities requires a small-scale operational quantum photonic network.

Many building blocks for quantum network (such as entanglement sources and detectors) have been researched, designed, built and even are available commercially. Yet a number of technological gaps remains. Some of these gaps – the design and development of hi-fidelity robust quantum memory units require advances in fundamental science. Yet there are the other areas for which the science had been well developed, and only the lack of deployable engineering solutions hinders the progress in quantum networking research and development. For instance, a crucial piece badly needed for putting together a quantum photonic network is a cascadable low-loss (< 1 dB), ultra-fast (GHz), fiber-based cross-bar switch, which would operate at 1550nm transparency window of optical fibers. This element will switch, route and time-bin entangled photon pairs for network operation [1].

The state-of-the-art fiber-optics switching solutions offered by telecom industry are either too slow (low-loss and low speed mechanical and MEMS switches) or have too much loss and polarization sensitivity (high speed and relatively high loss lithium niobate electro-optical switches). It is well understood in the community that low loss and high speed switches are possible to build utilizing the well-studied nonlinear optical phenomena in fibers [2,3]. Thus far such switches have been demonstrated, albeit near the 1300nm fiber transparency band. The switches

operating in more technologically relevant (thought to be more challenging) 1550 nm transparency window are yet to be built. The engineering challenges here start with selection of appropriate component solutions for the pump laser and the nonlinear fiber, designing low loss pump/signal combiners, identifying suitable subsystem designs and testing components in out-of-spec ranges. More specifically, the trade-offs between the strength of chosen fiber nonlinearity, its dispersion and loss needs to be characterized to determine the optimal design. While challenging, this task does not require fundamentally new scientific approaches. Instead it calls for adapting existing technologies to the new wavelength range, which amounts to an effort in system engineering.

In summary, there is a need for the development of a quantum switch that operates in the 1550 nm band, has low loss (0.5 dB), high speed (10GHz band), and high fidelity when switching quantum signals. The switch characteristics should be suitable for cascaded operation, and must be demonstrated.

PHASE I: Investigate components to meet the project goals. Demonstrate the concept design. Show switching operation through laboratory testing, modeling, simulation and detailed calculations. Deliverable specification should include loss not exceeding 1dB over 10GHz band and extinction ratios of 13dB in pulsed configuration. Consider the impact of cascaded operation on the isolation of spurious photons. Prepare a plan for prototype development and verification of the planned specifications.

PHASE II: Demonstrate, characterize and deliver a prototype switch. Deliverable specification should include the fidelity of a quantum signal through a single and through cascaded switches to be above 90% for room temperature operation; the switching gate of 50ps; background Raman noise level of 1e-5 photons/gate; and overall insertion loss of 0.5dB. Determine the exact operating signal wavelength range. Extend the system to other relevant wavelength bands if possible.

PHASE III DUAL USE APPLICATIONS: Improving the prototype toward commercialization. The contractor should work with Army scientists and engineers, along with commercial partners, to identify and implement technology transition to military (ARMDEC, ECBC & CERDEC) and civilian applications (Datacom providers). The applications could impact many areas where the temporal resolution of sensitive light detectors are important including imaging through turbid media, laser radar, fluorescence lifetime imaging, and deep space optical communications (high sensitivity pulse position modulation receivers). Another potential application domain is Datacom, which needs for a cost-effective fast optical packet switch for future intra-data center networks.

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KEYWORDS: quantum networks, entanglement, fiber-optics, switching, routing

A16-096 TITLE: Indoor GPS Satellite Constellation Antenna Array

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: The design, development and fabrication of a realistic indoor GPS constellation simulated signal environment to support GPS antenna and receiver testing in a jamming environment to greatly reduce the need to conduct outdoor jamming testing and bridge the capability gap between outdoor testing and laboratory testing.

DESCRIPTION: Typical laboratory GPS testing lacks realism compared to live testing and laboratory test configurations do not precisely represent the motion of the orbiting GPS satellites with respect to the GPS receiver antenna being tested. The spatial relationships between the GPS satellites and the test item's antenna is either ignored (when injecting the GPS signals into the receiver's RF input port) or can only be approximated (tripods/fixed GPS satellite positions) for a short time period since the live GPS satellites are constantly in motion.

The indoor GPS satellite constellation antenna array will provide a complimentary test capability that supplements outdoor GPS EA/ET testing and can greatly reduce the amount of outdoor GPS EA/ET testing events. It will not completely replace outdoor test events but it will provide better realism than existing laboratory testing without the need for spectrum coordination at local, regional, and national levels associated with outdoor GPS EA/ET testing. It will allow for additional opportunities to test GPS systems under realistic conditions to better ensure vulnerabilities are not overlooked. This solution bridges the gap between laboratory and outdoor GPS EA/ET testing.

The position of individual GPS satellite (space vehicle) signal emissions in the indoor array will be dynamic to match the simulated GPS satellite relative position with respect to the receiver under test. The fact that the orbital movement of the actual GPS constellation has the effect of real-time motion makes this solution as realistic as possible. The system should work with a commercial-off-the-shelf (COTS) GPS signal simulator (for example the Spirent Federal Systems, Inc. Model 7790) to produce a realistic and dynamic GPS signal constellation at signal levels consistent with live GPS signals and separate them onto individual outputs (channels) that will feed the array. The array will be controlled by the GPS Simulator. The array should be capable of simulating the dynamic positions of at least 14 satellites (L1 & L2 frequencies at C/A-code, Y-code, and M-code).

The size of the array would need to be scalable to fit within a climate-controlled anechoic chamber. The antenna array should be able to be used within a chamber equipped with up to seven other antennas which would be providing threat signal generation. GPS Satellite Simulator Signals will be provided from a control room, adjacent to the anechoic chamber, where EA/ET Signal Generators, Test Control Computers, and Data Collection equipment will reside.

PHASE I: Determine feasibility and provide a prototype design for the Indoor GPS Satellite Constellation Antenna Array.

PHASE II: Develop and demonstrate a prototype Indoor GPS Satellite Constellation Antenna Array which can be integrated with a commercial-off-the-shelf (COTS) GPS signal simulator.

PHASE III DUAL USE APPLICATIONS: A commercial variation may include a complete system package, including the antenna array, EA/ET system generation and control, control and data collection systems and software, and test item positioner, ready for installation into a suitable chamber and connection to a COTS GPS simulator.

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5. Additional Q&A from TPOC posted in SITIS on May 5, 2016.

KEYWORDS: GPS, Antenna, Array, Position, Dynamic, Satellite, Simulator, Constellation, Attack, Emerging, Threat, Anechoic, Chamber, Global, Positioning, Controlled, Radiation, Pattern, Jamming, Indoor

A16-097 TITLE: Expendable Active RF Technology for Helicopters (EARTH)

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: To develop an expendable active RF radar countermeasure that can be deployed from rotary wing aircraft and effective at defeating threats independently or in conjunction with low powered directed energy RF countermeasures.

DESCRIPTION: The Army is interested in novel RF countermeasures compatible with the limited size, weight, and power (SWaP) of rotary wing aircraft to counter advances in radar threat systems as a replacement for traditional passive radar countermeasure expendables. The radar countermeasure would be expected to provide a false radar target through active jamming from an expendable. Future expendable technology concepts should consider small power source and aerodynamics that could support enough flight/transmit time and coverage for the platform to maneuver or eliminate the threat. Deployment of this type of countermeasure would be a low weight and low cost alternative and/or supplement to traditional countermeasure systems against radar and RF guided weapons. Current RF expendables on Army Rotary wing are a simple chaff, basically metallic shavings that create a false radar signature in an attempt to either hide the platform or distract an active radar system. This topic is expected to replace chaff by providing active transmission of countermeasure waveforms through application of digital RF memory countermeasure techniques from an expendable.

Developed expendable size constraints are 1 inch x 1 inch x 8 inches (length). Furthermore the expendable should be activated via an impulse cartridge (also known as squib), examples include OMI-M796, and OMI-BBU-355. Objective weight of the expendable is below 200g and must be operable in all weather conditions and temperatures from -45 to 75 degrees Celsius. Preliminary output power objective is 10W average power and a frequency range from 2-18 GHz. Active emission times is expected to be between 15 and 30 seconds from ejection, giving the equipped rotor craft time to mask it's signature with terrain or other countermeasure capability.

PHASE I: Provide trade analysis and develop overall system design that includes transmitter circuit design and aerodynamics flight model accounting for rotor wash of the aircraft. Expected deliverable from Phase I would include a white paper describing the engineering trade space for potential system designs, notional circuit designs and an analysis of the viability of the aerodynamic flight model.

PHASE II: Develop and demonstrate expendable prototype with realistic power source suitable for long shelf life. Conduct testing to prove feasibility of flight time in operational conditions. Phase II deliverables would include a detailed design of prototype system, including bill of materials and layout, as well as a white paper focused on potential a long shelf life power supply solution.

PHASE III DUAL USE APPLICATIONS: At conclusion of Phase III, the expendable would be an additional asset for employment by military rotary wing aircraft by providing countermeasure effects against advanced radar threat systems. Installation and operation would be compatible with current expendable dispensing systems. Information on specifications of existing expendable dispenser system can be found at BAE Systems reference the AN/ALE-47 Dispenser System. The most likely transition of this technology would be to Program Manager (PM) Aircraft Survivability Equipment (ASE) and/or PM Close Combat Systems (CCS) for fielding on Army helicopters. The flight dynamics of the expendable could be modified to suit high-altitude commercial jetliner for self-protection against military grade radars.

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KEYWORDS: Expendable, active, Radio Frequency, helicopter, countermeasure, self-protection, electronic, radar, missile

A16-098 TITLE: Developing A Robust Software Assurance Tools for Cyber Security

TECHNOLOGY AREA(S): 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: The ubiquitous nature of modern computing requires an arsenal of security tools and techniques. One of the more powerful techniques is the employment of Automated Tools. While many Automated Tools exist they are unfortunately weak in many critical aspects such as forcing a tradeoff between large numbers of false positives and false negatives, failure to identify deliberately injected malicious code, and lack of breadth of coverage, including and a failure to account for many aspects of computing hardware such as hardware accelerators. This topic seeks to develop a set of robust Automated Tools for the modern heterogeneous computing systems following both active and passive security paradigms to address the shortcomings above which are intrinsic to existing technologies. The Automated Tools proposed will provide software security at development and deployment stages for both custom and integrated Commercial-Off-The-Shelf systems.

DESCRIPTION: The current set of Automated Tools available for the security professional have a number of advantages such as speed and volume of coverage [1] [2]. However, these advantages come at a cost which includes limited breadth of scope, over specialization, and a complete ignorance of modern computing hardware designs – e.g. hardware accelerators such as the Graphics Processing Unit (GPU) [3] [2] [4]. Additionally, current software assurance scanning technologies result in finding lists which are largely incomplete (many false negatives), or which contain many false positives requiring large amounts of human analysis to triage.

Therefore as part of mission critical cybersecurity we solicit for the development of a more robust and powerful set of Automated Tools for the modern computing system. This proposal seeks to develop a set of robust Automated Tools for the modern heterogeneous computing systems following both active and passive security paradigms to address the shortcomings above which are intrinsic to existing technologies. The Automated Tools proposed will provide software security at development and deployment stages for both custom and integrated Commercial-Off-The-Shelf systems.

PHASE I: Develop a white paper or prototype which documents a process for developing a robust Automated Tools set for modern computing systems that will provide cybersecurity. The proposed solution shall follow both active and passive design/implementation paradigms that employ automated interface testing for Commercial Off The Shelf (COTS) and machine learning methodologies across distributed and shared heterogeneous architecture environments [5].

The active design model will be defined by real-time testing to detect vulnerability to known hacking techniques,

malicious code variants, and interfaces to insecure COTS components using powerful machine learning algorithms to detect intentional and unintentional secure coding issues. This type of analysis would leverage dynamic testing techniques to find exploitable vulnerabilities. The passive design model of this proposed Automated Tools set will be defined by uncovering deliberately injected malicious code logic including the detection of specialized types of malicious code such as GPU-Assisted malware in already developed software applications.

PHASE II: Develop a working prototype, based on the selected Phase I design which demonstrates capabilities of a robust Automated Tools for Cyber Security.

The proposed solution shall provide a higher level of cybersecurity for the developer and security professional. The ability of Automated Tools to actively recognize potential malicious code and logic techniques as the system is developed will provide critical security throughout the Software Development Lifecycle (SDLC), which will significantly reduce costs [2]. By finding potential vulnerabilities earlier in the lifecycle, rather than through problem reports after systems are fielded, sustainment costs can be drastically reduced, and system readiness drastically enhanced. The recognition of the potential for malicious attack via the GPU has far reaching benefit for security as well, given the high number of systems that now routinely incorporate such devices in their architectures [4].

PHASE III DUAL USE APPLICATIONS: In conjunction with Army, optimize the prototype created in Phase II. Implement a Robust Software Assurance Tools for Cyber Security solution for test and evaluation, using commercially available technologies. The implementation should ensure that the system is interoperable with existing system of systems. Perform steps required to commercialize the system.

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KEYWORDS: Cyber Security, Automate, ROSE, Commercial Off The Shelf (COTS), malicious, vulnerabilities, Graphics Processing Unit (GPU), General Programming for GPU (GPGPU), Software Development Lifecycle (SDLC)

A16-099 TITLE: High Power MWIR Laser with Coherently Combined Emitters

TECHNOLOGY AREA(S): 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: Develop a mid-wave infrared (MWIR) laser module, based on coherent combination of several laser emitters, for directed energy and remote sensing applications.

DESCRIPTION: Recent advancements in MWIR laser technology offers efficient continuous wave (CW) and pulsed laser sources operating at near-room temperatures. State of the art semiconductor quantum cascade laser (QCL) emitters produce stable single-mode emissions above 1 watt (W) power levels. Various technologies are employed to increase the laser output power levels based on beam combination from several emitters. The progress in MWIR laser power scaling is limited due to the commercial availability of various optical components required for efficient MWIR beam combining, as well as the difficulties associated with the combination of a larger number of laser emitters into a single diffraction-limited output beam. Presently attainable MWIR laser output power levels do not exceed a few tens of watts. At the same time, coherent beam combining is rapidly evolving as an important technology capable of combining a large number (> 50) of individual emitters, and therefore presents an attractive option for beam combining in MWIR. The purpose of this SBIR is to develop a reliable MWIR laser module for scaling output powers in excess of 100W with high output beam quality, stability, and power. The laser module should be designed for high volume production manufacturing with high yields. The goal is to field this technology to rotary wing platforms where size, weight, and power (SWaP) is a primary concern. Only technologies that have a reasonable chance of meeting SWaP requirements will be considered. Commercial availability of these laser modules with output powers in excess of 100W for directed energy applications will significantly enhance the operational performance of several military laser systems.

PHASE I: Design an innovative concept for the coherent high power MWIR laser beam combining architecture capable of scaling the output beam power levels to hundreds of watts while maintaining near-diffraction-limited output beam quality. Develop a detailed initial concept design of the architecture and the optical components required during the course of the beam combining. The design should clearly demonstrate scalability of the combining approach to several tens of laser emitters operating in the spectral range around 3 to 5 microns, with the combined power levels exceeding 100W CW. Develop detailed analysis of the predicted performance of the combined output beam quality with detailed simulations. This Phase will demonstrate the feasibility of producing a demonstration of the proposed system concept and will outline demonstration success criteria, tolerance analysis, and performance assessment.

PHASE II: Using results from Phase I, produce a prototype beam combining module employing MWIR semiconductor lasers, capable of coherently combining a large number of individual laser emitters, with near-diffraction-limited output beam quality. Demonstrate the prototype in accordance with the demonstration success criteria developed in Phase I. The fractional beam power within the central node of the combined far field distribution should not be less than 80% of the total combined output. The size of the beam combining module should not exceed 18”x12”x4.” Required Phase II deliverables will include the prototype beam combining module, detailed performance characterization results in a laboratory environment, and a final report.

PHASE III DUAL USE APPLICATIONS: The developed high-power, coherently combined MWIR laser module will be employed to enhance operational characteristics of several potential applications.

MILITARY APPLICATION: This technology has applications in infrared missile countermeasures (IRCM), free-space optical communications, light detection and ranging (LIDAR), and laser-based chemical and biohazard detection.

COMMERCIAL APPLICATION: This technology has applications in remote sensing of industrial effluents, gas leak detection, mineral/petroleum prospecting, medical and dental surgery, LIDAR, and free space optical communication.

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KEYWORDS: coherent beam combining, mid-wave infrared, MWIR, laser arrays, infrared countermeasures, IRCM, light detection and ranging, LIDAR, chemical and biohazard detection, free-space optical communications.

A16-100 TITLE: Third Generation Sensor Anti-reflecting Surface Textures for Maximum Transmission through Infrared Optical Surfaces

TECHNOLOGY AREA(S): Materials/Processes

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: Second Generation Infrared Sensors have a single band focal plane with one F# and 5 or 6 lenses. Third Generation Sensors have a dual band focal plane with two F#s and a plethora of refractive lenses and mirrors. As a result the transmission through this optical system is about 65% of second generation sensors with the resultant increase in noise equivalent temperature difference. It is the objective of this topic to develop anti-reflecting surface textures to have transmission values equal to or better than Second Gen. These surface textures must include both the MWIR and LWIR bands. Innovative solutions to this important problem are being sought after such as the motheye or structured gradient meta-materials. Successful completion of this project would have an overwhelming positive impact on the performance of the 3rd Gen Sensor.

DESCRIPTION: Surface treatments have been optimized for both the LWIR and MWIR spectral band for systems where only a single band is being used. The next generation of systems being developed by the Army will be imaging simultaneously over a much broader band. There are currently surface treatments available that cover this broad spectral range, however, their performance is insufficient to meet all the needs of the Third Gen Sensor systems. The surface treatments are not limited to just one component of the optical system, each set of components needs improvement in transmission to see the largest improvement in performance. The components are listed below in the order of the potential for most significant impact on overall system performance. Radioactive surface treatments are not an acceptable solution.

Refractive lenses:
Typically these surface treatments are degraded by 3-5% versus a standard surface treatment for just the MWIR or LWIR individually. Overall system performance is degraded both because of the lower transmission surface treatment and due to the increased complexity in the design of these systems which result in an increased number of optical elements. The goal is to obtain greater than 99.2% average transmission per lens with high yield for the 3.5 - 5.0 µm and 7.8 – 10.5 µm spectral bands (based on a 1mm material thickness). At a minimum, materials to consider are Germanium, Zinc Selenide (ZnSe), Zinc Sulfide (ZnS), Barium Fluoride, and Gallium Arsenide, but also chalcogenide glasses such as AMTIR, GASIR lenses, and any other materials that will meet the transmission spectrum with environmental stability.

Mirror surface treatments:
Mirror surface treatments have two different requirements depending on their location in the system. Typical 3rd Generation FLIR systems will consist of a reflective afocal that will be required to pass light from 0.5 µm to 11 µm tend to have a reflective component to them creating a demand for high reflectivity surface treatments over an extremely broad range. Greater than 99% reflectivity is desired in the 3.5 -5.0 µm and 7.8 – 10.5 µm spectral bands while maintaining greater than 97% reflectivity over the remainder of the spectral band. In addition to the afocal surface treatments, fold mirrors will exist that do not require transmission beyond the 3.5 -5.0 µm and 7.8 – 10.5 µm spectral bands. These surface treatments can be further optimized due to the limited spectral bands.

Beamsplitter surface treatments:
In order to pass multiple spectral bands through the same aperture, it is required to combine the light paths prior to the afocal. This is accomplished via a beamsplitter that will be required to both pass the 3.5 -5.0 µm and 7.8 – 10.5 µm spectral bands and reflect the 0.5 – 2.0 µm or reflect the 3.5 -5.0 µm and 7.8 – 10.5 µm spectral bands and pass the 0.5 – 2.0 µm spectral band. It is desired to be able to achieve greater than 95% for the 3.5 -5.0 µm and 7.8 – 10.5 µm and greater than 92% for the 0.5 – 2.0 µm spectral band.

Cold filter surface treatments:
An important component of the 3rd Gen FLIR Dewar is the cold filter located inside the cold shield. This filter is at nearly the same temperature as the focal plane (~80K) and controls the amount of out of band radiation that reaches the detector. It is desired to have very high transmission in band while rejecting the out of band spectrum. A transmission of greater than 95% within the 3.5 -5.0 µm and 7.8 – 10.5 µm spectrum is desired.

Windows:
Broadband windows are another significant component that needs improvement. Windows offer an additional challenge in that they require a surface treatment that is not only highly transmissive, but also durable. In addition, windows may be required to pass light from 0.5 µm to 11 µm in order to maintain the desired common aperture between sensors that is present in 3rd Gen systems. It is desired that a 3rd Gen window be able to meet a 95% transmission over the spectral band while maintaining a severe abrasion resistance.

Environmental Conditions:
The surface treatments shall meet specified performance after being stored in temperatures IAW ATPD-2404A, 5.2.2.1 and temperature shock IAW ATPD-2404A, 5.2.4. The surface treatments shall meet the Operational Humidity IAW ATPD-2404A, 5.1.3.3. The surface treatments shall meet the exposure to blowing sand IAW ATPD-2404A, 5.1.6.2.

PHASE I: Create theoretical anti-reflecting surface texture designs that will exceed the performance of the current state of the art as described in the topic description. Develop a plan for improved processes to increase yield in surface quality to achieve as built surface treatments closer to that of theoretical. The cost for this innovative approach should not be greater than what is used in second generation FLIRs.

PHASE II: Revise surface treatment designs from phase I as needed and provide witness samples for all IR materials and components suggested in the topic description meeting each requirement. Develop surface treatments for other materials that are applicable for dual band applications. Implement improved surface treatment processes developed in Phase I to increase yield of dual band surface treatments. Provide samples for testing of transmission and durability.

PHASE III DUAL USE APPLICATIONS: Military Application: Successful demonstration of this technology will lead to its insertion into the Third Gen FLIR program that will be fielded by PMdGS. The success of this technology will immediately improve the performance of 3rd Gen technology (and other dual band infrared technologies), and be immediately inserted without impacting any other system components.
Commercial Application: The same impact would be expected for commercial applications that would utilize infrared focal planes. Applications include law enforcement, search and rescue, and high sensitivity broad-band radiometric measuring devices.

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KEYWORDS: Electronics, infrared, dual band, anti-reflection, motheye, Meta materials