MISSILE DEFENSE AGENCY (MDA)
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
SBIR 10.3 Supplemental Proposal Submission Instructions

INTRODUCTION

The MDA SBIR/STTR Program is implemented, administrated and managed by the MDA SBIR/STTR Program Management Office, located within the Advanced Technology (DV) Directorate. Specific questions pertaining to the MDA SBIR Program should be submitted to:

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Director, SBIR/STTR Programs
sbirsttr@mda.mil

MDA/DV
Bldg 5222, Martin Road
Redstone Arsenal, AL 35898
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If you have any questions regarding the administration of the MDA SBIR/STTR Program please call (256) 955-2020 or e-mail: sbirsttr@mda.mil.

Additional information on the MDA SBIR/STTR Program can be found on the MDA SBIR/STTR home page at http://www.mdasbir.com/. Information regarding the MDA mission and programs can be found at http://www.mda.mil.

MDA participates in one DoD SBIR Solicitation each year. Proposals not conforming to the terms of this Solicitation will not be considered. MDA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality will be funded. Only Government personnel will evaluate proposals.

NOTE: Beginning in CY11, MDA plans to participate in the xx.2 solicitation.

Questions about SBIR and Solicitation Topics

For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (1-866-SBIRHLP) (8:00 am to 5:00 pm EDT). For technical questions about the topic during the pre-solicitation period (20 July 2010 through 16 Aug 2010), contact the Topic Authors listed under each topic on the http://www.dodsbir.net Web site by 16 Aug 2010. Please Note: During the pre-release period, you may talk directly with the Topic Authors to ask technical questions about the topics. Their names, phone numbers, and e-mail addresses are listed within each solicitation topic. For reasons of competitive fairness, direct communication between proposers and topic authors is not allowed when DoD begins accepting proposals for each solicitation. However, proposers may still submit written questions about solicitation topics through the SBIR/STTR Interactive Topic Information System (SITIS), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing until the solicitation closes. All proposers are advised to monitor SITIS during the solicitation period for questions and answers, and other significant information, relevant to the SBIR/STTR topic under which they are proposing.

Federally Funded Research and Development Centers (FFRDCs) and Support Contractors:

Only Government personnel will evaluate proposals. In some circumstances, non-government, technical personnel from the following Federally Funded Research and Development Centers (FFRDCs) and support contractors will provide advisory and assistance services to MDA, including providing technical analyses of proposals submitted against MDA topics and of applications submitted to the MDA Phase II Transition Program.

FFRDCs: The Aerospace Corporation, Massachusetts Institute of Technology Lincoln Laboratory, Oak Ridge National Laboratory.

Universities / Non-Profit Organizations: Draper Laboratory, Institute of Defense Analyses, Johns Hopkins University Applied Physics Laboratory (JHU/APL,), Utah State University Space Dynamics Laboratory, Aerospace Corporation, MITRE Corporation, University of Connecticut, Sandia National Laboratory.

Support Contractor Organizations: BAE Systems, The Boeing Company, Booz Allen Hamilton, Cobham Analytic Services (Sparta, Inc), CACI International, Inc., Computer Sciences Corporation (CSC), deciBel Research, Inc., Dynamic Research Corporation, Inc., ERC, Inc., General Dynamics Information Technology, L-3 Communications Corporation, Lockheed Martin, MacAulay Brown, Inc., Millennium Engineering and Integration, Inc., Modern Technology Solutions, Inc., Northrop Grumman, Paradigm Technologies, Photon Research Associates, Inc. (Raytheon), QuinetiQ North America, Radiance Technology, Raytheon Company, Schafer Corporation, Science Applications International Corporation (SAIC), SYColeman Corporation, United International Engineering, Universal Technology Corporation.

Individual support contractors from these organizations will be authorized access to only those portions of the proposal data and discussions that are necessary to enable them to perform their respective duties. These organizations are expressly prohibited from rating proposals or making recommendations for award selection. In accomplishing their duties related to the source selection process, employees of the aforementioned organizations may require access to proprietary information contained in the offerors' proposals.

Pursuant to FAR 9.505-4, the MDA contracts with these support contractors include a clause which requires them to (1) protect the offerors' information from unauthorized use or disclosure for as long as it remains proprietary and (2) refrain from using the information for any purpose other than that for which it was furnished. In addition, MDA requires the employees of those support contractors that provide technical analysis to the SBIR/STTR Program to execute non-disclosure agreements. These agreements will remain on file with the MDA SBIR/STTR PMO.

Conflicts of Interest

You must avoid any actual or potential organizational conflicts of interest (OCI) while participating in any MDA-funded contracts, regardless of whether it was awarded by MDA. You must report to the MDA SBIR/STTR Program Office via e-mail any potential OCI before submitting your proposal or application. The MDA SBIR/STTR Program Office will review and coordinate any possible solutions or mitigation to the potential conflict with the contracting officer. If you do not make a timely and full disclosure and obtain clearance from the contracting officer, MDA may reject your proposal or application, or terminate any awarded contracts for default. See FAR Subpart 9.5 for more information on organizational conflicts of interest.

PHASE I GUIDELINES

MDA intends for the Phase I effort to determine the merit and technical feasibility of the concept. Only UNCLASSIFIED proposals will be entertained. Phase I proposals may be submitted for an amount normally not to exceed $100,000.

A list of the topics currently eligible for proposal submission is included in section 8, below, followed by full topic descriptions. These are the only topics for which proposals will be accepted at this time. The topics originated from the MDA Programs and are directly linked to their core research and development requirements.

Please ensure that your mailing address, e-mail address, and point of contact (Corporate Official) listed in the proposal are current and accurate. MDA cannot be responsible for notification to a company that provides incorrect information or changes such information after proposal submission.

USE OF FOREIGN NATIONALS

A foreign national is 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 2.15 at the front of this solicitation for definitions of "lawful permanent resident" and "protected individual."

ALL offerors proposing to use foreign nationals MUST disclose this information regardless of whether the topic is subject to ITAR restrictions. If the offeror proposes to use foreign nationals: Identify the foreign national(s) you expect to be involved on this project as a direct employee, subcontractor or consultant and country of origin. For these individuals, please specify the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. 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.

Proposals submitted with a foreign national listed will be subject to security review during the contract negotiation process (if selected for award). If the security review disqualifies a foreign national from participating in the proposed work, the contractor may propose a suitable replacement. In the event a proposed foreign person is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

ITAR RESTRICTIONS

The technology within some MDA topics is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. You must ensure that your firm complies with all applicable ITAR provisions. Please refer to the following URL for additional information: http://www.pmddtc.state.gov/compliance/index.html.

Proposals submitted to ITAR restricted topics will be subject to security review during the contract negotiation process (if selected for award). In the event a firm is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

PHASE I PROPOSAL SUBMISSION

The DoD SBIR/STTR Proposal Submission system (available at http://www.dodsbir.net/submission) will lead you through the preparation and submission of your proposal. Read the front section of the DoD solicitation, including Section 3.5, for detailed instructions on proposal format and program requirements. Proposals not conforming to the terms of this solicitation will not be considered.

You must submit the ENTIRE technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report electronically through the DoD SBIR/STTR Web site at www.dodsbir.net/submission/SignIn.asp. If you have any questions or problems with the electronic proposal submission, contact the DoD SBIR/STTR Helpdesk at 1-866-724-7457. Refer to section 3.0 of the DoD solicitation for complete instructions and requirements.

MAXIMUM PAGE LIMIT FOR MDA IS 20 PAGES

Only proposals submitted via the Submission Web site on or before the deadline of 6a.m (ET) on 15 September 2010 will be processed. ***Please Note:*** The maximum page limit for your technical proposal is twenty (20) pages. Any pages submitted beyond this, will not be evaluated. Your cost proposal and Company Commercialization Report DO NOT count toward your maximum page limit.

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

MDA is now implementing the use of a Phase I Option that **may be exercised at MDA'S sole discretion** to fund interim Phase I activities while a Phase II proposal is being evaluated and if selected, the contract is being negotiated. Only Phase I efforts invited to propose for a Phase II award through MDA's competitive process will be eligible for MDA to exercise the Phase I Option, if MDA so chooses. The Phase I Option, which **must** be included as part of the Phase I proposal, covers activities over a period of up to six months, if exercised, and should 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.

A firm-fixed-price Phase I Cost Proposal ($150,000 maximum, including option) must be submitted in detail online. Proposers that participate in this Solicitation must complete the Phase I Cost Proposal not to exceed the maximum dollar amount of $100,000 and a Phase I Option Cost Proposal (if applicable) not to exceed the maximum dollar amount of $50,000. Phase I and Phase I Option costs must be shown separately but may be presented side-by-side on a single Cost Proposal. The Cost Proposal DOES NOT count toward the 20-page Phase I proposal limitation.

PHASE I PROPOSAL SUBMISSION CHECKLIST

All of the following criteria must be met or your proposal will be REJECTED.

____1. The following have been submitted electronically through the DoD submission site by 6 a.m. (ET) 15 September 2010.

_____ a. DoD Proposal Cover Sheet

_____ b. Technical Proposal (**DOES NOT EXCEED 20 PAGES**): *Any pages submitted beyond this will not be evaluated. Your cost proposal and Company Commercialization Report DO NOT count toward your maximum page limit.*

_____ c. If proposing to use foreign nationals; identify the foreign national(s) you expect to be involved on this project, **the type of visa or work permit under which they are performing,** country of origin and level of involvement.

_____ d. DoD Company Commercialization Report (required even if your firm has no prior SBIRs).

_____ e. Cost Proposal **(<u>Online cost proposal form is REQUIRED by MDA</u>)**

____2. The Phase I proposed cost plus option does not exceed $150,000.

MDA PROPOSAL EVALUATIONS

MDA will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. MDA reserves the right to award none, one, or more than one contract under any topic. MDA is not responsible for any money expended by the proposer before award of any contract. Due to limited funding, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

MDA will utilize the Phase I Evaluation criteria in Section 4.2 of the DoD solicitation, including potential benefit to the Ballistic Missile Defense System (BMDS) in assessing and selecting for award those proposals offering the best value to the Government.

MDA will use the Phase II Evaluation criteria in Section 4.3 of the DoD solicitation, including potential benefit to BMDS and ability to transition the technology into an identified BMDS, in inviting, assessing and selecting for award those proposals offering the best value to the Government. In the Phase II Evaluations, Criterion C is more important than Criteria A and B, individually. Criteria A and B are of equal importance.

In Phase I and Phase II, firms with a Commercialization Achievement Index (CAI) at the 20th percentile will be penalized in accordance with DoD Section 3.5d.

Please note that potential benefit to the BMDS will be considered throughout all the evaluation criteria and in the best value trade-off analysis. When combined, the stated evaluation criteria are significantly more important than cost or price. Where technical evaluations are essentially equal in merit, cost or price to the government will be considered in determining the successful offeror.

It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Technical reviewers will base their conclusions on information contained in the proposal and their personal knowledge. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal and will count toward the applicable page limit.

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

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

INFORMATION ON PROPOSAL STATUS

The Principal Investigator (PI) and Corporate Official (CO) indicated on the Proposal Coversheet will be notified by e-mail regarding proposal selection or non - selection. If your proposal is tentatively selected to receive an MDA award, the PI and CO will receive a single notification. If your proposal is not selected for an MDA award, the PI and CO may receive up to two messages. The first message will provide notification that your proposal has not been selected for an MDA award and provide information regarding the ability to request a proposal debriefing. The second message will contain debrief status information (if requested), or information regarding the debrief request. **Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced.**

IMPORTANT: We anticipate having all the proposals evaluated and our Phase I contract decisions in the December 2010 timeframe. All questions concerning the evaluation and selection process should be directed to the MDA SBIR/STTR Program Management Office (PMO).

All communication from the MDA SBIR/STTR Program management will originate from the sbirsttr@mda.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

MDA SUBMISSION OF FINAL REPORTS

All final reports will be submitted in accordance with the Contract Data Requirements List (CDRL) of the resulting contract. Refer to section 5.3 of the DoD Solicitation for additional requirements.

PHASE II GUIDELINES

This Solicitation solicits Phase I proposals. For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, may be invited to submit a Phase II proposal. MDA makes no commitments to any offeror for the invitation of a Phase II proposal. Phase II is the prototype/demonstration of the technology that was found feasible in Phase I. Only those successful Phase I efforts that are **invited** to submit a Phase II proposal will be eligible to submit a Phase II proposal. MDA does encourage, but does not require, partnership and outside investment as part of discussions with MDA sponsors for potential Phase II invitation. Invitations to submit a Phase II proposal will be made by the MDA SBIR/STTR PMO.

Please Note: You may only propose up to the total cost for which you are invited. Contract structure for the Phase II contract is at the discretion of the contracting officer after negotiations with the small business.

The MDA SBIR/STTR PMO does not provide "debriefs" for firms who were not invited to submit a Phase II proposal.

PHASE II PROPOSAL SUBMISSION

Phase II Proposal Submission is by Invitation Only: *A Phase II proposal can be submitted only by a Phase I awardee and only in response to an invitation by MDA.* Invitations are generally issued at or near the Phase I contract completion, with the Phase II proposals generally due one month later. In accordance with SBA policy, MDA reserves the right to negotiate mutually acceptable Phase II proposal submission dates with individual Phase I awardees, accomplish proposal reviews expeditiously, and proceed with Phase II awards. If you have been invited to submit a Phase II proposal, please see the MDA SBIR/STTR Web site http://www.mdasbir.com/ for further instructions.

Classified proposals are not accepted under the DoD SBIR/STTR Program. Follow Phase II proposal instructions described in Section 3.0 of the program solicitation at www.dodsbir.net/solicitation and specific instructions provided in the Phase II invitation. Each Phase II proposal must contain a proposal cover sheet, technical proposal, cost proposal and a Company Commercialization Report submitted through the DoD Electronic Submission Web site at www.dodsbir.net/submission/SignIn.asp **by the deadline specified in the invitation.**

MDA FAST TRACK DATES AND REQUIREMENTS

Introduction: For more detailed information and guidance regarding the DoD Fast Track Program, please refer to Section 4.5 of the solicitation and the Web site links provide there. MDA's Phase II Fast Track Program is focused on transition of technology. The Fast Track Program provides matching SBIR funds to eligible firms that attract investment funds from a DoD acquisition program, a non-SBIR/non-STTR government program or private sector investments. Phase II awards under Fast Track will be for $1.0M maximum, unless specified by the MDA SBIR/STTR Program Manager.

- For companies that have never received a Phase II SBIR award from DoD or any other federal agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $187,500.)
- For all other companies, the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $1,000,000, it must obtain matching funds from the investor of $1,000,000.)

Submission: The complete Fast Track application along with completed transition questions (see note below) must be received by MDA within 120 days from the Phase I award date. Your complete Phase II proposal must be received by MDA within 30 days of receiving approval (see section entitled "Application Assessments" herein for further information). Any Fast Track applications or proposals not meeting this deadline may be declined. All Fast Track applications and required information must have a complete electronic submission. The DoD Electronic Submission Web site www.dodsbir.net/submission/SignIn.asp will lead you through the process for submitting your application and technical proposal electronically. Each of these documents is submitted separately through the Web site.

Firms who wish to submit a Fast Track Application to MDA MUST utilize the MDA Fast Track Application Template available at http://www.mdasbir.com (or by writing sbirsttr@mda.mil). Failure to follow these instructions may result in automatic rejection of your application.

Firms who have applied for Fast Track and are not selected may still be eligible to compete for a regular Phase II in the MDA SBIR/STTR Program.

Current guidance and instructions may be found at http://www.mdasbir.com.

MDA SBIR/STTR PHASE II TRANSITION PROGRAM

Introduction: To encourage transition of SBIR and STTR projects into the BMDS, the MDA's Phase II Transition Program provides matching SBIR and STTR funds to expand an existing Phase II contract that attracts investment funds from a DoD acquisition program, a non-SBIR/non-STTR government program or private sector investments. The Phase II Transition Program allows for an existing Phase II SBIR or STTR contract to be extended for up to one year per Phase II Transition application, to perform additional research and development. Phase II Transition matching funds will be provided on a one-for-one basis up to a maximum amount of $500,000 of SBIR or STTR funds in accordance with DoD Phase II Enhancement policy at Section 4.6 of the DoD Solicitation. Phase II Transition funding can only be applied to an active DoD Phase II SBIR or STTR contract.

The funds provided by the DoD acquisition program or a non-SBIR/non-STTR government program may be obligated on the Phase II contract as a modification prior to or concurrent with the modification adding MDA SBIR or STTR funds, OR may be obligated under a separate contract. Private sector funds must be from an "outside investor" which may include such entities as another company or an investor. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

Background: It is important that all technology development programs in MDA map to a BMDS improvement and, after a period of development and maturity, are transitionable to targeted BMDS end users. End user is defined as the element, component or product manager to which it is intended to transition the technology. Because of this, it is important that your Phase II contract be at or approaching a Technology Readiness Level of either 5 or 6.

Current guidance and instructions may be found at http://www.mdasbir.com.

2010 KEY DATES (PROJECTION)

MDA SBIR/STTR Industry Day	July 28-29, 2010	*
Solicitation Pre-release	July 20 – August 16, 2010	
Solicitation Opens	August 17 – September 15, 2010	
Phase I Evaluations	*October – November 2010*	*
Phase I Selections	*December 2010*	*
Letters Distributed	*December 2010*	*
Contract Award Goal	*February 2011*	
Phase II Recommendation Period (from 09.B PH I)	*August 2010*	*
Phase II Invitations (from 09.B PH I)	*September 2010*	*
PH II Proposals Due	*October 2010*	*
Phase II Evaluations	*November – December 2010*	*
Phase II Selections	*December 2010*	*
Letters Distributed	*January 2011*	*
Contract Award Goal	*April 2011*	*

Phase II Transition Program Solicitation is *generally* announced via http://www.mdasbir.com in the March/April timeframe.

*This information is listed for GENERAL REFERENCE ONLY at the time of publication of this solicitation. This date is subject to update/change.

MDA SBIR 10.3 Topic Index

MDA10-001	Sensor Data Fusion
MDA10-002	Sensor Resource Management
MDA10-003	End-to-End BMDS Strategic Communication Systems
MDA10-004	GPS and Command Link Assured Operation
MDA10-005	Acquisition Tracking and Pointing Technologies
MDA10-006	High Energy Solid State Laser Components and Subsystems
MDA10-007	Direct Electrically Pumped High Energy Flowing Media Laser Technologies
MDA10-008	Directed Energy Critical Component Technologies
MDA10-009	Develop and Demonstrate High Performance Infrared Focal Plane Arrays with Advanced Quantum Structures
MDA10-010	Smart Infrared Focal Plane Arrays and Advanced Electronics
MDA10-011	Next Generation Inertial Sensing Technology
MDA10-012	Interceptor Seekers and Passive Sensors
MDA10-013	Divert, Attitude Control and Axial Propulsion System Technologies
MDA10-014	Radiation Hardened Interceptor Avionics for Ascent Phase Interceptor
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MDA10-023	Advanced Reentry Vehicle and Wake Models
MDA10-024	Innovative Sensor Packaging and Testing
MDA10-025	High Speed Representation of Complex Scenes
MDA10-026	Photonic Multi-Beam Receive-Only Arrays
MDA10-027	Photonics TDU for Radar True Time Delay (TTD)
MDA10-028	Wideband Scalable Multi-channel Digital Receiver/Exciter (DREX)
MDA10-029	Develop Accelerated High Power RF MEMs Switch and Phase Shifter Reliability Test Methodologies
MDA10-030	Space Photonics Technology
MDA10-031	Large Format Space Focal Plane Array Technologies
MDA10-032	Radiation Hardened, Low Power, Variable Bandwidth/Resolution Digital-to-Analog or Analog-to-Digital Converters
MDA10-033	Lightweight Components
MDA10-034	Advanced Space Power Technologies
MDA10-035	Enhanced Spacecraft Survivability

MDA SBIR 10.3 Topic Descriptions

MDA10-001 TITLE: Sensor Data Fusion

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: C2BMC

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 3.5.b.(7) of the solicitation.

OBJECTIVE: This topic seeks to apply innovative concepts to creating a single integrated picture of the battlespace, for Ballistic Missile Defense, including the use of data fusion to obtain the best system track accuracy and discrimination of threatening objects from debris/countermeasures. The capability to collect, process, and fuse information from dispersed and disparate sensors in the BMDS is critical in providing warfighters with a clear picture of the evolving battlespace for awareness and in producing fire control solutions for weapon systems. These disparate sensors include ground-based radars, Overhead Persistent IR (OPIR) system, UAV-based Airborne IR (ABIR), and Space-based PTSS constellation. Because of diverse viewing and measurement phenomenology from these sensors, data fusion must accurately and reliably support situational awareness as well as search, acquisition, track, discrimination, engagement and hit/kill assessment.

DESCRIPTION: The emphasis of the MDA mission has expanded from homeland defense against ICBM threats to include theater and regional defense against short and medium range missile attacks. The focus is on scenarios where multiple “raids” are launched near simultaneously from multiple launch sites aimed at numerous defended areas of friends and allies. In order to cover such a large battle space and dispersed, evolving threat complex (boost, midcourse and terminal phase); the BMDS architecture has called for the deployment of multiple diverse and distributed sensors (ground-based/sea-based/airborne/space based and RF/IR). As such, the ability to fuse sensor data from multiple viewing perspectives and different RF/IR phenomenology can provide a more accurate picture of evolving threats than any single sensor operating independently.

The goal of the data fusion process, and this solicitation, is to take advantage of a combination of sensor measurements, features, track states, object type, and identification likelihoods to provide a highly accurate integrated picture of the battle space and produce fire control solutions to interceptors. Approaches to addressing this solicitation must be innovative with a theoretical foundation such as mathematical decision theory, probabilistic inferencing methodologies, or pattern recognition techniques. This fusion could be expected to support system acquisition, track, discrimination and hit/kill assessment of threat objects in a debris/countermeasures environment as well as threat complexes dispersed widely in space and time. Solutions must be used for situation awareness and weapon assignment and fire control.

PHASE I: Develop and conduct proof-of-principle demonstrations of advanced sensor data fusion concepts using simulated sensor data.

PHASE II: Update/develop technology (algorithms, software, hardware, or a combination thereof) based on Phase I results and demonstrate technology in a realistic environment using data from multiple Radar assets sources. Demonstrate ability of technology to work in real-time in a high clutter environment.

PHASE III: Integrate technology into BMDS system and demonstrate the total capability of the updated system. Partnership with traditional DOD prime contractors will be pursued as government applications of this technology will produce near term benefits from a successful program.

COMMERCIALIZATION: The technology is applicable to air traffic control and weather radar applications.

REFERENCES:

1. R. Duda, P. Hart, and D. Stork, “Pattern Classification”, 2nd Ed., Wiley Interscience, November, 2000.

2. Jenson, Finn V. Bayesian Networks and Decision Graphs. New York: Springer, 2001.

3. Gilks, W.R., Richardson, S. and Speigelhalter, D.J. Markov Chain Monte Carlo In Practive. Boca Raton: Chapman & Hall, 1996.

4. Neapolitan, Richard E. Learning Bayesian Networks. Upper Saddle River: Prentice Hall, 2004.

5. Martinez, David, et.al., “Wideband Networked Sensors”, MIT Lincoln Labs, http://www.fas.org/spp/military/program/track/martinez.pdf, October 2000.

6. D. Hall and James Llinas, “An Introduction to Multisensor Data Fusion,” Proceedings of the IEEE, 85 (No. 1) 1997.

7. D.C. Cowley and B. Shafai, “Registration in Multi-Sensor Data Fusion and Tracking,” Proceedings of the American Control Conference, June 1993.

8. Y. Bar-Shalom and W.D. Blair, Editors, Multi-Target/Multi-Sensor Tracking: Applications and Advances, Vol. III, Artech House, Norwood, MA, 2000.

9. T. Sakamoto and T. Sato, “A fast Algorithm of 3-dimensional Imaging for Pulsed Radar Systems,” Proceedings IEEE 2004 Antennas and Propagation Society Symposium, Vol. 2, 20-25 June 2004.

10. W. Streilein, et al. “Fused Multi-Sensor Mining for Feature Foundation Data,” Proceeding of Third International Conference of Information Fusion, Vol. 1, 10-13, July 2000.

KEYWORDS: Inferencing Algorithms, Decision Theory, Sensor Fusion, Data Fusion, Sensor Integration, Signal Processing, Algorithm, Multi-Sensor, 3-D Imaging

MDA10-002 TITLE: Sensor Resource Management

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

ACQUISITION PROGRAM: C2BMC

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective is to develop techniques for employment planning and real time tasking of diverse and distributed sensor resources to support ballistic missile defense in a multi-raid, multi-target environment. The Sensor Resource Manager (SRM) is a critical functionality for Command and Control, Battle Management and Communications (C2BMC) as it dynamically assigns sensors in response to changing priority and complexity. In addition, this functionality is subject to sensor availability, accessibility, and signal to noise considerations while it schedules individual sensors to perform search, acquisition, track, discrimination, and hit/kill assessments in order to support weapon assignment and fire control.

DESCRIPTION: The emphasis of the MDA mission has expanded from defense of homeland against ICBM threat to include defense of friends and allies against short and medium range missile attacks (i.e. theater and regional missile defense). The focus is on scenarios in which multiple “raids” are launched near simultaneously from multiple launch sites aimed toward numerous defended areas. MDA has adopted a Phased Adaptive Approach (PAA) to build up the BMDS system by incorporating existing and newly developed radars, EO/IR sensors, and interceptors to counter new threats. The sensor architecture includes OPIR (Overhead Persistent IR), ground-based radar, UAV based airborne IR (ABIR) and satellite-based PTSS (Precision Tracking Space System) constellation. The integration of various components is the responsibility of C2BMC system. There are many difficult challenges for C2BMC, one of which is Sensor Resource Management. The function of SRM is for employment planning and real time tasking of diverse and distributed sensor resources to handle threat targets dispersed widely both in space and time. The SRM can be formulated into the following problems: 1) How to optimally assign sensors/platforms to cover multiple threat complexes in multi-raid threat scenes subject to constraints of sensor availability, accessibility, phenomenology, and S/N considerations. 2) How to coordinate and schedule sensor resources to perform search, acquisition, track, discrimination, and hit/kill assessment to provide the best "quality of services" to weapon systems. The metrics of quality of services include metric accuracy and discrimination of threatening objects. Furthermore, since the battle space may be extended with purview over multiple Operational Commands, some degree of inter-command resource allocation could also be anticipated.

Proposals for the development of innovative techniques/algorithms for the assignment and/or scheduling of sensors are invited. These may be based on techniques using information theory to maximize information gained by multi-sensor management, or using fuzzy logic approach to make computation loads less burdensome, or using dynamic programming or stochastic programming or others. The proposed scheme should allow for the need for dynamic reallocation of sensors in response to changing threat scenes, priority and complexity, while subject to constraints of sensor availability, accessibility, and measurement capabilities (S/N and Phenomenology).

In proposing schemes recognition should be made of the following features:

1. Some sensor tasks will benefit from simultaneous observation from different platforms.

2. Depending on the objective, required observations may differ in character from short single looks, through frequent revisits to sustained periods of continuous observation.

3. For some sensors the slew and reacquisition time can be significant and constrain the ability to observe objects with large angular separation.

4. Priorities for sensor tasking must reflect the need to provide fire control solutions for weapon systems appropriate to each layer in the BMDS architecture.

5. The fidelity of track and discrimination information required will vary with time to match key decision points in an engagement.

6. Sensor resources will be required post interceptor launch to support tracking, in flight target update of threat state vectors and discrimination state and to provide kill assessment.

Proposed schemes should clearly identify how the performance improvement resulting from extending at any time the algorithm's future planning horizon ('far sightedness') is achieved at the expense of increased to computational complexity to allow trade-offs of performance against processing load.

PHASE I: Develop a mathematical basis for the proposed approach, augmented as appropriate by coding or analysis sufficient to demonstrate its computational tractability and ability to handle the features 1-6 listed above.

PHASE II: Implement prototype algorithms and integrate with simulation framework to allow their testing and evaluation in realistic scenarios. The testing of algorithms in the BMDS Benchmark environment is highly recommended. As such, the company will formulate a Benchmark problem capturing C2BMC SRM challenges and solve this Benchmark problem using the proposed algorithms. MDA C2BMC SRM team will organize workshop/tutorial and work closely with the SBIR contractors to further refine their algorithms for C2BMC.

PHASE III: If successful, this work has the potential to be incorporated into the BMDS C2BMC function; a task which would form the basis of Phase 3 work would probably be achieved through partnership with a DOD prime contractor.

DUAL USE/COMMERCIALIZATION POTENTION: The technology is applicable to air traffic control and weather radar applications.

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KEYWORDS: optimization, sensor management, resource allocation

MDA10-003 TITLE: End-to-End BMDS Strategic Communication Systems

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: GMD / DV

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Devise innovative concepts to enhance the reliability of both Missile Defense Agency (MDA) Satellite Communications and communications between the Ballistic Missile Defense System (BMDS) Fire Control and Platform Vehicle Architectures under severe wartime conditions. The focus is to increase probability of message delivery in the presence of both adversarial electronic counter-measures (ECM) and signal fading caused by ionospheric scintillation arising from high altitude nuclear explosions. Provide analysis of proposed communications solutions within the framework of MDA layered architecture, and develop prototype hardware that will demonstrate the utility of the proposed solution.

DESCRIPTION: MDA is seeking innovative approaches to hardening communications systems for current and future Satellite Communication (SATCOM) architectures coupled to Platform Class vehicles. The MDA based platforms range from Unmanned Aerial Vehicles (UAVs) to Interceptor/Kill Vehicle Architectures. These systems are assumed to be based within the BMDS architecture. All future SATCOM and MDA Platform communication systems must employ effective means to mitigate link performance degradation mechanisms associated with wartime environments.

Specific issues and technical risk items that should be considered include:

1. Representation and modeling of scintillation fading channels (as described by MDA STD-001).

2. Representation and modeling of signal fading induced by rain.

3. Multi-carrier transmission and reception architecture.

4. Link Attributes (i.e., data rate, bandwidth, range, latency, error rates).

5. Channel waveform design up to bandwidths of 800 MHz on RF carriers between 1.5 GHz and 23 GHz.

6. Communication system performance prediction methods.

7. Receiver mitigation techniques/algorithms for frequency-selective signal fading.

8. Performance evaluation concepts employing automated calibration processes for signal-to-noise ratio (SNR).

9. Platform weight, size, and power constraints (especially on flight vehicles).

10. New technology insertion alternatives and schedules.

11. Cost trades of proposed communications solutions.

Any proposed communications schemes must be scaleable as Missile Defense architectures grow in both geographic coverage (locations & satellite transponders field of view) and in hardware (number and type of platform vehicles).

PHASE I: Contractors shall propose and analyze candidate end-to-end communications solutions for providing robust connectivity within the evolving MDA architecture. The contractor shall identify the strengths/weaknesses associated with different solutions, methods and concepts. The output shall be a set of communications system and hardware trades, which substantiate the proposed solution(s) and provides quantifiable metrics for comparison. Insertion of new technologies to mitigate effects from high altitude nuclear explosions should be emphasized.

PHASE II: The contractor shall select the optimal communication system design proposed in Phase I and perform a detailed design of the system. Specific hardware components will be identified and new designs initiated if necessary. New technologies will be developed and demonstrated for hardness, reliability and performance. Contractor shall begin coordination with MDA to ensure products will be relevant to ongoing and planned projects.

PHASE III: The contractor shall work with MDA industrial partner(s) to maximize the transfer of this development to missile defense and to identify a tractable Phase III projects that can become a by-product of this overall program.

COMMERCIALIZATION: Other efforts within the DOD are focused on two-way data links to weapons systems and this technology will, most likely, be transferred to those programs. The number of weapon platforms that could ultimately use this technology would be substantial. Commercial applications would be in the cell-phone industry, airline communications, and over-the-air communications.

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KEYWORDS: SATCOM, satellite, communications architecture, jamming, high altitude nuclear explosions, fading channels, end to end communications.

MDA10-004 TITLE: GPS and Command Link Assured Operation

TECHNOLOGY AREAS: Sensors, Space Platforms, Weapons

ACQUISITION PROGRAM: C2BMC

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate the coherent simulation technology to stimulate and evaluate techniques to compensate and recover from severe intentional or environmental disruption of GPS and related guidance signals and command data links. Address tightly coupled GPS/INS solution and multi antenna/multichannel receiver stimulation test capability approaches to address advanced operating modes in a secure environment. Develop a simulation environment for developing methods of overcoming guidance and command link drop-out during deliberate jamming or during and after exposure to a nuclear or EMP environment. Investigate techniques to mitigate impact of GPS disruption on BMDS sensor registration.

DESCRIPTION: Simulation technologies are required to test guidance and navigation solutions under a variety of environmental conditions. These conditions may temporarily disrupt GPS reception, requiring weapon system recovery protocols and algorithmic contingencies. The ability to replicate global positioning constellation signals, jamming signals, and environmental effects in a hardware-in-the-loop environment is required. The ability to replicate self-induced and naturally occurring environmental effects is desired, e.g., hypersonic plasma effects, ionosphere, scintillation and multi-path scattering models. In addition, replication of intentional disruption from jamming and a nuclear EMP environment is necessary. The objective capability should be capable of operation in a hardware-in-the-loop environment interfacing with closed-loop weapon simulations, i.e., receiver state data would drive the GPS simulator through a run-time interface. The simulator would in turn, present GPS signals affected by the described environmental influences.

Capability is required to perform wavefront generation for up to 7 antennas on a vehicle moving at high-speed/acceleration in 6 degrees of freedom. A typical missile simulation scenario would involve a missile INS/GPS connected to the GPS simulator, the output of the navigation system would feed a seeker and avionics package on a motion simulator. Actuation commands would drive a simulation of the weapon dynamics which in turn would drive the GPS simulator and flight motion simulator. Numerous other test applications could be envisioned for ground and space based support components, including the need for operation in complex urban environments.

The ability to replicate other navigation signals is also desired. In addition to GPS (L1, L2, L5, C/A, P, M codes), Galileo, Glonass, and signals from Asian navigation systems would provide additional test flexibility. Both digital and RF outputs are necessary for facility data collection and simulation.

PHASE I: Research, quantitatively analyze, and develop a conceptual design and assess the feasibility of comprehensive GPS simulator. Hardware critical component demonstration to quantify limitations of existing systems and potential improvements state-of-the-art component technologies is desired.

PHASE II: Design, develop, and characterize a prototype proof of concept of the GPS simulator and demonstrate its functionality. Investigate private sector applications along with military uses of key components developed in Phase II.

PHASE III: Develop and execute a plan to manufacture the simulator system, or component(s) developed in Phase II, and assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and GPS simulation components developed in Phase II for potential commercial use in such diverse fields as law enforcement, homeland defense, and the numerous other defense applications that require GPS solutions.

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KEYWORDS: Hardware-in-the-loop, GPS, Simulation, Inertial Navigation, Antenna Wavefront, GPS Jamming.

MDA10-005 TITLE: Acquisition Tracking and Pointing Technologies

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors, Space Platforms, Weapons

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this SBIR topic is to design, develop and test acquisition tracking and pointing (ATP) technologies and components to support future MDA missions. These include, but are not limited to, fast steering mirrors, optical inertial reference units, strapdown alignment systems, inertial sensors for precision pointing and inertial stabilization, optical sensors for jitter and/or image stabilization, and processors and algorithms. Although this is a broad topic area covering multiple ATP technologies, this topic is placing special emphasis on jitter suppression / image stabilization sensors. In explanation, we are seeking high speed near infrared sensors to be utilized as control sensors in a larger jitter suppression/image stabilization subsystem, utilizing optimal inertial reference units or stapdown alignment sources with fast steering mirrors. Offerors may also propose other highly innovative efforts that fall within the scope of acquisition, tracking and pointing for consideration under this topic. However, offerors are highly encouraged to contact the topic authors to discuss innovations outside the stated focus area.

DESCRIPTION: Jitter suppression and/or image stabilization is required on several Missile Defense Agency (MDA) systems including the Airborne Laser Test Bed (ALTB), Airborne Infrared platform (ABIR), the Precision Tracking and Surveillance System (PTSS), the future Space Tracking and Surveillance System (STSS) and interceptors. The true challenge is to create a sensor with sufficient field of regard, resolution, and speed to support proposed jitter suppression and image stabilization architectures. We are envisioning a minimum 256x256 system capable of sustained 10 kHz operations to support high speed control loops and sensitivity in the 800-1100 nm wavelength band. To minimize data through put requirements, offerors may propose thresholding and windowing approaches to capture and deliver pixels of interest at the required rates.

In addition, to support potential space applications, components proposed in this area must address space qualifiability. The following space environmental parameters be used as guidance.

The environmental parameters for space applications include: Operation in vacuum or near vacuum conditions; The components should have a shelf life of at least 5 years and a on-orbit service life of a minimum of 5 years with a goal of 15 years. The components have to operate in a radiation hard environment including proton and gamma radiation. For proton radiation exposure (Proton – nominal 63 MeV) a minimal exposure total dose of 100 kRad is required with a desired >300 kRad total dose absorbed without major loss of functions. For ionizing radiation a similar hardness (Ionizing) minimum total ionizing does of minimum100 kRad and desired >300 kRad without degradation is the goal. The operating temperature range drives concept and capabilities with -54 degrees C to 40 deg. C desired to cover several requirements. For long term survival temperature range -60 to 71 degrees C is desired.

The jitter sensor performance goals for near term and far term are likewise: Array sizes are needed 256 by 256 pixels with a 512 by 512 goal for future applications. Frame rates of 10 kHz are needed. The detector responsivity in the 800-1100 nanometer wavelength is needed with a quantum efficiency over 80 percent with a goal of over 90 percent. Detector non-linearity should be less than 1% for sensor operation and the sensor should operate in a linear mode.

PHASE I: Develop a preliminary design for the proposed component. Modeling, Simulation, and Analysis (MS&A) of the design must be presented to demonstrate the offeror understands the physical principles, performance potential, scaling laws, etc. MS&A results must clearly demonstrate how near-term goals will be met, at a minimum. Proof of concept hardware development and test is highly desirable. Proof of concept demonstration may be subscale or specific risk reduction activities associated with critical components or technologies. Test results (if performed) should be used in conjunction with MS&A results to verify scaling laws and feasibility. Phase I will include the development of plans to further develop/exploit this technology in Phase II. Offerors are strongly encouraged to work with system, spacecraft, and/or payload contractors to help ensure applicability of their efforts and begin work towards technology transition. No specific contact information will be provided by the topic authors.

PHASE II: Complete critical design of prototype component including all supporting MS&A. Fabricate a prototype or engineering demonstration unit (EDU) and perform characterization testing within the financial and schedule constraints of the program to show level of performance achieved compared to stated government goals. In addition, environmental testing, especially radiation testing, is highly encouraged in this phase. The final report shall include comparisons between MS&A and test results, including identification of performance differences or anomalies and reasons for the deviation from MS&A predictions. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort to which end they should have working relationships with, and support from system, spacecraft, and/or payload contractors.

PHASE III: The offeror is expected to work with other industry partners and DOD offices to modify and improve the design of the Phase II proof of concept prototypes to meet individual system applications. The first use of this technology is envisioned for the Airborne Laser Test Bed (ALTB).

COMMERCIALIZATION: There are a number of commercial applications requiring high speed, near infrared imaging that could take advantage of this development effort.

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KEYWORDS: Acquisition, Tracking Pointing, jitter suppression, image stabilization, sensors

MDA10-006 TITLE: High Energy Solid State Laser Components and Subsystems

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: Airborne Laser and ABIR

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Identify and develop new laser materials, laser subsystems, components, and supporting technologies to enable high power solid state lasers for Missile Defense directed energy applications. Important goals are high electrical and optical efficiency, minimization of size and weight, and environmental ruggedness.

DESCRIPTION: Current demonstrated capability for long range directed energy lethality has been based on chemical and gas dynamic lasers that are too large and expensive to field in large numbers on many operational airborne platforms. Advances in solid state laser technology have demonstrated kilowatt class solid state lasers for short range target defeat. This topic addresses solid state laser technology improvements that will work in conjunction with Office of the Secretary of Defense (OSD) funded efforts progressively to improve solid state, electrically-driven laser technology and to approach and provide a compact and environmentally rugged directed energy source. Advanced high energy laser innovations are sought in technologies leading to highly efficient, light-weight and compact laser systems and/or subsystems. Scalability of a developed system up to 10s to 100s of kilowatt (or more) level of continuous wave (CW) output is desired. The ability for laser components developed under this topic by the company awardee to be incorporated into an existing larger high power laser system leading to marked performance improvement would also be appropriate. This topic encompasses improvements in laser materials including ceramic and crystalline gain media. Also relevant are technologies developed by the company to combine laser systems to form diffraction limited beams. Focus areas will address key elements of critical component technology in cooperation with service and OSD efforts to realize an efficient, compact solid state laser with high damage capability. High power lasers that are compact in terms of size and weight are needed. Development of a subsystem by the company awardee, such as thermal management system, pump diode system, resonator system, gain media cooling system, etc. leading to this goal is within the scope of this topic. New advances in ceramic materials may offer reductions in thermal lensing, depolarization, and other improvements thus making these materials attractive as laser gain media. The desired output wavelength is in the 1.0 to 2.0 micron range. Typical materials may be Nd:YAG, Yb:YAG, Nd:YLF, Nd:YVO4, and others. Their structures may be ceramic or crystalline.

Production of a high energy CW beam, with high brightness and good beam quality is a fundamental goal of the developed system. High electrical efficiency, compactness, and environmental ruggedness are highly desirable features. Another valued capability is for laser weapon effectiveness in damaging threatening targets to prevent them from completing their mission.

Additionally, technologies for improving the current state of the art by enabling compact, efficient laser sources in the multiple kilowatt range would be appropriate. Such technologies could be improvements in diode laser pump systems, such as diode laser efficiency, pump diode wavelength stabilization, thermal management of laser system components, innovations in optical components and systems and other strategies to enhance overall laser system performance.

PHASE I: Develop key laser device, component, and laser material technologies for advanced BMDS laser systems that will improve the performance, efficiency, compactness, operational suitability, and reduce costs of directed energy solutions for BMDS applications. Demonstrate in Phase I through modeling, analysis, and proof of principle experiments that the proposed approach is viable for further investigation in Phase II. Proposers are highly encouraged to work with system integrators and/or their respective payload contractors to help ensure applicability of the proposed effort and to facilitate future technology transition.

PHASE II: Validate the feasibility of the proposed concept developed in Phase I by development and demonstration of a key components brassboard prototype and the execution of supporting laboratory/field experiments to demonstrate technology viability. Validation would include, but not be limited to, system simulations, operation in test-beds, or operation in a demonstration subsystem. The goal the Phase II effort is to demonstrate technology viability. and the offeror should have working relationships with system and payload contractors. A partnership with a current or potential supplier of MDA element systems, subsystems or components is highly desirable.

PHASE III: In this phase, the contractor will apply the innovations demonstrated in the first two phases to one or more MDA element systems, subsystems, or components. The objective of the Phase III is to demonstrate the scalability of the developed technology, transition the component technology to the MDA system integrator or payload contractor, mature it for operational insertion, and demonstrate the technology in an operational level environment.

COMMERCIALIZATION: High power laser components have numerous commercial and other DoD applications in material processing and welding, remote sensing both terrestrial and space, satellite communications, power beaming, and weather sensing applications. Numerous military other applications of the technology also apply outside of MDA in areas of tracking, designation, directed energy, demilitarization of munitions, and IED destruction.

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KEYWORDS: Directed Energy, High Energy Laser, Laser Diode Pumps, Ceramic Laser Materials.

MDA10-007 TITLE: Direct Electrically Pumped High Energy Flowing Media Laser Technologies

TECHNOLOGY AREAS: Air Platform, Sensors, Weapons

ACQUISITION PROGRAM: Airborne Laser

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop alternate high extraction efficiency closed cycle laser critical component technologies for MDA agile platform directed energy sources.

DESCRIPTION: Chemical lasers have consistently demonstrated both higher power levels than solid-state lasers and capabilities of military significance. Chemical laser defensive systems are ideal for both large area and point defense. Examples include the Airborne Laser (ABL) and the Advanced Tactical Laser (ATL) which have recently shown success in engaging and defeating targets with a chemical laser directed energy solution. These laser systems are based on the megawatt class chemical oxygen iodine laser (COIL). All current high energy laser (HEL) programs have been technically successful, but need to be significantly improved logistically and operationally to be suitable for deployment. The chemical/gas laser size, weight, power and chemical support subsystems require the deployment aircraft to be a large platform with attendant rapid deployment, sustainment, and operational limitations. Solid state lasers have shown to be robust even under severe environment applications and potentially have a smaller footprint than current chemical lasers. However, they have not shown the high power and long lasing time needed for long range engagement.

This topic addresses technologies focused on enabling advanced closed-cycle flowing media laser systems to provide a compact solution for deployment on tactical aircraft or unmanned aerial systems (UAS) platforms to provide a directed energy kill capability for ballistic missile targets in boost, ascent, midcourse and terminal phases.

One example is the all-gas-phase-iodine-laser (AGIL). This chemical laser also uses gaseous iodine as a lasing medium. However, AGIL uses a reaction of chlorine atoms with gaseous hydrazoic acid, resulting in excited molecules of nitrogen chloride (NCl) which then pass their energy to the iodine atoms much like the singlet oxygen does in COIL, thus eliminating the aqueous solutions of COIL. AGIL has numerous possible advantages over traditional COIL. The chemicals are all in gaseous phase, therefore easier to work with than liquids, especially in microgravity conditions. The chemicals are also lighter, which is a significant advantage in aerospace applications.

Another promising example is the Diode Pumped Alkali Laser (DPAL). DPALs offer the potential for high power and efficient operation by leveraging the advantages of solid state and gas laser systems. These lasers are produced by direct optical pumping of alkali atoms in the gaseous phase. The extremely low quantum defect of the alkali system minimizes thermal loading and, like other gas lasers, the gain medium can be flowed to reduce thermal management requirements. One key to producing efficient systems is matching the absorption linewidth of the gain media to the emission bandwidth of the diodes. Absorption linewidths are typically on the order of 500 MHz while the diode emission is typically on the order of a few nanometers. Previously, in order to obtain sufficient overlap, a combination of pressure-broadening of the gain medium and diode-narrowing using external cavities was used. The pressure-broadening can lead to detriments in laser performance such as beam quality degradation and the diode-narrowing techniques are expensive and bulky, thus limiting their practical use.

A particular area of interest includes enabling technologies and support systems for the high-power optical pumping of alkali vapor atoms. Semiconductor diode laser technology presents the most cost-effective and scalable method to obtain the high powers and narrow spectroscopic line-widths required for these applications. Research and development is needed to realize scalable narrow-line-width wavelength-stabilized laser diode pump sources for DPAL applications. The availability of these high-power spectroscopic pump sources would also find use in industrial and medical applications such as spin-exchange optical pumping (SEOP). With an efficient optical pump source, diode-pumped alkali vapor lasers (DPALs) have the potential for scaling to extremely high power levels for industrial and military applications. The main impediment to achieving these power levels has been the availability of high-power narrow spectral line-width laser diode pump sources. Traditional efforts to produce narrow-line high-power diode laser pump sources typically rely on one of three methods, each with inherent tradeoffs and limitations. Due to the high powers that must be dissipated by the laser diodes, all methods require that the wavelength selection element be physically decoupled from the semiconductor gain sections to allow practical temperature variation during operation. A straightforward way of producing high-power narrow-line semiconductor pump sources for DPALs is to construct arrays of optical amplifiers.

PHASE I: Develop key subsystem, components, and laser material technologies for advanced electrically stimulated flowing media laser systems that will improve the performance, efficiency, compactness, operational suitability, and cost of directed energy solutions for BMDS applications. Demonstrate in Phase I through modeling, analysis, and proof of principle experiments of critical elements of the proposed technology that the proposed approach is viable for further investigation in Phase II. Phase I work should clearly validate the viability of the technology proposed to meet the operational environment for directed energy applications in a component critical performance demonstration. The Phase I objective is to show viability of the concept to be scalable and integrated; and will culminate in a CDR-level design, including the ability to demonstrate and validate the design concept. Phase I should also result in a clear technology development plan, schedule, transition risk assessment, and requirements document. Proposers are highly encouraged to work with High Energy Laser (HEL) system integrators and/or their respective sub-system contractors to help ensure applicability of the proposed effort and the viability of the technology for transition.

PHASE II: The Phase II objective is to validate a scalable and producible technology approach that MDA users and prime contractors can transition in phase III to their unique laser application. Validate the feasibility of the proposed concept developed in Phase I by development and demonstration of a key components brassboard and the execution of supporting laboratory/field experiments to demonstrate technology viability. Validation would include, but not be limited to, system simulations, operation in test-beds, or operation in a demonstration subsystem. The goal the Phase II effort is to demonstrate technology viability and the offeror should have working relationships with system and payload contractors. A partnership with a current or potential supplier of MDA element systems, subsystems or components is highly desirable as is interaction with OSD High Energy Laser Joint Technology Office programs.

PHASE III: In this phase, the contractor will apply the innovations demonstrated in the first two phases to one or more MDA element systems, subsystems, or components. The objective of Phase III is to demonstrate the scalability of the developed technology, transition the component technology to the MDA system integrator or payload contractor, mature it for operational insertion, and demonstrate the technology in an operational level environment.

COMMERCIALIZATION: High power laser components have numerous commercial and other government agency applications in metal cutting, material processing, welding, remote sensing (both terrestrial and space), satellite communications, power beaming, and weather sensing. Outside of MDA, numerous other DoD applications of the technology include tracking, designation, directed energy, demilitarization of munitions, and IED destruction.

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KEYWORDS: directed energy, high energy laser, alkali laser, gas dynamic laser, chemical laser, spectroscopic laser diode pumps

MDA10-008 TITLE: Directed Energy Critical Component Technologies

TECHNOLOGY AREAS: Air Platform, Sensors, Space Platforms, Weapons

ACQUISITION PROGRAM: Air Borne Laser Test Bed

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Directed Energy (DE) has many applications in ballistic missile defense because of its potential to illuminate distant threats, and to rapidly detect, characterize, and engage them. Thus, multiple simultaneous threats can be addressed by DE systems, enabling them to be prioritized and dealt with in the most effective manner. However, to achieve these benefits requires compact, high-brightness, high-power DE sources that can operate reliably at high duty cycles in operational environments.

DESCRIPTION: In order to achieve these objectives, innovative component technologies in diverse areas are needed as the foundation of high brightness laser systems. The primary focus to this particular topic is innovations in laser pump fiber coupling, though revolutionary concepts in any area that supports the fielding of DE systems for BMD will be favorably received under this topic. These include high efficiency laser pump diodes with narrow emission bandwidths, fiber optic laser components, fiber combiners for pump diodes, efficient high-flux thermal management, and higher performance fiber laser optic materials and designs.

In order to realize the full benefits offered by higher efficiency laser pump diodes, effective means of coupling their outputs, possibly from dispersed locations, into a lasing media, would be very beneficial. Dispersed locations for the pump diodes could enable more convenient integration on a small platform and more effective thermal management for high power, high duty cycle operation.

Cladding-pumped (double-clad) fiber laser systems offer robust and reliable performance and can utilize a range of laser diode pump sources. Fiber pump couplers are critical in order to transport the pump light from high-brightness, high-power diode laser pump sources to the double-clad fiber amplifiers or lasers. The ideal pump coupler minimizes the loss in brightness and power between multiple pump diodes and the fiber amplifier/laser. Coherently-combinable fiber laser systems require narrow line-width, polarized output master oscillator power amplifier (MOPA) configuration. Thus, couplers are needed that are compatible with double-clad, polarization-maintaining (PM), large mode area (LMA) fibers. These fibers are typically low numerical aperture and are not strictly single mode, making them particularly sensitive to external stresses and deformations, which can produce bend losses and conversion to higher order mode guiding. In addition, couplers are needed for photonic band gap and photonic crystal fibers (PCF), to improve power handling and reliability.

Under this topic, innovative options are sought that address these needs. In particular, pump combiner concepts are desired for using laser diode pump sources in the vicinity of 975 nm to pump Ytterbium-doped fibers operating at ~ 1 micron. Concepts for pumping Thulium-doped fibers operating at ~ 2 micron are also of interest (double-photon pumping at 793 nm, and more recently, single-photon pumping using InP-based laser pump diodes, emitting at 1650 nm). Proposals should emphasize approaches to achieve high efficiency by the pump combiner, to ensure scalability in the number of diode-fed fibers that can be combined, to maximize the total power that can be fed to the double-clad fiber, to preserve polarization in the combiner, and to provide for bi-directional / "counter" pumping. Plans for comprehensive testing of the technologies to be developed, including characterization of losses, polarization-maintaining performance, and power handling capabilities, should be included in the proposal. In addition, proposals should include plans for reliability testing to assess component lifetimes and serviceability in operational military environments.

A collateral interest is in thermal management of the laser diode pumping arrays, a continuing challenge for fiber and solid state lasers as they are scaled to high powers and high duty cycles. One attractive option is to develop new composite heat-sink materials, such as Copper-Diamond or Silver-Diamond, that can combine high thermal conductivity with thermal expansion coefficients that are matched to pump diodes, extending their lifetimes and max duty cycle. In addition, it may be possible to develop new solid state media with both higher thermal conductivity and higher quantum efficiency, reducing the waste heat that must be dissipated. Yb-doped Lutetia (Lu203) is an example of such a novel new gain material.

PHASE I: Design and model options proposed. Develop and plan an experiment to demonstrate combination of six pump modules into one double-clad PM output fiber at a combined power of greater than 500W and high polarization-extinction ratio (goal of greater than 20dB for the PM feed through). Perform complete testing at 500W or greater, including overall loss characterization, polarization-maintaining performance, fusion applicability to LMA fibers, and assessment of power handling capabilities. Develop an initial design for a multi-kW fiber laser/amplifier pump combiner. Use modeling and simulation as required.

PHASE II: Based on Phase I designs and models, build prototype coupler for combining at least six fiber-coupled pump diodes, capable of coupling greater than 1 kW of pump power into a double-clad fiber. Perform complete testing, as in Phase I. Perform reliability testing to assess component lifetime and serviceability in operational military environments. Conduct system level designs and experimental verification showing a path of scalability up to high power laser systems (10kW to 100kW plus laser system) applications. Collaboration with MDA Prime and laser payload contractors is highly encouraged to facilitate phase III transition suitability.

PHASE III: Collaborate with MDA prime contractors and subsystem integrators to incorporate the designs developed into appropriate sensor, targeting, and weapon systems.

COMMERCIALIZATION: Cladding-pumped (double-clad) fiber laser systems are attractive for a variety of defense applications as well as for material processing in automotive, aircraft, and other manufacturing industries. Fiber pump couplers are critical in order to transport the pump light from high-brightness, high-power diode laser pump sources to the double-clad fiber amplifiers or lasers. Partnerships with companies in these industries are the goal for Phase III, so that the military applications will be able to leverage the commercial interests to achieve even higher performance levels and economies of scale for the pump combiners and overall fiber laser systems.

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KEYWORDS: Fiber Laser, Laser Pump Combiner, Double Clad Fiber, Pump Array Thermal Management

MDA10-009 TITLE: <u>Develop and Demonstrate High Performance Infrared Focal Plane Arrays with Advanced Quantum Structures</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: ABIR, PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop next-generation high-performance infrared (IR) focal plane arrays (FPAs) by exploring advanced quantum structures and utilizing innovations in nano-engineering. The topic includes, but is not limited to the investigation and demonstration of the type-II strained-layer superlattice FPAs based on III-V materials.

DESCRIPTION: MDA is seeking innovative research proposals in the area of infrared detectors and focal plane arrays using advanced quantum structures, such as Antimony (Sb) based strained layer superlattice (SLS). SLS is a new infrared detector material that has the theoretical promise to outperform existing materials such as mercury cadmium telluride (HgCdTe) and indium antimonide (InSb). In the past few years, tremendous progress has been made in various research laboratories. Long-wavelength infrared single-element detectors with performances approaching that of HgCdTe are being achieved. SLS FPAs at 320x256 format with 30 µm pixel pitch with good performance have been successfully demonstrated.

However, in order to achieve high-performance FPAs that can provide the best system performance for missile defense, several technical issues still need to be solved by technology and engineering innovation. Novel detector architecture and structure design is one area that can be explored further. Both single- and multiple-spectral band FPAs can benefit from such improvement. Better understanding and optimization of various combinations of interface elements may also payoff greatly. In the epitaxial wafer growth area, significant improvement can be made by innovations in nano-engineering. Substantial reduction in growth defect and advances in precision control of a large space of growth parameters are critical to reduce dark current noise, improve uniformity, increase device reliability and reproducibility. Additionally, innovation is needed to enhance the substrate quality and size, including reducing micro- and macro-defect counts, improving surface quality, and doping control. Substrate crystal orientation and its impact to superlattice material growth may also be studied. It is anticipated that large diameter (up to 6-inch) wafers will be needed in the near future.

So far, successful superlattice materials are grown by molecular beam epitaxy (MBE). There is no fundamental physics-derived reason to exclude other growth methods to achieve high-quality material growth. In fact, different growth methods may offer advantages over MBE , such as lower defect density, better uniformity, larger wafer size, lower production cost, and superior manufacturability. MDA encourages alternative approaches to material growth. These include utilization of technology and engineering innovations to solve technical issues specific to superlattice growth, such as interface intermixing, strain compensation and balance, temperature optimization, stoichiometry optimization, and precursor selection.

Demonstration in material growth should have quantitative technical goals, including the following: High-resolution X-ray rocking curve with full-width-at-half-maximum of 20 arc second, and the mismatch between SLS and substrate, which can be inferred by peaks in X-ray rocking curves, of less than 300 parts per million (ppm); atomic force microscopy surface roughness near 2 angstrom; wafer macro defect (defined as defect diameter larger than 20 µm) density of less than 500 per square centimeter, and wafer micro defect (defined as defect diameter less than 20 µm) density of less than 2000 per square centimeter. In addition, these SLS materials should be processed to form single-element diodes that meet the following performance goal: At operating temperatures higher than 65 Kelvin and cutoff wavelength of 10 µm, the quantum efficiency should be larger than 60% and the dark current density should be less than 1 micro-ampere per square centimeter.

In the detector array processing and FPA fabrication area, novel ideas in etching chemical selection, etching and surface cleaning protocol, passivant selection, and passivation scheme perfection are sought. Technology innovations in this area are essential in achieving low leakage current for FPAs with small pixel size and multiple-spectral bands. Although many passivation materials and methodologies have been experimented on Sb-based superlattice materials, the ultimate passivant and protocol is still to be discovered that offers a stable and highly effective mechanism to eliminate leakages. In addition, novel approaches are encouraged for substrate thinning or removal, detector array anti-reflection coating, hybridization, and FPA packaging.

Proposed novel ideas will be validated by device demonstrations at the FPA level. Single band or multiple bands on one FPA are desired.

PHASE I: Prepare and deliver feasibility study of proposed ideas. This study includes design, modeling, and experimental study. Single-element detector concept design and single pixel/small format array demonstration are strongly encouraged in Phase I.

PHASE II: Design, develop, and characterize a prototype of the proposed detector array or FPA with dramatically improved characteristics than current state of the art.

PHASE III: Develop and execute a plan to market and manufacture superlattice FPA. Assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing.

COMMERCIALIZATION: The contractor shall pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial uses in such diverse fields as law enforcement, rescue and recovery operations, maritime and aviation collision avoidance sensors, medical uses and homeland defense applications.

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KEYWORDS: Type II strained layer superlattice (SLS), infrared focal plane array (IRFPA), Dry etching and passivation, single- and dual-band detectors and FPA, InAs/GaSb III-V materials, substrate.

MDA10-010 TITLE: Smart Infrared Focal Plane Arrays and Advanced Electronics

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PTSS, ABIR

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate advanced, smart read out integrated circuitry (ROIC) for advanced infrared sensors that can be operated robustly in ballistic missile defense environments. Explore innovative ideas to mitigate adverse radiation effects from high-energy particles and lasers.

DESCRIPTION: Infrared sensors are important components in ballistic missile defense systems. As infrared sensor technologies continue to evolve, advanced smart ROICs become even more critical to effectively interpret the electric signal on the focal plane. This topic focuses on the below critical issues that need to be addressed with innovative ideas.

First, advanced discrimination and surveillance applications require multiple-band and large format focal plane arrays. Small pixel size is desired for high resolution. This presents challenge to the ROIC which needs to be able to accommodate multiple-band information with very small real estate on the pixel, and intelligently pre-process the raw data to reduce the data output and improve the signal to noise ratio. Digitization on the focal plane array either on the column, row or on the pixel is desired while reducing the power requirement. Ideally, the ROICs can perform all functions at high speed with sufficient accuracy for time-sensitive decision making and actions. It could also prove advantageous if ROICs could accomplish on-focal-plane image processing such as spatial filtering, background noise subtraction, change detection, multiple-band spectral data manipulation. This could dramatically reduce the bandwidth requirements for transferring data off the chip for supplemental digital signal processing algorithms.

Next, to optimize the system performance the advanced ROICs must perfectly match the advance detector arrays to which they are hybridized. There should be design flexibility to accommodate system trades in speed, power, injection efficiency, detector bias voltage swing, and polarity. ROIC designers are encouraged to collaborate with the detector and FPA community, including the vendors developing new detector materials or structures, to achieve the best overall performance of IRFPAs. This may involve improving charge injection efficiency, offering flexibility on n-on-p or p-on-n polarities, and making various numbers of electrical contacts per pixel while keeping the fill factor at a reasonable level. Advanced features are also highly desirable, e.g., super framing, programmable spatial resolution, pixel level change detection, programmable color fields, random window addressing for high speed imaging of multiple targets, on-ROIC analog to digital converter, multiple integration modes, programmable unit cell gain, short circuit prevention, and blooming control.

Finally, ROICs used in missile defense systems are subject to harsh radiation environment originated from high-energy particles either in a nuclear event, or natural radiation. Hostile laser beam radiation form additional adverse operation environment for ROICs and may cause local and global system malfunction. Any ROIC research must also explore innovative and robust solutions designed to mitigate the adverse effects caused by high-energy particle and laser radiation. Studies should be performed to fully understand the possible mechanisms that lead to local and global circuit malfunction. Quantitative relationships should be established between types of radiation, radiation dose, and radiation impact to the ROIC performance, as well as the infrared sensor systems as a whole. The proposed solutions should prevent catastrophic system failure, intelligently remove noise associated with radiation events, and increase operational lifetime. ROIC designs must be radiation hard to a minimum of 300kRads(Si) total dose of natural radiation and include features for mitigation of single-event upsets and latch-up.

Overall, this topic solicits innovative solutions to design and fabricate advance ROICs at single-band or dual-band with radiation hardening solutions. The desired characteristics for single-band ROICs are the following: format 1024 x 1024, 1280x720 or larger, pixel pitch from 8 µm to 20 µm, operating temperature 60 - 100 Kelvin, bias range 0 - 1 Volt, detector bias resolution 5 millivolts, well capacity up to 50 million electrons, read noise less than 200 electrons, dynamic range 14 bits, full frame rate 200 Hz, power consumption less than 200 mW, matching detector quantum efficiency 45 - 70%, and resistance-area product at zero bias (R0A) 1,000 ohm-cm2. For dual-band ROIC demonstrations, the desired characteristics are similar to that of the single-band ROIC, except that smaller formats are acceptable, the expected minimum detector resistance-area product at zero bias (R0A) 100 ohm-cm2 or larger, and the frame rate up to 100 Hz.

PHASE I: Demonstrate innovative concept through single unit cell design. Prepare and deliver feasibility study. This activity includes data gathering that establishes good understanding of the problems and quantitative analysis of promising solutions or designs. Small format array demonstration is strongly encouraged in Phase I.

PHASE II: Design, develop, and characterize a prototype of the proposed ROIC. Collaborate with detector vendors and make ROIC wafers available for hybridization and testing.

PHASE III: Develop and execute a plan to market and manufacture the ROIC. Assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial uses in such diverse fields as commercial satellite imagery, law enforcement, rescue and recovery operations, maritime and aviation collision avoidance sensors, medical uses and homeland defense applications.

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KEYWORDS: Readout integrated circuit (ROIC), digitization per column, digitization per pixel, radiation-hard ROIC and FPA, large format, single and multiple spectral band

MDA10-011 TITLE: Next Generation Inertial Sensing Technology

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors, Space Platforms, Weapons

ACQUISITION PROGRAM: ABIR, PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate innovative, revolutionary approaches to dramatically improve state of the art performance of angular rate or displacement sensing with emphasis on minimization of size, weight, volume, and power and to radiation hardness for space applications. Offerors may propose complete sensor packages or development of critical components to improve current or proposed sensor architectures.

DESCRIPTION: Proposed MDA systems, such as the Persistent Tracking and Surveillance System (PTSS), the next generation Space Tracking and Surveillance System (STSS), the Airborne Laser Test Bed (ALTB) and Airborne Infrared (ABIR) projects require extremely high-accuracy Line of Sight (LOS) stabilization and extremely accurate inertial pointing knowledge. In order to achieve their mission objectives, they require ultra high performance inertial angular rate or displacement sensors to provide absolute inertial line of sight knowledge and the necessary low frequency sensor information to support precision pointing and line of sight (LOS)/image stabilization for the acquisition, tracking and pointing (ATP) system. In addition, these systems need to be compact, lightweight, low powered and radiation hardened (space applications). The goal of this program is to develop the next generation of Strategic+ grade inertial sensors for a variety of MDA and DoD systems demanding extremely precise absolute inertial attitude knowledge or extended operations in highly denied environments.

The goals presented in this topic are strictly focused on the development and demonstration of revolutionary approaches to improve inertial angular sensing performance with minimal impact to or improvement in size, weight, and power as compared to current state of the art inertial sensing systems. However, the end goal (Phase III effort) is to create a high performance inertial angular sensor of compact form factor that meets a variety of future MDA mission performance goals under their demanding operational environments.

Performance Goals reflect the demanding needs for long range pointing, tracking and engagement and are stated (Near-term Goal / Far-term Goal): For bias drift stability, 1 sigma over 8 hours (< 0.0005 deg/hr / < 0.00001 deg/hr). For G-sensitive bias drift (< 0.001 deg/hr/g / < 0.0005 deg/hr/g) is needed. The scale factor error (long-term) is less than 5 ppm with a less than 1 ppm long term goal. Techniques to reduce angular random walk to less than < 0.00005 deg/ (hr) 1/2 in the near term and < 0.000001 deg/ (hr) 1/2 long term are also needed. Other factors of interest are improvements to angular cross-axis sensitivity with < 0.1% and an order of magnitude reduction needed for long term applications (< 0.01%). The linear acceleration sensitivity should be less than 1e-6 radians/g with a long term need for < 1e-7 rad/g. Other factors include Alignment Calibration Stability < 1 arc-sec / < 0.5 arc-sec; Angular Rate capability > + 2.3 rad/s (w/o change in measurement mode); Angular Acceleration Capability > + 4.4 rad/s2 (w/o change in measurement mode).

Physical envelopes are challenging with desired power consumption < 2 W/unit and long term < 1 W/unit for interceptor applications. Size is a key goal with <4” Diameter x 3” height / <3” Diameter x 2” height envisioned. Mass is also important, with goals of < 0.75 kg per device near term and <0.5 kg per device long term.

Space applications drive the severe temperature needs with operating ranges from -54 to 32 C and survivable temperature ranges from -54 to 71 C. For space applications the radiation hardness of the critical components should be survivable for long term exposures of 100 kRad (SI) TID / >300 kRad (SI) TID and 100 kRad (SI) Proton / >300 kRad (SI) Proton.

PHASE I: The offeror will develop/demonstrate the underlying physical principles and develop a preliminary design to demonstrate the approach/design will meet above performance goals. Modeling, Simulation, and Analysis (MS&A) of the design must be presented to demonstrate a thorough understanding of the underlying physical principles, performance potential, scaling laws, etc. MS&A results must clearly demonstrate how near-term goals will be achieved at a minimum. Proof of concept hardware development (laboratory breadboard) and test is highly desirable. Proof of concept demonstration may be subscale or demonstration of a critical component and used in conjunction with MS&A results to verify scaling laws and feasibility. Although not required, offeror’s are highly encouraged to team with MDA and DoD inertial system manufacturers capable of transitioning the emerging technology into useable product lines. The Government will not provide contact information.

PHASE II: The offeror will conduct risk reduction experiments and/or proof of principle demonstrations. The offeror will complete the critical design of the prototype including all supporting MS&A. The offeror will fabricate a minimum of one brassboard/Engineering Demonstration Unit (EDU) and perform characterization testing within the financial and schedule constraints of the program to show level of performance achieved compared to stated government goals including radiation testing of critical components if feasible. The final report shall include comparisons between MS&A and test results, including identification of performance differences or anomalies and reasons for the deviation from MS&A predictions. Although not required, offeror’s are highly encouraged to team with manufacturers capable of incorporating the developed technology into useable product lines. The Government will not provide contact information.

PHASE III: The offeror is expected to work with other industry partners and DOD offices to modify and improve the design of the Phase II proof of concept prototypes to meet individual system applications.

COMMERCIALIZATION: Current high performance IMUs cost $1.5M and up depending on customer unique requirements and these units currently fall short of the predicted performance requirements to meet several proposed missions. In addition, these systems are frequently multi-sensor packaged units. A low cost sensor or system that can meet these requirements would be very competitive. A sensor meeting the desired goals would also have great impact on guidance, navigation and control systems for spacecraft, launch vehicles, missiles, KVs and other applications requiring precision inertial knowledge. Non-DoD applications include spacecraft guidance, navigation and control (GN&C) and commercial aircraft inertial navigation systems (INS).

REFERENCES:
Subset of Standards Maintained by the IEEE/AESS Gyro and Accelerometer Panel

1. 528-2001 IEEE Standard for Inertial Sensor Terminology (Japanese translation published by the Japan Standards Association).

2. 529-1980 (R2000) IEEE Supplement for Strapdown Applications to IEEE Standard Specification Format Guide and Test Procedure for Single-Degree-of-Freedom Rate- Integrating Gyros.

3. 671-1985 (R2003) IEEE Standard Specification Format Guide and Test Procedure for Nongyroscopic Inertial Angular Sensors: Jerk, Acceleration, Velocity, and Displacement.

4. 813-1988 (R2000) IEEE Specification Format Guide and Test Procedure for Two-Degree-of-Freedom Dynamically Tuned Gyros.

5. 952-1997 IEEE Standard Specification Format Guide and Test Procedure for Single-Axis Interferometric Fiber Optic Gyros.

KEYWORDS: Inertial rate sensors; Inertial Pointing, Line of sight (LOS) stabilization; Acquisition, Pointing and Tracking; guidance, navigation and control

MDA10-012 TITLE: Interceptor Seekers and Passive Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: DV, AB, PTSS, ABIR

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Demonstrate highly integrated, compact, high performance interceptor infrared seeker technologies, including dual-band infrared sensors, advanced seeker component technologies and forward-thinking architecture and algorithms.

DESCRIPTION: The passive infrared seeker is a critical subsystem in a ballistic missile defense interceptor system. It performs detection, tracking, discriminating and aim point selection functions by measuring a series of physical variables of a single or multiple targets, including line-of-sight angle and angle rate, projected target shape, and signal intensity as a function of angle, range, temperature, emissivity, spectral property, polarization property, and temporal behaviors. The information is further processed to enable actionable interceptor functions, i.e., seeker maneuvering and engaging threat objects.

The interceptor seeker needs very high performance two-band FPAs at medium formats (512x512 to 1kx1k). One major challenge is the novel design on the two-band architecture and operation principal such as spatially co-location, temporally simultaneous and spectral crosstalk. Another challenge is the FPA processing technique associated two-color design, such as chemical interaction with deep dry etching and surface passivation at different wavelengths on the same pixel. Any new novel two-band structure will need advanced signal processing electronics to integrate with the new seeker architecture. Focus will be on real time two-band discrimination and very large field of view.

This topic solicits innovative ideas in, but not limited to advanced dual-band IR FPA development, and in seeker architecture and signal processing electronics design. The proposal can address individual research area, or integrated concepts. The contractors should be knowledgeable of the current state-of-the-art seeker component technologies and their development trend. Cross-disciplinary scientific approach to integration that involves other advanced seeker component development is highly desirable. Teaming with major missile defense system contractors is strongly encouraged.

The following lists quantitative performance requirement for the solicited technologies. Novel ideas are solicit with the following desired goals: a) Pixel-co-registered dual-band FPA at long-infrared wavelengths, with a format of 512 x 512, and a pixel pitch of 30 um. The median quantum efficiency for each band should exceed 60%, and the spectral cross talk between the two bands should be less than 10%. The median dark current noise should be at the same level as the state of the art single-band FPAs and b) A signal processing electronics unit, including advanced algorithms and electronic hardware, that apply the dual-band FPAs and can accommodate very large field of view in real time. It should be able to accommodate various discrimination algorithms, background noise cancellation, windowing, random access to a smaller array of pixels. It should accommodate dual-band image data collection and processing up to 200 Hz frame rate.

PHASE I: Identify dual-band FPA technologies to be developed and demonstrated. Develop device processing techniques proposed and demonstrate the design at a single detector level. Complete preliminary seeker signal processing block design and hardware trade. Make teaming arrangement and form a detailed work plan for hardware assembly and software development. Obtain support from interceptor system vendors for potential technology insertion opportunity in the following phases is desired.

PHASE II: Design, develop, and characterize a dual-band IRFPA, or demonstrate partially or fully integrated breadboard unit that demonstrates and validates the dual-band seeker signal processing electronics. The demonstrated unit and technology have to be scalable to a real time operation. The contractor is encouraged to coordinate with missile defense prime contractors for detailed system requirements and specifications, and identify technology applicability. Make team arrangement for Phase III.

PHASE III: Assist the Missile Defense Agency in transitioning the technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractors for the engineering integration and testing. Work closely with interceptor system house for technology maturation and technology insertion, which may include but are not limited to the modification and refinement of the architecture, design, hardware, and software. Develop and execute a plan for marketing and manufacturing.

COMMERCIALIZATION: The contractor can pursue commercialization of the dual-band IRFPA technologies and seeker signal processor developed in Phase II for potential commercial uses in such diverse fields as computer gaming, computerized learning and training, commercial satellite imagery, law enforcement, rescue and recovery operations, maritime and aviation collision avoidance sensors, medical uses and homeland defense applications.

REFERENCES:
1. http://www.acq.osd.mil/osbp/sbir/solicitations/index.htm, for MDA SBIR topic descriptions in the past few years on interceptor seekers, and works done under these solicitations.

2. SPIE proceedings on Infrared Technology and Applications, 2000-2009.

KEYWORDS: Interceptor seekers, passive infrared seekers, strapdown seekers, seeker architecture, seeker algorithm, multi-band large format FPA, spectral crosstalk

MDA10-013 TITLE: Divert, Attitude Control and Axial Propulsion System Technologies

TECHNOLOGY AREAS: Air Platform, Battlespace, Weapons

ACQUISITION PROGRAM: MDA/AB

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate innovative technologies for advanced solid/liquid propulsion components and systems (DACS and Axial) for endoatmospheric/exoatmospheric Ballistic Missile Interceptors. These technologies should reduce cost and maintenance requirements, improve reliability and meet DoD Insensitive Munitions (IM) and safety objectives. Additionally, technologies that remain stable in long term silo storage and/or mobile environments, deliver Thrust Vector Control (TVC) and variable thrust and incorporate non-destructive integrity inspection / test features are desired. Enabling technologies should facilitate development of high mass fraction motors (> 0.9, DACS > 0.6) with propellants that have high specific impulse (> 275 seconds) that are suitable for use in an operational environment. DACS criteria include improved thruster and system thrust/weight over current DoD state-of-the-art; reliable ignition and fast response time (< 20 ms); multiple ignition methods for solid propellant systems that are IM compliant, compact and light weight. Criteria related to all propulsion systems include operation at ambient temperature (-60 °F to 170 °F); high performance; resistance to temperatures above 2500 °C (~ 4500°F) and high pressures (2000 psi) with minimum out-gassing.

DESCRIPTION: Advanced technologies are needed to address cost reduction, IM and safety requirements while maximizing overall interceptor capability. Increased interceptor terminal velocity and reduced overall time of flight are desired to increase system battlespace and minimize the effect of degraded or alternate sensor handover capability. High performance, light weight DACS are also desired to enable kill vehicles capable of engaging advanced threats to be packaged within restricted geometries. Innovative development in the following enabling technology areas is desired:

Material Utilization: Increased combustion temperatures associated with advanced solid and liquid propulsion systems with lifetimes commensurate with interceptor system operational requirements demand more robust materials. Advanced techniques for propulsion component design and utilization of advanced materials enabling performance, packaging, durability, manufacturability, and cost improvements are desired. Components designed and constructed of materials such as carbon matrix composites, ceramic matrix composites, cermets, and refractory metals capable of surviving increased operating temperatures, reduce oxidation and erosion are sought. (Note: This topic area seeks the utilization of advanced materials for propulsion system components, not development/enhancement of new/existing materials.)

Propellants: Advanced solid and liquid propellant chemistry resulting in improved specific performance, packaging, operational flexibility, and maintenance / support requirements are desired. High density-specific impulse, high performance, low toxicity and suitability for application in cold and airborne environments are necessary technology features. Propellant formulations should be IM compliant to facilitate ease of transportation and reduced hazard to personnel. Refer to DoD Ammunition and Explosives Safety Standards for all hazard classifications.

Component Design / System Architecture: Novel concepts for lightweight high performance DACS that enable large mass fraction (> 40% system mass fraction and 60% DACS mass fraction) are desired. Designs that can tolerate higher flame temperature propellants and yet include high thrust to weight thrusters (actuators, injectors, chambers and nozzles) using advanced materials are of special interest. Other areas of interest include innovative component and subsystem design for the pressurization, propellant storage and delivery, and feed systems (e.g., thermally augmented or mini-pump feed systems are potential additions). In the thruster area, there are also component design techniques that may result in substantial footprint reductions by achieving reduced component dimensions (e.g., plug or expansion deflection nozzles, multi-grid nozzles; chamber techniques to produce a much shorter length versus L*). For booster applications, TVC technologies with high vectoring magnitude and response capability while minimizing loss at reduced system power, mass, and volume footprint are desired to enhance booster performance and reduce DACS requirements. Emphasis should be placed on the use of more environmentally and operationally “friendly” propellants (i.e., low toxicity, insensitive), with little or no decrease in impulse and response performance relative to current state of the art alternatives.

Modeling and Simulation: The DoD continues to develop and synthesize advanced liquid, gel, and solid propellant formulations of increased delivered energy. Increased delivered performance propellant formulations will change the performance requirements for component materials. Most missions will require a long storage life in a wide range of environments. To support development of materials solutions, physics based reaction and degradation models are required. The models should include consideration of long term propellant exposure in predictable but uncontrolled environments ranging from storage conditions on ground based installations, mobile ground, sea, and air launch platforms. Further, approaches to determining formulation kinetics that identify the most challenging compounds formed during decomposition and combustion reactions (intermediate as well as final) that a component will face to achieve first iteration work-to requirements are desired. Models of this nature will guide tailoring of propellant formulations along with development of thruster hardware (including feed and storage) solutions.

Additional Technologies / Challenges to Address: Despite recent progress, several technical propulsion challenges remain, including, but not limited to: understanding the compatibility of ablative composites (tank/seal) materials in green & non-green liquid propellant environment (HAN, ADN, Hydrazine, etc.); demonstration of complex braided structures and integral assemblies for green & non-green liquid mono-propellant specific hardware; enhanced matrix compositions that improve life for oxidizing environments at 2500 °C and beyond to exploit emerging high performance propellant formulations. Additional technologies of interest include: monolithic SiC or silicon thrusters using liquid or gel propellants; colloidal thrusters; innovative bi-propellant or monopropellant concepts; solid propellant multi-pulse or breech concepts; pulse detonation rocket engines.

PHASE I: Develop a proof of concept design; identify candidate materials, designs and test capabilities, and conduct feasibility assessment for the proposed propulsion technology. Fabricate and characterize materials for component technologies or define proof of capabilities test concepts. Results from the design and assessment will be documented for Phase II.

PHASE II: Develop and demonstrate prototype designs incorporating Phase I technology in a relevant test environment. Develop and document design and/or test approaches. Perform appropriate characterization and testing, e.g. sub-scale motor tests, component level tests and/or IM related testing such as fast and slow cook-off.

PHASE III: The developed technology should have direct insertion potential into missile defense systems. Conduct engineering and manufacturing development, test and evaluation and hardware qualification. Demonstration would include, but not be limited to, demonstration in a real system or operation in a system level test-bed with insertion planning for a missile defense interceptor.

COMMERCIALIZATION: The technologies developed under this SBIR topic should have applicability to automobile industry, unmanned vehicles, etc.

REFERENCES:
1. George P. Sutton, "Rocket propulsion Elements; Introduction to Engineering of Rockets," 7th edition, John Willey & Sons, 2001.

2. Paschal N, Strickland B, Lianos D, "Miniature Kill Vehicle Program," 11th Annual AIAA/BMDO Technology Conference, Monterey, CA, August 2002.

3. Vigor Yang, Thomas B. Brill, and Wu-Zhen Ren, "Solid Propellant Chemistry, Combustion, and Motor Interior Ballistics", AIAA, 2000.

4. Murthy S.N., Curran E.T, "Development in High Speed Vehicle Propulsion Systems," AIAA, 1996.

5. G. Hagemann, H. Immich, T. Nguyen "Advanced Rocket Nozzles", Journal of Propulsion and Power, Vol 14, No 5, pp620-634, AIAA, 1998.

6. Palaszewski, Bryan, "Propellant Technologies: A Persuasive Wave of Future Propulsion Benefits", NASA Glenn Research Center, Cleveland, OH, Feb. 1997, http://sbir.grc.nasa.gov/launch/Propellant.htm.

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KEYWORDS: Propulsion, DACS, divert, attitude, green, solid, liqud, propellant, insensitive munitions, modeling, HAN

MDA10-014 TITLE: <u>Radiation Hardened Interceptor Avionics for Ascent Phase Interceptor</u>

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes, Sensors, Electronics, Space Platforms, Weapons, Nuclear Technology

ACQUISITION PROGRAM: DV, GMD, THAAD, ABIR, SM-3, DVP

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this research and development effort is to encourage the genesis of innovative, high performance avionics systems, subsystems, and components that will enhance the capability of successfully achieving early intercept missile defense in current and future interceptors in a hostile environment.

DESCRIPTION: Avionics systems currently used in the BMDS interceptors are too expensive, bulky, and heavy. They provide limited bandwidth, power, and range and are sensitive to shock, vibration, radiation. To achieve MDA goals for improved ascent phase intercepts, MDA boost and assent phase platforms must intercept as early as possible in the battlespace. This will ensure the defeat of threats systems before countermeasures are deployed. Further early intercept will minimize the undesirable impact from debris to host-nation territory while also reducing the number of interceptors needed to ensure a successful engagement. To optimize the ability to execute a shoot-look-shoot strategy MDA will need improved interceptor avionics technology. This will bring greater flexibility, agility, and achieved interceptor velocity to current ascent phase defense systems. The technology developed to enhance current systems will also be applicable to next generation interceptor systems. These evolved systems will demand further performance enhancements to support new missions while simultaneously and continuously reducing size, weight and power (SWAP). Interceptor Avionics, for this topic, includes the seeker signal/image processors, flight computer, gyros, accelerometers, associated electronics and their integrated units (Inertial Reference Unit, Inertial Measurement Unit), with or without Global Positioning System augmentation, DACS, secure interceptor communication system (with or without implementation of Software Defined Radio (SDR) solutions), innovative antenna technology, internal wiring/wireless interconnectivity, connectors, networks, and interceptor power sources (batteries) and power conditioning.

Achieving ascent phase intercepts requires avionics technology that will provide for and operate reliably in the rapid acceleration, high g-load conditions required to overtake and intercept a threat missile. Improved interceptor avionics systems based on modern low power, high density microelectronics; MEMS; electro-optics as well as lower cost are desired. Any improved components and integrated system must be able to withstand high shock and vibration upon missile lift-off, stage separation events, and during Divert-Altitude Control System operation, impose minimum operational requirements prior to launch, and operate in a thermal environment from -50 C to + 80 C (85 C intermittent). They should not be sensitive to Electro-magnetic Interference or prolonged storage at the above temperatures. Proposing firm should also consider the effects of natural and prompt ionizing radiation effects on their avionics solutions in their proposal.

PHASE I: Conduct experimental and analytical efforts to demonstrate proof-of-principle of the proposed technology to enhance avionics performance for ascent phase intercepts. Determine expected performance through extensive analysis/modeling effort. Identify technical risks for the avionics and subsystems and develop a risk mitigation plan. Proposed designs should strive for twice the performance of current technology at half the cost, and strongly suggest a growth opportunity for further performance increases and cost reduction.

PHASE II: Design, develop and characterize prototypes of the proposed technologies and demonstrate functionality. Demonstrate feasibility and engineering scale-up of proposed technology; identify and address technological hurdles. Demonstrate applicability to both selected military and commercial applications.

PHASE III: Develop and execute a plan to manufacture the avionics system, or component(s) developed in Phase II, and assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing.

COMMERCIALIZATION: The proposed avionics technology growth areas would have applicability to automobile industry, communication satellites, the computer industry, cell-phone industry, airline communications, and over-the-air communications. Other efforts within the DoD are focused on two-way data links to weapons systems and relevant technology from this effort will be transferred to those programs. The contractor will pursue commercialization of the proposed technologies in the fields of munitions and missile guidance, instrumentation for motion control, simulation & training, vehicle safety and personal navigation.

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1. H. Helvajian, “Microengineering Aerospace Systems”, The Aerospace Press, American Institute of Aeronautics and Astronautics, 1999.

2. Rebeiz, Gabriel M. RF MEMS Theory, Design and Technology. John Wiley & Sons, Inc. Hoboken, New Jersey, 2003.

3. "In Flight Alignment Techniques for Navy Theater Wide Missiles", E.J. Ohlmeyer, T.R. Pepitone, AIAA 2001-4401.

4. "Fundamental of High Accuracy Inertial Navigation", AIAA Progress in Astronautics and Aeronautics Vol. 174.

5. MIL-STD-461, "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference", military standard, procedure CE106.

6. D.M. Fleetwood and P.S. Winokur, “Radiation Effects in the Space Telecommunications Environment,” Proc. 22nd Int. conf. On Microelectronics (MIEL 2000), Vol. 1, NIS, Serbia, 14-17 May 2000.

KEYWORDS: interceptor, avionics, gyros, accelerometer, communication, power, signal processors, data processors, electronics, communications architecture, jamming, high altitude nuclear explosions, RF data link.

MDA10-015 TITLE: Advanced Synergistic Structures and Materials for Interceptor Kill Vehicles

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Weapons

ACQUISITION PROGRAM: SM3, ABIR, THAAD, GMD, PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop technology for an interceptor Kill Vehicle (KV) that integrates disparate components and materials into the load bearing structure to increase the performance and capability of the KV.

DESCRIPTION: The phrase “Synergistic Structures” in this context refers to Structures and Materials with multiple functions (e.g., fuel tanks or batteries that function as load-bearing KV structure and/or protect against hostile environment) or structures/materials with embedded components (e.g., electrical, optical, power, cabling, propulsion, sub-structures, isolation, etc). The synergy must not compromise the integrity of the interceptor. The MDA has funded numerous technology development programs that could be applied toward KVs. However, many of these efforts focused on an individual functions without the consideration of combining components and materials into a system to save mass, volume, and ensure structural integrity. The MDA is interested in developing revolutionary and evolutionary KV technologies that will significantly improve key performance parameters (speed, volume, mass, accuracy, agility, etc.). In recent years, a number of new technologies have emerged (new materials, nano-research, component/electronic miniaturization, enhanced kill effects, etc.) that make it feasible to integrate components in a system without degradation of other subsystems. This effort will focus on the development of embedded materials and components of previously independent structures/subsystems with considerations to the following: radiation shielding, structural stability, harmonics, mass, reduced part count, enhanced lethality, and reduced volume. Additionally, the structural system must be designed to the operational environment (temperature variations, high acoustic levels, maneuvering loads, high shock loads, nuclear effects, and severe vibration loads).

Proposals should provide sufficient detail to allow the evaluation team to ascertain the potential benefits and risks associated with the concept and describe the system-level benefits.

PHASE I: Develop initial design concept; conduct analytical and experimental efforts to demonstrate proof-of-principle; develop preliminary design complete with documentation that will provide proof-of-functionality; and model or produce/demonstrate “breadboard operational prototype” to ensure proof of basic design concept. Proposed concepts should be modeled with representative KV-type environment. The contractor will provide any embedded components for models, breadboards, etc. Simulated embedded components may be substituted for actual components if their use is substantiated by analyses. The contractor will develop a Phase II strategy plan that includes (but not limited to) development and integration strategy, potential demonstration opportunities, program schedule, and estimated costs.

PHASE II: Design and fabricate a prototype structural concept that could be demonstrated in a representative KV environment. The goal is to transition and commercialize this technology by developing working relationships with the relevant BMDS systems and contractors. The contractor will provide any embedded components for prototypes.

PHASE III: Develop and execute a plan to manufacture the prototype developed in Phase II, and assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing. The contractor will provide any embedded components.

COMMERCIALIZATION: The commercial potential for highly integrated/synergistic structures is immense in the aerospace, automobile, and infrastructure industries.

REFERENCES:
1. Starr, A.F., et al., "Fabrication and Characterization of a Negative-Index Composite Metamaterial," Physical Review B, Vol. 70, 113102 (2004).

2. Adams, J.H., AIAA 2001-0326, 39th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, 8 January 2001.

3. Wilson, J.W., et al, "E-Beam-Cure Fabrication Polymer Fiber/Matrix Composites for Multifunctional Radiation Shielding," AIAA 2004-6029, Space 2004 Conference and Exhibit, San Diego, CA, 28-30 September 2004.

4. Thostenson, E.T., Ren, Z, Chou T-W, "Advances in the science and technology of carbon nanotubes and their composite: a review", Composites Science and Technology, 61, pages 1899-1912, 2001.

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KEYWORDS: Synergistic Structures, Integrated Structures, Kill Vehicles, Radiation Shielding, Communications, Optics, Composite Materials, Nano-Materials, Lethality Enhancement

MDA10-016 TITLE: Active Sensor Technologies for Interceptor Seekers

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: Advanced Interceptor and THAAD/SM3/GM3 upgrade

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop highly integrated, severe environment, active sensor ranging, velocity and active imaging components for multi-mode seekers to enhance long range target acquisition, track, and intercept.

DESCRIPTION: Key functions of a missile defense seeker are to detect, track, discriminate, and provide steering commands to drive the missile to hit the target. Due to technology limitations in power size and weight and sensitivity these approaches have been primarily focused on passive EO and IR. The effectiveness of a missile interceptor could be greatly enhanced if, within the size and weight of current seeker footprints, active ranging and velocity could be added to refine the velocity and line of sight angle estimates and derive information regarding target motion. The combination of active and passive measurement ability in a gimbal or strapdown (preferred) configuration would provide a tremendous improvement to the next generation of interceptor seekers for evolving complex target scenarios.

These active technologies will be part of an integrated seeker suite for future potential upgrades to current BMDS interceptor systems and airborne sensor platforms to enable advanced, agile interceptors and miniature interceptors that are survivable in adverse environments. The goal is to provide range data to enhance the defeat of various targets, facilitate discrimination, and engage new developing asymmetric threats. A primary goal is adding target range and velocity data for long range detection, tracking and intercept of high endo-atmospheric and exo-atmospheric targets in all phases of flight including boost, ascent, midcourse and terminal.

This topic calls for active interceptor seeker components that will be able to provide range, amplitude and/or velocity information at long ranges (from 100 to 1000km). Active strapdown seekers to include laser ranging and laser imaging are of interest as well as future high frequency RF imaging sensors. The innovative concepts, components and technologies to be developed for strap-down capability include the innovation in modular laser transmitter or RF imaging technology to be adaptable to future interceptor optical systems.

The technology challenge is to operate within the constraints of current seeker footprints with transmitter and receiver and real time processing components as add-on to current and developmental BMDS seeker and sensor optics without substantially changing aperture or diameter of the interceptor. The seekers must perform all of these functions while the sun, moon, or earth-limb are may pass through the seekers' field of view. The components must also be inherently thermally stable over extreme temperature ranges, survive and operate through radiation environments and function in the shock and vibration of a boosting and diverting thrusting missile kill vehicle. The offeror should consider power constraint as a key technology issue. A representative 28V battery at approximately 750 Watts for 120 seconds after launch available for up to 20 minutes to power the transmitter/receiver concept. Add-on batteries of suitable reserve and rechargeable types no larger than 100 cubic inches may be available to add to the existing payload.

Focus Areas: Compact laser systems are needed (1 to 5 micrometer wavelengths) that can operate with minimal cooling during fly-out timelines, modular designs to fit in and around existing passive detectors and optical elements. High peak power short pulse lasers that can also switch to high pulse repetition rates for target imaging are desired. The target acquisition ranges require lasers that can fit within the current interceptor available space and still generate significant photons per pulse and pulse rates to achieve the desired operating ranges. Transmitters with chip-scale-packaging, scalable sources for increased ranging are needed. Novel concepts that increase link margins are also of interest.

Ultrafast and ultrasensitive laser detectors and arrays (1-5 micrometer) that are inherently radiation hard, operate with only a limited photon return signal, preserve return amplitude, and have no dead zone for reset are of interest. Arrays much larger than current 32 by 32 are envisioned to lessen the acquisition search and optical stability requirements of the pointing and tracking system.

Active multiple pulse receiver readout integrated circuits with dual mode capability, ability to process multiple returns per pixel from each transmitter pulse and address photon counting direct detection and coherent Doppler imaging (bandwidths substantially over 1 GHz) are desired.

Beam control (zoom, fast steering, pointing, stabilization) are sought to substantially advance the performance of miniaturized line of sight pointing systems, achieving greater than +/- 60 degrees steering with stable sub-millisecond response across the field of regard. System accuracy should be able to achieve stable micro-radian accuracy within the period of response. Concepts that can be adapted and re-utilize the existing passive EO/IR sensor optical configuration are of significant advantage to facilitate technology insertion.

The volume constraints goal for the eventual transceiver systems are in the order of one half liter. All elements should be compatible with stable operation in a radiation enhanced vacuum environment and over a wide military operating temperature range.

The proposal should show by analysis or modeling how the proposed technology approach provides a novel improvement to the state of the art and addresses the BMDS mission environment.

PHASE I: Research, quantitatively analyze, and assess the feasibility of novel active sensor components. It is desirable that critical component technology elements be validated with demonstration experiments and modeling analysis in the context of an interceptor engagement scenario. Develop a component system(s) design and performance model that would provide range, range rate, and other 3 dimensional targeting information to improve BMDS engagement for ascent phase and other phase scenarios.

PHASE II: Design, develop, and characterize a prototype of the active seeker system component(s) and demonstrate the proof of concept functionality. Work with MDA prime interceptor developers to determine component performance and size, weight, and power (SWaP) goals to facilitate Phase II transition. Investigate private sector applications along with military uses of key components developed in Phase II.

PHASE III: Develop and execute a plan to manufacture the sensor system, or component(s) developed in Phase II, and assist the Missile Defense Agency in transitioning this technology to the appropriate Ballistic Missile Defense System (BMDS) prime contractor(s) for the engineering integration and testing.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial uses in such diverse fields as law enforcement, rescue and recovery operations, maritime and aviation collision avoidance sensors, medical uses and homeland defense applications.

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1. W. Dyer, W. Reeves, and G. Dezenberg, "The Advanced Discriminating Interceptor", AIAA Missile Science Conference Proceedings, 1994.

2. M. Z. Tidrow, "MDA Infrared Sensor Technology Program and Applications", SPIE Proceedings, Vol. 5074 (2003), p39.

3. A. V. Jelalian, "Laser Radar Systems," Artech House, Inc., 1992.

4. “Raytheon RIM-161 Standard SM-3”, http://www.designation-systems.net/dusrm/m-161.html

5. C. Kopp, “Theatre Ballistic Missile Defense Systems”, Technical Report APA-TR-2008-0701, July 2008, http://www.ausairpower.net/APA-BMD-Survey.html

6. M. E. DeFlumere, W. E. Shaw W. P. Watson, MULTI-WINDOW/MULTI-TARGET TRACKING (MW/MT TRACKING) FOR POINT SOURCE OBJECTS, United States Patent Application 20090237511, BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION INC, NASHUA, NH., US, http://www.freepatentsonline.com/20090237511.pdf or http://www.freepatentsonline.com/y2009/0237511.html

7. M. E. DeFlumere, M. W. Fong and H. M. Stewart, “DUAL MODE (MWIR AND LADAR) SEEKER FOR MISSILE DEFENSE”, BAE SYSTEMS, Nashua, NH 03060, Approved for Public Release; Distribution is Unlimited. http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA408948

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10. P. E. Cassady; R. N. Murata; S. McKenna; M. J. Yoder; W. E. Keicher; P. M. Blumenau; D.H. Leslie; D. G. Youmans,” Laser radar technology for airborne theater missile defense “, Proceedings SPIE Vol. 2472, Applied Laser Radar Technology II, Gary W. Kamerman, Editors, pp.50-61,16 June 1995.

11. Missile Defense Agency Downloadable Resource Guide to Programs.
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http://www.mda.mil/global/documents/pdf/bmds_briefing09.pdf

KEYWORDS: Remote Sensing, Laser Rangefinder, Laser Imaging, Discrimination, Laser Detectors, Photon Counting Detector, Solar Blind, Interceptor, Strap Down Seeker, Miniaturization

MDA10-017 TITLE: Anti-Tamper Technologies for Missile Defense

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes, Sensors, Electronics, Space Platforms, Weapons

ACQUISITION PROGRAM: DEP, AB, GM, TH, SN, PTSS, ABIR

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop advanced methodologies, materials, and approaches for protection of BMDS assets from intrusion, reverse engineering, and tampering. Specifically, develop a means to protect against Side Channel Attacks (SCAs) on Field Programmable Gate Array (FPGA) devices, for the protection of Critical Program Information (CPI) against exploitation.

DESCRIPTION: The MDA Director has issued a directive necessitating the protection of Critical Program Information (CPI) from unintentional transfer and the policy for the implementation of Anti-Tamper (AT) technology on MDA acquisition and associated technology programs. AT technology consists of engineering activities that result in the prevention and/or delayed exploitation of critical technologies in U.S. weapons systems. The purpose is to add longevity to critical technology by deterring efforts to reverse-engineer, exploit, or develop countermeasures against a system or component.[1-4]

This topic seeks to develop innovative countermeasures to SCAs that may be performed on FPGA devices, as a means to prevent unauthorized access to CPI, or otherwise provide protection against system reconfiguration or unauthorized access. In cryptography, an SCA is any attack based on information gained from the physical implementation of a cryptosystem, rather than from brute force or theoretical weaknesses in the algorithms.[5] For example, timing information, power consumption, electromagnetic leaks, sound or fault injection can provide an extra source of information which can be exploited to break the system.[5,6] Though the particular solution may be tailored to a specific application, the concept and methodology of the solution should be applicable to Commercial Off-The-Shelf (COTS) and military hardware. Preference will be given to solutions that provide protection of CPI without introducing additional risks, weights, or costs to the weapon platform and its mission. Additionally, attention will be focused on the covertness of the technology, personal and mission safety, minimal impact to system availability and maintainability, low (or no) power requirement, and seamless integration in the BMDS weapon platform. As a result, the MDA will maintain a technological edge in support of the warfighter.

PHASE I: The contractor shall develop the conceptual framework for a new and innovative AT protection technology or technique that is integrated with, or tailorable to, the CPI being protected. The contractor will also perform an analysis and limited bench level testing to demonstrate the concept and an understanding of the new and innovative protection technology.

PHASE II: The contractor shall demonstrate and validate the use of the AT protection technology into one or more prototype efforts, and evaluate the effectiveness of the technique. A partnership with a current or potential supplier of MDA systems, subsystems, or components is highly desirable. The contractor shall also identify any anticipated commercial benefit or application opportunities of the innovation.

PHASE III: Integrate selected AT protection technologies into a critical system application, for a BMDS system level test-bed. This phase will demonstrate the application to one or more MDA element systems, subsystems, or components - as well as the product's utility against industrial espionage. When complete, an analysis will be conducted to evaluate the ability of the technology/technique to protect against tampering in a real-world situation.

COMMERCIALIZATION: The proposal should show that the innovation has benefits to both commercial and defense applications, while understanding the need to minimize proliferation of the technology to prospective reverse engineering entities. The projected benefits of the innovation to commercial and defense applications should be clear, whether they reduce cost, or improve the producibility or performance of products that utilize the innovative technology.

REFERENCES:
1. Willis, L., Newcomb, P., Eds. Reverse Engineering, Kluwer Academic Publishers, 1996.

2. Ingle, K.A., Reverse Engineering, McGraw-Hill Professional, 1994.

3. Furber, S., ARM System-On-Chip Architecture, Addison-Wesley, 2000.

4. Huang, A., Hacking the Xbox: An Introduction to Reverse Engineering, No Starch, 2003.

5. Wikipedia, "Side Channel Attack". http://en.wikipedia.org/wiki/Side_channel_attack

6. Discretix Technologies, Ltd., Introduction to Side Channel Attacks,
http://www.discretix.com/PDF/Introduction%20to%20Side%20Channel%20Attacks.pdf

KEYWORDS: Anti-Tamper, Protection, Reverse Engineering, Exploit, Cryptography, FPGA, Side Channel Attack, Countermeasures

MDA10-018 TITLE: Ballistic Missile Defense System Advanced Power Storage Devices

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Space Platforms, Weapons

ACQUISITION PROGRAM: AB, GM, QS, SS, TC, TH, PTSS, ABIR

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 3.5.b.(7) of the solicitation.

OBJECTIVE: These include developing new technologies, improving existing technologies, adapting new applications of existing technologies, and inventive uses of commercial off-the-shelf and military off-the shelf technologies. Please note that some technology encompassed by this topic may be restricted under the International Traffic in Arms Regulations (ITAR, CFR 22, Part 121), which controls the export and import of defense-related material and services. If applicable, Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish.

DESCRIPTION: MDA currently uses a variety of rechargeable and nonrechargeable reserve-type batteries to power Ballistic Missile Defense Systems (BMDS). These power storage devices provide in-vehicle power for up to several hours and in some cases must source tens of kilowatts in relatively compact volumes. Next generation MDA applications are projected to demand even higher power and energy levels, and this topic is seeking technologies that can achieve those levels. For any of these new technologies, consideration should be given for cost reduction, reliability and safety. Detailed areas of interest include (but are not limited to) the following:

Nonrechargeable Reserve Batteries: Main interests for nonrechargeable (primary) reserve thermal batteries include innovations to increase energy density, power density and improve manufacturability. A main focus area for improving energy and power density are innovations that provide substantial increases in levels now attainable with thermal batteries (e.g. specific power of greater than 10 kW/kg, specific energy greater than 125 Whr/kg at the battery level). Main focus areas for manufacturability enhancements include improved processes for materials (e.g. improve yield, reduce contaminants), battery assembly (e.g. reduce human assembly errors, adapt new manufacturing methods), inspection (e.g. improve ability to screen defects), quality control and modeling (e.g. for battery design, manufacturing, simulation).

Aerospace-Grade Rechargeable Lithium Cells & Batteries: Main interests for rechargeable (secondary) lithium cells and batteries include innovations to develop precursor materials, widen the temperature operating range for these cells, improve manufacturability of cells and batteries, achieve highly capable modeling and battery management systems. A main focus for developing precursor materials needed to manufacture these lithium cells includes development of improved currently used and new precursor materials and processing techniques. Main focus areas for other cell materials include innovative anodes, cathodes, separators, additives and electrolyte formulations and manufacturing processes. The main focus areas for improving low temperature (below -20°C) and high temperature performance (above 60°C) include maintaining high levels (>80%) of capacity retention, cycle life, and discharge rate ability after days of exposure to extreme temperatures. The focus areas for improved cell and battery manufacturing include innovations to develop reliable, lower cost processes for optimal cell designs and resulting battery configurations that accommodate MDA missions (e.g. in-flight power up to two hour discharges at 28 volts nominal output). Modeling focus areas include innovations that allow accurate cell and battery performance simulation of voltage decay, capacity fade, and response to out-of-normal conditions, environmental exposure, etc. Main focus areas for improvements in battery management systems include innovations to improve charging and cell balancing methods, and abnormal condition detection before failure occurs.

PHASE I: Develop conceptual framework for material, cell, battery or production process design/design modification for integration into MDA systems or subsystems to increase performance, lower cost and increase reliability and producibility. At a minimum, the innovation’s proof-of-concept should be demonstrated with modeling or by a hardware simulation. Where possible, scaled demonstrations of the innovation should be provided to assist in judging merit of the innovation.

PHASE II: Validate the feasibility of the power storage device or manufacturing process technology by demonstrating its use in the testing and integration of prototype items for MDA element systems, subsystems, or components. Validation by demonstration should sufficiently show near term application to one or more MDA-interest systems. A partnership with a current or potential supplier of MDA element systems, subsystems or components is highly desirable, though not required. The possibility of commercial benefit or application opportunities for the innovation is also desirable.

PHASE III: The intention is to successfully implement the new power storage technology for use by MDA and other customers as appropriate. Implementation would include, but not be limited to, demonstration in a real system or operation in a system level test bed, and flight testing of the battery or solar array concepts. The new power source technology should be implemented at a manufacturer and be ready for inclusion in MDA applications.

COMMERCIALIZATION: High energy & power batteries have commercial uses, and it is anticipated the battery technologies developed under this SBIR will likely find wider use in non-MDA applications. As well, these batteries are used in some consumer applications (e.g. cordless tools) and in various industrial settings (e.g. load leveling).

REFERENCES:
1. http://www.mda.mil, provides links to overviews of MDA platforms.

2. http://www.osti.gov/bridge, provides links to Department of Energy documents describing various MDA-interest battery technologies.

3. Journal of Power Sources (www.elsevier.com) and Electrochemistry Society (www.electrochem.org) provide detailed information on current state-of-the-art advances and research efforts, some are applicable to MDA-interest batteries.

4. Handbook of Batteries, 3rd Edition, McGraw-Hill, provides detailed information regarding the design and construction of thermal, liquid reserve and rechargeable batteries.

KEYWORDS: power density, energy density, thermal battery, lithium battery, rechargeable

MDA10-019 TITLE: Manufacturing Process Maturation for Propulsion Technology

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: DEP, GM, TH , AB

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The Manufacturing and Producibility (DEP) Directorate of the Missile Defense Agency (MDA) is seeking producibility and cost reduction improvements for low-cost, high-performance materials and components. Reliable performance in both lower and upper boost phases, as well as end game, requires innovative, mature, and reduced-cost manufacturing processes. Additional considerations are for materials and components that demonstrate innovative technologies which moderate the response of large diameter (12 inches or greater) solid rocket motors (SRM) to unplanned stimuli such as heat, bullets or high-speed fragments. Applications of interest include solid boost motors as well as solid and liquid propellant divert and attitude control systems (DACS).

DESCRIPTION: MDA propulsion systems exhibit stringent performance requirements while simultaneously exposing materials to severe operating conditions. Reduced weight and power consumption while maximizing the fast response times require innovative actuation/valve technologies to minimize the response time for fine attitude control and pointing for divert and attitude control systems. Innovative projects to reduce the weight and volume of pressure regulators with a tighter regulation range. Erosion-resistant ceramic materials cannot resist the structural loads imposed by very large temperature gradients. Department of Defense (DoD) is required by statute to have programs that utilize Insensitive Munitions (IM) technologies. The current technology used to minimize the effects of unplanned stimuli on SRMs is insufficient and new IM technologies must be developed. Current large SRMS tend to react violently when exposed to fire, bullets and fragments.

- Actuator/Valve technology: Low voltage, high power density, high performance actuators for 5 to 2000 lbf applications. Response times should range from 5 ms at 5 lbf to 15 ms above 1000 lbf. Actuation technologies should maintain response, stiffness, and precision performance characteristics at high temperatures (>500F functional capability). Additionally, MDA desires actuation technologies with reduced part counts and designs that enhance reliability and simplicity of fabrication. For valve technology, reduced part count/complexity while operating at very fast response times, typically 1 ms to 3 ms response time for opening and closing.

- High pressure regulators are used to regulate pressure for propellant feed systems for DACS systems. These regulators regulate pressure from 10 ksi to approximately 1000 psi. This solicitation requests innovative technologies to miniaturize the pressure regulator to reduce packaging weight and volume while increasing the regulated pressure tolerance to approximately 100 psi. Current technologies regulation range is approximately 400 psi (1000psi to 1400 psi).

- High temperature, ablation-resistant structural parts and components: Ablation-resistant materials such as ceramics, composites, and refractory metals for components such as liners, nozzles, and hot gas paths. DACS materials including Zr- or Hf-based materials shall be subjected to pressures up to 3000 psi and flame temperatures from 4000°F to 5000°F. SiC-based composites may be considered, but are known to be temperature limited relative to these goals. Aluminized motor materials (TaC-based) must operate at 2000 psi and at flame temperatures greater than 6000°F. The materials must be able to tolerate large temperature gradients such as those experienced at motor initiation. A typical minimum property is a tensile strength of over 50 ksi (345 MPa).

- Structural insulation components: DACS components are attached to missile structures and electronic components that cannot tolerate high temperatures. Currently, most non-pyrolyzing insulation materials have poor mechanical properties. Optimal structural insulation materials will be dimensionally stable to high temperatures, will not pyrolyze, and will exhibit nominal 15 ksi (34.5 Mpa) strength. Structural insulators will have high fracture toughness and thermal stress resistance, and exhibit low thermal diffusivity. Materials are desired for use at 3000°F with a future temperature goal exceeding 4000°F.

- Non-Structural insulation components: New materials are desired which pyrolyze to form dense, adherent, and low thermal diffusivity char layers. Such materials are typically rubbers (such as EPDM) which are compatible with both case materials and propellant compositions. High elongations (goal: >50%) are desired to enable case-propellant structural compatibility, and chemical compatibility must also be considered.

- For IM, Define and identify concepts for IM technology improvements and new technologies for SRMs which include but are not limited to new energetic material formulations and motor case/container venting technology. Identify the possible IM benefits and outline a proof of concept test plan, which can include but are not limited to testing of new energetic materials to obtain valuable characterization data, and analog or sub-sale motor test designs and venting tests. The use of MIL STD 2105C for designing, conducting and evaluating IM test programs is highly desirable.

PHASE I: Develop a strategy to demonstrate the producibility of the proposed propulsion product including integration with an MDA system. The goal of the Phase I effort will be to demonstrate that it is feasible to increase performance, reduce cost, and/or increase production reliability of the selected component. The proposal should provide a quantifiable assessment of the feasibility and pay-off of the selected technology. Critical experiments and/or analyses to support the Phase I feasibility is desired.

PHASE II: Implement the manufacturing plan and quantify key milestones. Validate the feasibility of the material or component by demonstrating its use in the operation of manufactured items for MDA systems, subsystems, or components (such demonstration assumes adequate material and component characterization). A partnership with a potential supplier of MDA systems, subsystems, or components is highly desirable. Identify commercial applications of the technology and other DoD opportunities that benefit from the innovation.

PHASE III: Complete technology transition via successful demonstration of a new product technology. This demonstration should show near-term application to one or more MDA element systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and reduction of unit cost or total ownership cost of the proposed subject.

COMMERCIALIZATION: Manufacturing improvements in materials have direct applicability to space launch vehicles, gas turbines, and automotive technologies. Actuator technologies have wide applicability to the aerospace industry to include both aircraft and rocket technologies. Because of the wide variety of chemicals and materials involved, it is anticipated that the private sector will benefit from test procedures for aging propellants.

REFERENCES:
1. George T. Sutton, “Rocket Propulsion Elements; Introduction to the Engineering of Rockets”, Seventh Edition, John Willey and Sons, 2001.

2. Missile Defense Agency Link: http://www.acq.osd.mil/mda/mdalink/html/mdalink.html

3. Ballistic Missile Defense Basics: http://www.acq.osd.mil/mda/mdalink/html/basics.html

KEYWORDS: Divert and Attitude Control System, High Temperature Material, Insulation, Propellants, Rocket Motor

MDA10-020 TITLE: Materials and Life Cycle Sustainability

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: AB, GM, TH

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Enhance the performance, producibility, and sustainability of missile body structures and components for implementation into Ballistic Missile Defense (BMD) systems primarily through utilization of novel materials and processes. Provide materials solutions to reduce procurement cost, lower life cycle cost, lower operational maintenance, reduce lead time, enhance mission reliability and improve manufacturability for low-rate, non-labor intensive production for BMD systems.

DESCRIPTION: MDA is seeking high-performance materials and process technologies for enhancement of current and block upgraded missile defense systems. These endo-atmospheric and exo-atmospheric intercept systems are highly complex missile systems. Incorporating existing and novel materials and process technologies offer a significant potential for enhancing performance properties while improving the producibility and sustainability of these structures. Process technologies should be appropriate for modest production volumes; incorporate modularity, flexibility, simplified and/or low-cost tooling; and be consistent with Lean and Six Sigma methodologies. The focus of this topic is for the missile body, launch canister, and kill vehicle structures or components, excluding propulsion systems which are covered in another topic.

Technical areas of interest include, but are not limited to:

Material Life Cycle and Sustainability: Missile and light weight palletized containment systems must address issues involving extended lifetimes with cyclic operational and life cycle loads. Addressing issues associated with these environments are key to maintaining robust capabilities in terms of both flight vehicle and containment system readiness. Environments of interest include, but are not limited to, moisture absorption/associated failure modes, material out-gassing, plume effects (temp/erosion), transportation cyclic loads (combined environment), and UV response. The capability to assess health and condition of material systems in these environments will be important. Solutions address such issues as limiting or blocking moisture absorption through barriers/coatings or the material system matrix/fiber system type employed, as well as creating material systems that are less prone to debilitating effects from this (i.e. delaminating). The benefits include improved health of internal electronic systems, propellants, and optics. Other metrics include strength and durability under combined temperature and cyclic mechanical loads. Advanced or improved testing methods for quickly and efficiently characterizing these metrics are also of interest.

Aerostructures: Advanced missile defense interceptors require aero-structures designed to survive harsh operational and long term storage environments. In addition, evolving threat dynamics and proliferation underscore the need to increase system performance while reducing cost per kill. As related to aero-structures the following three (3) goals can be used to focus development efforts related to topic and to serve as overarching requirements:
(1) Maximize interceptor performance and long term storage.
(2) Minimize interceptor cost.
(3) Ensure interceptor radiation survivability and structural integrity during flight.

Advanced missile defense interceptors require lightweight thermal protection systems (TPS), radomes and aerostructures designed to minimize internal temperature rise and ensure missile airframe structural integrity during flight, including operation in adverse weather. These systems must meet a variety of requirements such as weight, erosion/ablation performance, and cost.

Clearly the flow-down of the requirements listed above indicate the desire to have material systems that are lower mass, higher strength/stiffness, and tailorable thermal conductivity to allow advanced thermal management schemes due to longer flight times within the atmosphere. In addition, the long term storage requirement flow-down dictate material systems that minimize out-gassing and water permeability over time. Interceptor cost drivers span many different aspects to include schemes to reduce/streamline composite manufacturing tooling cost and process controls.

Preliminary material suitability metrics include:
a. Cold wall heating rates of 50-400 Btu/ft2-s
b. Shear rates of 10-50 psf
c. Operating temperature range of 2500-6000F
d. Survive weather encounter
e. Lightening Strike protection
f. HANES Standard

Weather Encounter: Advanced missile interceptors have the potential for encountering adverse weather conditions during flight. As a result, there is a need to enhance the producibility, operability and survivability of various missiles and missile components for operation in adverse environments. Adverse weather conditions may include natural events such as rain, snow, ice, gravel, sand/dust, or catastrophic naturally occurring weather events such as volcanic particulates. Typical velocity regimes are in the range of subsonic through high supersonic. Current needs include: analytic tool development, new or improved ground and flight testing methodologies, facility environment characterizations, and improvements in single impact and sled testing methods for all hydrometeor and solid particulate types. Included in this topic are also novel low-cost testing methods that can use subscale rockets and innovative instrumentation, recession gauges, or material samples to record impact events during flight.

PHASE I: Conduct experimental and/or analytical efforts to demonstrate proof-of-principle and to improve producibility, increase performance, lower cost, or increase reliability. Explore the concept and develop novel processes for fabrication and utilization of selected missile components. If applicable, produce test coupons of the materials and measure relevant properties. Assess the fabrication cost and impacts on service methods, safety, reliability, sustainability and efficiency. Perform a preliminary manufacturability and cost benefit analysis showing that the structure can be produced in reasonable quantities and at reasonable cost/yields, based on quantifiable benefits, by employing techniques suitable for scale up. Conduct weather environment characterization, develop/validate physics based numerical models of vehicle flowfield/weather coupling, develop material impact models, and develop/modify test evaluation methodologies for all aspects of weather encounter phenomena.

PHASE II: Based on the results and findings of Phase I, demonstrate the technology by fabricating and testing a prototype in a representative environment. Demonstrate feasibility and engineering scale up of proposed technology and identify and address technological hurdles. Demonstrate the system’s viability and superiority under a wide variety of conditions typical of both normal and extreme operating conditions. Demonstrate scalable manufacturing technology during production of the articles. Identify and assess commercial applications of the material or process technology.

PHASE III: Demonstrate new open/modular, non-proprietary materials and/or structures technology. Provide a potentially qualifiable design for an innovative structure that will provide for advancement of the state-of-the-art in aerospace and missile structure performance, safety, weather robustness, life extension, preventative and other maintenance. Demonstrate commercial scalability of the manufacturing process and the implementation of the software-based design tools for the commercial development and deployment of advanced structures and radomes. Commercialize the technology for both military and civilian applications. Demonstration should be in a real system or operational in a system level test-bed.

COMMERCIALIZATION: The proposed technology should benefit commercial and defense manufacturing through cost reduction, improved reliability and sustainment, or enhanced producibility and performance.

REFERENCES:
1. Deason, D.M., Missile Defense Materials & Manufacturing Technology Program, ASM Annual Meeting, Columbus, OH, Oct. 2003.

2. Deason, D.M. and Hilmas, G., et al. “Silicon Carbide Ceramics for Aerospace Applications - Processing, Microstructure, and Property Assessments,” Proceedings: Materials Science & Technology Conference, Pittsburgh, PA, Oct. 2005.

3. Reynolds, R.A., Nourse, R.N. and Russell, G.W. “Aerothermal Ablation Behavior of Selected Candidate External Insulation Materials,” 28th AIAA Joint Propulsion Conference and Exhibit, Jul 1992.

4. Murray, A., Russell, G.W. “Coupled Aeroheating/Ablation Analysis for Missile Configurations,” Journal of Spacecraft and Rockets, Vol. 39, No. 4, Apr. 2002.

5. J.D. Walton, Jr, “Radome Engineering Handbook,” Marcel Dekker, New York, 1970.

6. Russell, G.W. “DoD High Speed Aerothermal Analysis and Design - Historical Review and New State of the Art Approaches,” NASA Thermal and Fluids Analysis Workshop, NASA Langley Research Center, Hampton, VA, Aug. 2003.

7. Lindsay, J. and O’Hanlon, M.E., Defending America: The Case for Limited National Missile Defense, Brookings Institute Press, Apr. 2001.

8. Moylan, B., and Russell, G., “Updating Mil-Std-810 to Address High-Speed Weather Encounter Testing”, 53rd Annual Technical Meeting of the Institute of Environmental Sciences and Technology. April 29-May2, 2007.

9. Moylan, B., “Enhanced Testing Methods to Assess Weather Environmental Impacts on High-Speed Vehicle Designs”, 53rd Annual Technical Meeting of the Institute of Environmental Sciences and Technology. April 29-May2, 2007.

10. Robust Kill Vehicle Design Using Tailorable Material Systems,” Laddin Montgomery, Aero Thermo Technology, Inc., Huntsville, AL; Proceedings from National Space and Missile Materials Symposium – 23 June 2008.

11. Effects of Coatings on Moisture Absorption in Composite Materials,” James R. Newill; Steven H. McKnight; Christopher P. Hoppel; Gene R. Cooper; Army Research Lab, Aberdeen Proving Ground, MD; October 1999; Report Number: A305273.

12. Russell, G., Burnes, R., Strobel, F., Murray, A., "Tutorial - Aerothermal Analysis and Design Overview," NASA Thermal and Fluids Analysis Workshop 2003, NASA Langley Research Center, Hampton, VA August 2003, 63 pages, uploaded in SITIS 9/8/10.

13. Russell, G.W., et.al., "Aerothermal Analysis and Design - A Hypersonic - Application Army Hypersonic Compact Kinetic Energy Missile Laser Window Design," NASA Thermal and Fluids Analysis Workshop, NASA Langley Research Center, Hampton, VA, August 2003, 13 pages, uploaded in SITIS 9/8/10.

KEYWORDS: Missiles, Life Cycle Sustainment, Thermal Control, Thermal Insulation, Radomes, Lightweight, Shock Resistance, Vibration Resistance, Rain Erosion, Hybrid Composite, Lightning Strike, Advanced Materials, Reliability, Producibility, Manufacturing

MDA10-021 TITLE: Radiation Hardening Manufacturing Technology

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Space Platforms, Weapons

ACQUISITION PROGRAM: DVP

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The overall objective of this effort is to increase the radiation hardness/survivability of electronics components through innovative approaches in design, materials, signal processing algorithms, new test methods and equipment, advanced production processes and capabilities, and/or novel approaches in combining these factors for BMDS systems. The goal of this topic is to provide an increased level of resistance to damage of electronics/semiconductor components induced by nuclear environment radiation with a minimal impact on weight, performance or product availability.

DESCRIPTION: Ballistic Missile Defense System (BMDS) missile systems must function reliably when exposed to background radiation from space and radiation resulting from nuclear events (including x-ray, any radiation-induced latch-up, single event effects, total ionizing dose, dose rate, etc.). Systems must also survive and function after prolonged periods in battlefield/storage environments. Optimal utilization of mass in missile systems and space platforms precludes exclusive reliance on traditional shielding methods as a means of countering the adverse effects of radiation. MDA is seeking the development of innovative concepts that use radiation-hardening by process, by design, by architecture, by material, by test, or a combination of these approaches that will allow systems to endure and reliably operate in BMDS mission environments (radiation, shock, vibration, thermal, etc) without increasing weight or decreasing performance. Systems of interest include all BMDS kill vehicles and space-based platforms.

Technical areas of interest include: advanced designs, advanced materials, innovative test methods and equipment, and production processes and capabilities. Semiconductor technology nodes of interest range from 250nm to 65nm. The minimum radiation environment performance goals are taken from the International Traffic in Arms Regulations, Part 121.1, Category XV and are:
(1) A total dose of 5×105 Rads (Si);
(2) A dose rate upset threshold of 5×108 Rads (Si)/sec;
(3) A neutron dose of 1×1014 n/cm2 (1 MeV equivalent);
(4) A single event upset rate of 1×10−10errors/bit-day or less, for the CREME96 geosynchronous orbit, Solar Minimum Environment;
(5) Single event latch-up free and having a dose rate latch-up threshold of 5×108 Rads (Si).

The use of Technology Readiness Levels to describe current technology maturity will be helpful in evaluating the planned effort. This topic's focus is on innovations that are minimally invasive, producible and can be inserted into all missile defense systems.

PHASE I: Define component approach and architecture. Identify key subcomponents. Conduct research and experimental efforts to identify, investigate, and demonstrate materials, unique device designs, novel architectures, and/or production process changes that address reliable operation of BMDS systems in perturbed environments consistent with High Altitude Nuclear Bursts as described in reference 2 or prolonged natural space radiation. A sound basis must also be shown for the radiation hardness capability of the treatment. Where ever possible, modeling, simulation, analysis, and/or testing should be performed to support conclusions. Consider implications for practical implementation of proposed concepts. Offerors are strongly encouraged to work with system and payload contractors to help ensure applicability of their efforts and begin work towards technology transition.

PHASE II: Using the resulting radiation hardened materials, techniques, designs, Technology Computer Aided Design (TCAD) tools, production and/or process changes or additions in Phase I, implement, test and verify the proposed concept in prototype fashion to demonstrate feasibility and efficacy. Validation would include, but not be limited to, BMD system simulations, operation in test-beds, operation in a demonstration sub-system, and/or radiation testing. The offerors are encouraged to further seek partnerships with system primes or interceptor vendors as appropriate, and the degree to which the offeror can make such suppliers attracted to their solution is a strong consideration in gauging viability of their approach. Demonstrate applicability to both selected military and commercial applications.

PHASE III: The technology developed will apply to integrated circuit designs having the relatively low production volumes of the Ballistic Missile Defense System including Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) and the initial engineering lots developed for high volume commercial markets. There may be opportunities for the advancement of this technology for use in both commercial and military space activities during phase III program. Partnership with traditional DOD prime-contractors will be pursued since the government applications will receive immediate benefit from a successful program.

COMMERCIALIZATION: Commercial potential exist in the medical community, homeland security sector, and power and automotive industries. Certain technology developed will have a significant impact on the breakthrough of current commercial microelectronics technology and apply to manufacturing of advanced microelectronics for commercial market. Modern integrated circuits are increasingly more susceptible to SEE and this topic will assess quality control features within new devices to assure uniform radiation hard manufacturing producibility.

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1. http://www.mda.mil/mdalink/html/basics.html.

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KEYWORDS: radiation effects, radiation hardening, materials, space

MDA10-022 TITLE: Solid Rocket Motor Thrust Termination Modeling

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Battlespace, Space Platforms, Weapons

ACQUISITION PROGRAM: DV, SN, GM, DE, AB

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The object of this effort is to develop both engineering and high fidelity methods to accurately model the effects of a solid rocket motor’s thrust termination system. The model must be able to not only predict the impact on the stage trajectory but also provide a description of the port and nozzle exhaust properties (gas and particle properties, particle size distribution and initial velocity profiles of all components).

DESCRIPTION: Many solid rocket motors employ thrust termination systems to manage the desired burnout velocity that controls the vehicle range. During this thrust termination process, exhaust ports in the motor case burst open, venting out the chamber gases to depressurize and quench the solid rocket motor combustion process. Further, the direction of the exhaust ports are positioned in a forward direction to provide reverse thrust for the thrust terminated stage. Depending on the time that thrust termination is initiated during the course of the motor burn will determine how much material (propellant, combustion products, slag, and other inert materials) that is ejected from the main nozzle and thrust termination ports. Current modeling and simulation tools to address end-to-end thrust termination are not fully integrated to support the MDA requirement to describe the entire battlespace. The Solid Performance Program (SPP), for example, provides the products of combustion for solid rocket motors but does not address all possible chemical interactions and mixing between propellant combustion products, charring of other materials such as insulation as well as the secondary combustion with slag. In addition, several engineering methods and computational fluid dynamic (CFD) codes have demonstrated initial capabilities to describe the associated thrust termination flowfields and calculate the associated change in thrust but have not been developed to compute the debris field that is important for active and passive signature generation. This effort is to upgrade and develop new physics based models for incorporation into modeling and simulation capabilities to address the overall thrust termination event starting from the combustion of gases/particles through the nozzle to the evolving flow from the various ports that were terminated causing the rapid depressurization. In addition the interactions of the reacting flowfield emanating from the ports with the atmospheric species need to be addressed. First principle and engineering methods to capture these complex processes need to be modified or developed to 1) predict the time-dependent characteristics of the motor ejecta from the exhaust ports and main motor nozzle and 2) provide an interface to existing trajectory codes.

PHASE I: Select one or more pertinent phenomenological process (e.g., propellant, slag, or an inert material) and identify first-principles requirements for the formation and size distribution of the ejecta. Provide an approach towards the development of a model for the formation, distribution, and transport of the ejecta. Candidate data sets for comparison to model predictions can be provided as GFI if required. Develop and demonstrate the capabilities of a test bed model using a simplified approach.

PHASE II: Fully evaluate the data collected in Phase I and characterize the phenomena associated with the ejected materials. Complete the model development for the phenomena identified in Phase I and either directly output 6 DOF and associated thermal information associated with the thrust termination materials or develop an interface for an established trajectory code used within MDA (SEG6DOF, TGX, IMPULSE, etc.). A prototype demonstration of the capability developed shall be provided at the end of phase II. Deliver the technical and software user documentation, prototype software, model demonstrations and verification for MDA use. Maximum practical use of existing software is desired to reduce development and validation costs.

PHASE III: Develop and test an interface that can be coupled to existing MDA Radar and optical signature codes. Integrate the models developed in Phase II into existing CFD codes to provide a complete time-accurate simulation for one specific case which can in turn be used for developing a comprehensive time-dependent passive and active signature for the thrust termination event. Perform parametric studies with the event-specific data to evaluate the overall model performance. Validate the integrated model against available signature data as provided as GFI (visible, IR, and radar).

COMMERCIALIZATION: Models which can accurately predict the formation of ejecta from solid rocket motors can be transitioned to support existing space launch systems. Interest in inlet survivability for submerged nozzles and the ability to capture the ejection of inert materials, such as liners and insulation, may be utilized to improve the reliability and performance of solid rocket motors.

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1. IHPRPT Improvements to the Solid Performance Program (SPP), D.E. Coats, D.R. Berker, E.C. Hylin, S.S. Dunn, D.P. Babbitt, J.A. Tullos, JANNAF 16th Nondestructive Evaluation Subcommittee (NDES)/25th Rocket Nozzle Technology Subcommittee (RNTS)/38th Structures & Mechanical Behavior Subcommittee (SMBS) Joint Meeting, Newport, RI, 20-22 March 2007.

2. Simmons, F.S. Rocket Exhaust Plume Phenomenology, AIAA, Reston, VA, 2000.

3. G. Sutton and O. Biblarz. Rocket Propulsion Elements, Seventh Edition, Wiley Interscience, 2001.

KEYWORDS: modeling and simulation; rocket combustion; aluminum oxide particles, insulation, liners, thrust termination; trajectory modeling, solid rocket motors; chuffing

MDA10-023 TITLE: Advanced Reentry Vehicle and Wake Models

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Battlespace, Space Platforms, Weapons

ACQUISITION PROGRAM: DV, SN, GM, DE, TH, AB

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop robust modeling and simulation tools to predict plasma effects on reentry vehicle hardbody signatures as well as wake radar cross-sections and optical signatures.

DESCRIPTION: At hypersonic velocities, the flowfields near reentry vehicles and advanced hypersonic weapons become dissociated and ionize, forming significant plasma levels. The shock wave at the nose of the vehicle and viscous boundary layers are significant sources of free electrons, even for non-ablating vehicles. Ablation from the surfaces of modern heatshields further modifies or adds to the plasma levels. From the boundary layer near the vehicle, the plasma flows into near body recirculation regions that are just behind the vehicle and then into the trailing wake region. The plasma around hypersonic vehicles and in the wake affects both the optical and radar signatures of the vehicle. The enveloping plasma and trace species in the boundary layer may attenuate vehicle surface emissions while adding new sources of optical emissions. Electro-Optical (EO) emissions from the wake region can significantly alter the overall optical appearance of the vehicle and can interfere with optical tracking and targeting methods. The near body plasma and that survives to the wake causes alteration of the body's radar cross-section. In some cases, the plasmas mask important scattering centers on the body, reducing the radar cross-section.

The Missile Defense Agency's (MDA's) modeling and simulation directorate is developing, updating, improving, and validating end-to-end modeling and simulation capabilities for the entire missile fly-out scenarios. As part of this broad objective, one focus area must simulate the detection, acquisition, discrimination, and tracking of reentry vehicle bodies and predict near-body phenomena impact on sensor systems designed to perform these tasks. The current MDA modeling and simulation tools for this task include the Fast Line-of-Sight Imagery for Target and Exhaust-plume Signatures (FLITES), which is the MDA standard for EO signatures of hardbody objects and nearby flowfields. The Plume Attenuated Radar Cross-Section Code (PARCS) models the radar cross-section of a turbulent wake. The REACH code, as well as other advanced CFD tools, is designed to simulate the complex plasma flowfield around a reentry vehicle.

The objective of this effort is to develop and validate advanced modules that integrate into a suite of modeling and simulation codes that will: calculate the plasma levels and non-equilibrium neutral and plasma chemistry in the flow around reentry vehicles; extend the flow calculation to the near and far wake regions behind the vehicle; calculate the radar cross-sections, Doppler profiles, and other relevant radar observables as a function of range, frequency, and aspect angle; calculate the transmission coefficient as a function of wavelength and location through the enveloping plasma; and, calculate EO signatures in the plasma surrounding the hard body and the near and trailing wake. The code suite will handle a broad spectrum of potential vehicle types including conics, multi-conics, elliptical, and lifting bodies. The codes will also handle non-zero angles of attack, trajectory shaping, range extension, and other non-ballistic flight profiles. The code suite should integrate smoothly into other existing MDA phenomenology software products and leverage existing software where possible.

Candidate simulation modules include the flowfield around and behind the reentry vehicle, the plasma chemistry solver, and the reentry vehicle ablation model. As appropriate, each module must treat continuum to rarefied flows, non-equilibrium chemistry, and a wide range of ablation products. Post-processing modules to interface these advanced flowfield modules with PARCS and FLITES will also be considered.

PHASE I: Select one (or more) modules for development and validation. Identify innovative algorithms for inclusion in the selected module. Plan the interface requirements to other parts of the suite of simulation codes. Demonstrate the improved algorithm against current MDA and DoD simulation capabilities.

PHASE II: Develop, build, and test the module. Perform initial testing of the interface to the other elements of the code suite. Document the components of the module and prepare a users' manual to include sample input and output data files. Perform initial code runs to validate the code predictions against any available flight data.

PHASE III: Transition the module developed under Phase II to specific MDA applications that will characterize plasma effects on reentry vehicle near-body and wake radar cross sections and optical signatures for priority targets.

COMMERCIALIZATION: Military application: Design of sensor concepts for intercept and tracking of current and future hypersonic/reentry weapon systems. Validation and analysis of intelligence data gathered on foreign assets. Commercial application: Design of reentry systems for NASA and commercial transport systems.

REFERENCES:
1. Tony C. Lin, L.K. Sproul, D. W. Hall and John Sontowski, "Reentry Plasma Effects on Electromagnetic Wave Propagation", AIAA 95-1942, 26th AIAA Plasmadynamics and Lasers Conference, San Diego, CA, 1995.

2. Van Tuyl, Andrew H., "Vortex filament model of the wake behind a missile at high angle of attack," (U.S. Navy, Naval Surface Weapons Center, SilverSpring, MD), AIAA Journal 1988, 0001-1452 vol.26 no.3 (264-270).

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5. David E. Mather, Jeffrey M. Pasqual, Jamey P. Sillence, and Paul Lewis, "Radio Frequency (RF) Blackout During Hypersonic Reentry", AIAA 2005-3443, AIAA/CIRA 13th International Space Planes and Hypersonic Systems and Technologies (2005).

6. Crow, D., C. Coker, B. Smith, and W. Keen, "Fast Line-of-sight Imagery for Target and Exhaust-plume Signatures (FLITES) Scene Generation Program", SPIE Defense and Security Symposium 2006, Technologies for Synthetic Environments, Hardware-in-the-Loop Testing XI, April 2006.

KEYWORDS: Wakes, Flow fields, Shock Wave, IR Signatures, RF Signatures, Optical Signatures, Radar Signatures, Boundary Layers

MDA10-024 TITLE: Innovative Sensor Packaging and Testing

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PTSS, ABIR, SM3, ABL, TH

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OBJECTIVE: Develop and demonstrate novel infrared sensor packaging, integration, and testing capabilities for the evaluation of infrared sensors for various missile defense applications, such as ABIR, AEGIS, ABL, THAAD, and PTSS and its upgrades.

DESCRIPTION: In the past decade, rapid progress has been made in infrared sensor technologies. This is especially prominent in the areas of infrared detector materials, read out integrated circuits (ROICs), on-chip and off-chip signal processors, cryogenic cooling, and focal plane arrays (FPAs) that are capable of imaging in multiple spectral bands and in polarization sensitive modal. However, most of the progress is limited to laboratory level demonstration. Even though people working in various missile defense systems are much interested in learning these technological innovations, they are unable to incorporate them into their systems due to the low technology readiness level (TRL). There is a gap between technology development and system application, i.e. a lack of a middle stage development for the following: a) Innovative packaging that enhances reliability, prevents ungraceful degradation, and reduces overall system power, size, and weight; b) Testing under mission-relevant environment, with proper subsystem integration and prototyping that make it easier to demonstrate the utilities from a system application aspect, and initiation of a validation-feedback-improvement iteration. These are critical to move technologies from laboratory development to system acceptance.

The following are solicited to bridging these gaps. For innovative packaging task, novel ways to design and fabricate an FPA chip assembly, optics assembly, cooler-dewar assembly, electronics package, and calibration package are solicited. For example, new recipes are needed as III-V FPA backfill in order to strengthen the mechanical integrity and keep the quantum efficiency at the level of above 70% and dark current increase near 0%. Negative luminescence has numerous potential applications, e.g., in cold shielding of focal plane arrays, or variable temperature reference planes for dynamic multipoint nonuniformity corrections, or infrared scene simulators. There is a report of achieving negative luminescence efficiency of 35% using III-V superlattice diodes. Innovative ideas of achieving larger than 90% efficiency using III-V materials are sought after. Unconventional ways of using such a material for optics-dewar package and dynamic temperature calibration and nonuniformity correction are also solicited. Clever ways to incorporate compact optics and efficient coolers so that the overall infrared camera power, weight, and volume can be reduced 30% are also included in this solicitation.

For testing under mission-relevant environment task, innovative ideas are sought to characterize infrared sensor component under various radiation environment, and under various mission scenarios such as ABIR, PTSS, and SM-3. This also includes modeling and simulation of adverse environmental effects to sensor performance. One hurdle for testing is that most of the laboratory camera packages are not suitable for mission-relevant hardware-in-the-loop tests or for flight tests even when such opportunities come up. For example, due to the lack of common packaging standard in the IRFPA industry, there might be over 10 different varieties of FPA-ROIC-leadless chip carrier combination for a given FPA. This makes testing and performance validation by the government laboratories difficult since much time and effort has to be spent for retrofitting incompatible parts. Furthermore, many sensor packages are not testing ready by design. As a result, substantial modifications need to be carried out before the package can be tested under each new testing scenario. Ideas are solicited for designing and demonstrating versatile infrared sensor testing packages, such as a standard testing unit that includes optics, a cooler and dewar package, a leadless chip carrier that are compatible with typical FPA formats, such as two-color FPAs of the format of 640 x 512 and single color FPAs with a format up to 2048 x 2048. The versatile testing package design should include built-in functions for error debugging, radiation and electromagnetic interference shielding, compatibility to high speed data collection and signal processing, and flexibility of interchanging parts, such as FPAs and optics.

PHASE I: Feasibility study and preliminary design. Breadboard-level experiments or computer modeling should be carried out to demonstrate the feasibility of the innovative packaging concept. Critical testing unit design parameters and testing scenarios should be defined for the testing under mission-relevant environment task. Teaming arrangement encouraged for Phase II.

PHASE II: Fully design, engineer, and characterize a demonstration unit. Depending on the proposed concept, testing under various mission-relevant scenarios may be carried out to demonstrate the innovative concept and functionality. The contractors are encouraged to work closely with missile defense system primes, component suppliers, and engineers at various testing facilities.

PHASE III: Develop and execute a plan to market and manufacture. Depending on the demand from missile defense systems or from commercial sectors, the contractor may perform technology transition or make prototypes for marketing.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial uses in such diverse fields as mining, remote sensing, aviation, facility security, and homeland security.

REFERENCES:
1. D. Hoffman, A. Hood, Y. Wei, A. Gin, F. Fuchs, and M. Razeghi, Journal of Applied Physics 99, 043503 (2006).

2. Commercially available ROIC specifications such as FLIR ISC0903, ISC0904, and ISC0905.

KEYWORDS: IRFPA, radiation-hard FPA and ROIC, hardware-in-the-loop test, flight test, sensor packaging

MDA10-025 TITLE: High Speed Representation of Complex Scenes

TECHNOLOGY AREAS: Sensors, Battlespace

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OBJECTIVE: Develop innovative approaches to representing highly detailed battlespace environments (Terrestrial/Urban/Suburban, Ocean (Deep water and Littoral)) in a manner that allows such data to be ingested by MDA scene generation tools for use in real-time and near real-time simulations.

DESCRIPTION: The increasing application of higher resolution observation sensors on platforms ranging from satellites to small scale UAV's to blimps are driving requirements for improved representation of large, complex structures, such as terrain, water surfaces and cities. Full representations of such structures involve databases with sizes reaching well into the terabyte level. Static level of detail models used in current MDA tools such as FLITES(1) cannot be expected to manipulate that level of data and achieve the required frame rates and physical accuracy required by the MDA mission. While the gaming and visualization industries have developed off-the-shelf approaches to data representation(2,3) that address some of the performance related issues, such approaches do not support the type of physics based rendering with detailed optical phenomenology that is required by the MDA mission. What is needed is a new method of producing highly detailed representations of natural background surfaces (e.g., terrain and water surfaces) and constructed objects (e.g., buildings) that are comparable to corresponding representations produced by full physics-based models, but that can generate the battlespace representations in real-time or near real-time simulations.

PHASE I: Assess current approaches to representing complex scenes by existing MDA tools as well innovative representations that offer improved efficiencies in terms of computational throughput and memory utilization. Provide a preliminary design of a methodology that allows efficient representation of complex scene data in way that is computationally tractable at high frame rates and supports interfacing to existing MDA scene generation tools.

PHASE II: Provide a prototype capability for the design. It is anticipated that such a solution may involve innovative hardware and software elements, but it is strongly encouraged that hardware elements be commercially available, i.e. proprietary hardware that may not be able to follow the industry growth pattern is strongly discouraged. Compare the fidelity of the new real-time or near real-time representations to that of more conventional physics-based representations that do not operate in near real-time.

PHASE III: Conduct software development, test and evaluation, verification, and validation. Demonstration would include, but not be limited to, operation in a complete missile fly-out in a system level test-bed with insertion of a simulated missile defense interceptor.

COMMERCIALIZATION: Techniques, processes and hardware developed in this effort will have broad application across the DOD and Homeland defense simulation community, including hardware and software in the loop test and evaluation, signal processing algorithm and software design and development and sensor design and development.

REFERENCES:
1. D. Crow, C Coker, W. Keen, "Fast Line-of-sight Imagery for Target and Exhaust-plume Signatures (FLITES) scene generation program", Technologies For Synthetic Environments, Hardware-in-the-loop Testing XI, Proc. of SPIE Vol 6208.

2. D. Luebke, M. Reddy, J. Cohen, A Varshney, B. Watson, R. Huebner, "Level of Detail for 3D Graphics", The Morgan Kaufmann Series in Computer Graphics.

3. www.openscenegraph.org

KEYWORDS: simulation, scene generation, level of detail, FLITES

MDA10-026 TITLE: Photonic Multi-Beam Receive-Only Arrays

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: MDA/SNI

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OBJECTIVE: Study, design, and develop a photonic multi-beam RF receive-only array architecture that would enable multiple simultaneous receive beams with high bandwidths, would provide an instantaneous dynamic range of at least 60 dB in each channel, would provide the necessary accurate time delays to accomplish the beam-forming and provide the necessary beam pointing accuracy, would minimize the photonic and RF losses in the system design, and would use packaging/integration approaches to support the producibility of the design.

DESCRIPTION: The use of photonics provides an opportunity to design a multi-beam receive-only phased array which can simultaneously form multiple beams, and receive and track multiple signals. This topic involves the study, design, and development of photonic multi-beam receive-only arrays. The design goals for the multi-beam array are to provide at least 10 simultaneous beams with each beam having the necessary pointing and tracking accuracy over a minimum scan range of +/- 60 degrees, provide an instantaneous dynamic range of at least 60 dB, be tunable over two octaves including coverage in the X-Band, and each beam (channel) should provide a bandwidth of at least 60 MHZ.. In addition, the design should minimize the optical and RF losses through the system, minimize the need for need for calibration and tuning, provide opto-electronic interconnects which can be readily integrated into the system, and use packaging/integration concepts which reduce the system SW&P and provides a producible design. The antenna sizes of interest range from 40,000 to 400,000 elements. The offeror shall use innovative approaches in meeting the design goals; and discuss the technical challenges in the proposed effort, the enabling technologies required to realize the design, and the innovation(s) in the design.

PHASE I: Study and develop a conceptual design of a photonic multi-beam receive-only array which can be evaluated with modeling and simulation (M&S). Also, provide a conceptual design of the integrated and packaged system including the SW&P, interfaces, and system performance metrics including individual beam shapes and gains throughout the scan area. The contractor shall discuss the technical challenges in the design, the enabling technologies necessary to realize the design, and the innovation(s) in the design. Offerors are encouraged to coordinate their work with a system integrator during early phases of the program to facilitate future technology transition.

PHASE II: Complete the design of the photonic multi-beam receive-only array and fabricate the design in a breadboard or brassboard which can be used to evaluate the performance of the essential metrics necessary to allow the design to be transitioned to a prototype with an integrated packaged system. The contractor shall evaluate the design to insure the technologies developed are producible; and discuss any technologies where additional development is required to improve performance and/or to improve producibility. Coordination with a current or potential supplier of MDA element systems, subsystems or components could be beneficial.

PHASE III: In this phase, the contractor would complete the design and accomplish the fabrication of a Photonic Multi-Beam Receive-Only Array, and apply the innovation(s) and technologies demonstrated in the first two phases of the program to one or more MDA element systems, subsystems, or components. These would include ground radar (or surface radar) applications and airborne applications.

COMMERCIALIZATION: Innovations developed under this topic will benefit the DoD and will have a range of commercial applications. The multiple beams receive only phased array would allow tracking of aircraft for use in air traffic control for DoD or commercial applications. The multiple beams array would also have applications in weather radar and radio astronomy. Other potential applications of this technology include applications where the tracking of multiple moving objects is required and a range of aerospace applications where SW&P are considerations.

REFERENCES:

1. H. Jasik, J. L. Volakis, R. C. Johnson, "Antenna Engineering Handbook," MCGRAW-HILL, 2007.

2. R. J. Mailloux, "Phased Array Antenna Handbook - Second Edition," Artech House Publishers, 2005.

3. H. L. Chi (Editor), “Microwave Photonics,” CRC Press, Boca Raton, FL, 2006.

4. M.W. Beranek, “Fiber optic interconnect and optoelectronic packaging challenges for future generation avionics,” Proceedings of SPIE, Vol. 6478, 2007.

5. B. Jung, J. Shin, and B. Kim, "Optical True-Time-Delay for Two-Dimensional X-Band Phased Array Antenna," IEEE PHOTONICS TECHNOLOGY LETTERS, VOL. 19, NO. 12, pp. 877-879, JUNE 15, 2007.

6. Y. Han and J. Lee, "Multiple-element photonic microwave true-time-delay beamforming incorporating a tunable chirped fiber Bragg grating with symmetrical bending technique," OPTICS LETTERS, Vol. 32, No. 12, pp. 1704-1706, June 15, 2007.

7. O. Okusaga, W. Zhou, G. Carter, “Using highly dispersive fiber grating as wavelength-tunable true-time-delay in phased array antenna,” Proceeding of SPIE, Volume 6890, 2008.

8. H. Zmuda and E. Toughlian, "Photonic Aspects of Modern Radar," Norwell, MA, Artech House, 1994.

KEYWORDS: Antenna, beamformer, opto-electronic interconnects, true time delay, Phased-Array, Photonics, simultaneous multiple beams.

MDA10-027 TITLE: Photonics TDU for Radar True Time Delay (TTD)

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: MDA/SNI

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OBJECTIVE: Develop a practical phased array radar time delay unit (TDU) employing photonics technology that operates at X-band, has 60 dB instantaneous dynamic range and wide instantaneous bandwidth (> or = to 1 GHz).

DESCRIPTION: Photonic techniques for true time delay (TTD) beamsteering of active phased array antennae have long been recognized. A variety of system demonstrations employing different photonic architectures have been conducted. Individual components for these architectures have been developed and improved. What TDUs that exist in the marketplace today, do not meet the signal fidelity, size, weight, power (SWaP), environmental requirements of deployed MDA radars and they are not low cost. This project focuses only on the time delay unit (TDU), not the entire architecture, that is, the photonics TDU will have signal input (e.g. microwave connector), signal output and electrical control interface (e.g. digital electrical and power connectors) to select the amount of delay and provide

power. Photonics will be employed internal to the TDU to achieve the required TTD. The challenge of this project will be to provide system required performance in a practical low cost TDU. We define a practical TDU to have the following attributes:
• Size: < or = to 25 in^3 (410 cm^3)
• Weight: < or = to 1.5 kg
• Power: < or = to 20 W
• Cost: < or = to $250

These attributes apply to production TDUs. This project shall focus on performance requirements with a technical path to meet all the attributes.

Successful development of TDUs meeting the performance and practical attributes will benefit DoD radar and RF electronic warfare (EW) systems.

PHASE I: Design a practical photonics TDU to meet radar system constraints and performance while employing mature component technologies. The design shall meet the performance requirements of this topic while satisfying the size, weight, power requirements of an Advanced Radar Electronically Scanned Array (ESA).

PHASE II: Fabricate the photonics TDU in a form-fit-function prototype suitable for demonstration in an X-band radar. The ability to perform classified work may be required.

PHASE III: Transition the photonics TDU into an operational radar.

COMMERCIALIZATION: Photonic TDUs are being developed for commercial and military applications, these components are enabling higher performance ESA for EW and Radar and they would find numerous applications in military systems as well as commercial systems.

REFERENCES:
1. William C. Chang (Ed.), RF Photonic Technology in Optical Fiber Links (Cambridge University Press, Cambridge, 2002). In particular, note the chapter: “System design and performance of wideband photonic phased array antennas” by Gregory L. Tangonan, Willie Ng, Daniel Yap and Ron Stephens.

2. Chi H. Lee (Ed.), Microwave Photonics (CRC Press, Boca Raton, FL, 2007). This reference does not discuss TTD directly, but discusses related technologies that may be useful in a TDU.

3. Willie Ng, Andrew A. Walstron, Gregory. L. Tangonan, Jar Juch Lee, Irwin Newberg and Norman Bernstein, “The first demonstration of an optically steered microwave phased array antenna using true-time-delay” IEEE J. Lightwave Technology, Vol. 9, No. 9, September 1991.

4. Jean Chazelas, Daniel Dolfi, Sylvie Tonda-Goldstein and Jean-Pierre Huignard, “Optical beamforming networks for radars & electronic warfare applications” RTO-EN-028, September 2002.

KEYWORDS: time delay unit (TDU), true time delay (TTD), active electronically-steered antenna (AESA), radar, electronic warfare (EW)

MDA10-028 TITLE: Wideband Scalable Multi-channel Digital Receiver/Exciter (DREX)

TECHNOLOGY AREAS: Sensors

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OBJECTIVE: Study, design, develop, and implement techniques to cohere multiple wideband DREX channels for application to next generation BMD Radar.

DESCRIPTION: Next Generation BMD Radar Systems are anticipated to utilize highly digitized sub-arrayed digital beam-forming (DBF) architectures and Multiple-Input Multiple-Output (MIMO) Radar processing. These architectures will require multiple DREX channels, scalable from 10s to 100s of channels. Implementation of DBF and MIMO techniques often assumes perfectly calibrated and cohered DREX channels. However, practical hardware channels are not perfectly matched in phase and amplitude response. The problem is further complicated by the increasing use of instantaneous wideband waveforms (100 MHz – 1 GHz) where narrowband assumptions no longer hold true. The goal of this SBIR is to develop techniques to calibrate and cohere multiple wideband DREX channels. The techniques should be scalable from few to hundreds of channels and be suitable for real-time implementation. Channel mis-match errors including but not limited to amplitude imbalance, phase imbalance, group delay, and sample location uncertainty should be considered. These errors could be time and frequency varying depending on the hardware. A necessary component is to develop/use a parametric model of multichannel DREX imbalance and its effects on Radar system performance. Compensation schemes will then be developed and implemented to compensate for imbalance and restore radar system performance.

PHASE I: Study the effects of the various forms of wideband DREX channel mis-match on DBF and MIMO radar performance. Study and develop a conceptual design of a scalable coherence method for multiple wideband DREX channels. The contractor shall discuss and document the technical challenges in the design, the enabling technologies necessary to realize the design, and the innovation(s) in the design. Offerors are encouraged, but not required, to work with a Radar system or prime contractor during early phases of the program to facilitate future technology transition.

PHASE II: The contractor shall complete the design of the multichannel coherence method and implement a preliminary version. The Contractor shall refine the parametric model of channel imbalance effects on DBF and MIMO performance. The contractor shall implement the method using representative wideband (100MHz bandwidth minimum) multichannel hardware for both transmit and receive. A minimum of 4 hardware channels (goal of 16+channels) will be implemented to evaluate the performance of the essential metrics necessary to demonstrate channel coherence. The contractor shall perform analysis to show how the method would scale to hundreds of channels based on the few channel demonstration. As recommended in the Phase I to facilitate technology transition to a Phase III effort the contractor is encouraged to identify MDA radar element transition opportunities, whether directly with MDA or as part of a partnership with an MDA Radar system supplier.

PHASE III: In this phase, the contractor would further refine the multichannel DREX coherence methods, implement a runtime version with representative multichannel hardware and apply the innovation demonstrated in the first two phases to one or more MDA element systems, subsystems, or components.

COMMERCIALIZATION: The proposed technology has a number of related commercial applications in radio frequency (RF) sensors. Commercial radar systems, commercial RF communications systems (e.g. Telecom, SATcom), all require DREX and have increasing needs for wideband low power, highly digital (flexible) DREX technology.

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KEYWORDS: Digital Receiver/Exciter, radar receiver, Digital Beam Forming, waveform generation, Multiple-Input Multiple-Output (MIMO) Radar, coherent channels.

MDA10-029 TITLE: Develop Accelerated High Power RF MEMs Switch and Phase Shifter Reliability Test Methodologies

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: MDA/SNI

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 3.5.b.(7) of the solicitation.

OBJECTIVE: This topic seeks to identify and develop high-power Radio Frequency Micro Electro-Mechanical Systems (RF-MEMS) accelerated reliability test methodologies to reduce technology acceptance time for switched phase shifters that utilize capacitive or contact RF MEMS switches. Currently RF MEMs life testing conducted on these devices at government and contractor facilities requires significant time and cost due to a lack of physics-based test acceleration methodology. Identification of acceleration protocols, beyond currently conducted real-time life testing approaches, is required to shorten the test time required and accelerate acceptance of these technologies by government programs. The development of an acceptable physics-based model and accelerated test methodology would significantly reduce the cost and time required for system qualification and insertion of high-power RF-MEMS switches and phase shifters for Radar/EW phased array applications.

DESCRIPTION: High power radar and EW modules are required for Electronically Scanned Arrays (ESAs) to provide significant system performance improvements. These modules, from a system perspective, are a major portion of the system cost and they provide thermal and reliability challenges to designers and manufacturers that must be overcome to provide effective ESA solutions. RF MEMS switches and phase shifters have been under development to provide phase control in some phased-array radar architectures. These devices offer the potential of low insertion loss, ultra-linear performance and very low operating power. The qualification and adoption of these technologies by programs requires demonstrated reliability, however current real-time testing is costly because it requires significant time to cycle the RF MEMS switches and phase shifters. The goal of this program is to establish RF MEMS device accelerated reliability test methodologies applicable to X-Band (8-12 GHZ) MEMs devices with output power levels of up to 5W peak/channel, up to 2W average/channel.

PHASE I: Identify, model and demonstrate innovative material, design, process and testing technologies that significantly improve accelerated high-power RF MEMs reliability testing. This should include equipment improvements, test procedure standardization/improvement and/or physics based models based on experimental results on capacitive or contact RF MEMS switches that lead to at least a 5X test time reduction over current real-time life test methodologies.

PHASE II: Develop and demonstrate a prototype lifetime test station and test methodology for high power RF MEMs switches and phase shifters capable of X-band operation with up to 5W peak/channel, up to 2W average/channel. Deliver the prototype test station to the government after conducting validation testing of RF MEMs with the performance identified in this topic. The prototype equipment and processes developed should have dual use/commercial application.

PHASE III: Transition the phase II developed technologies through the application of the RF MEMs accelerated reliability test technology to support an MDA system insertion.

COMMERCIALIZATION: RF MEMS switches and phase shifters are being developed for commercial and military applications, these components are enabling higher performance ESA for EW and Radar and they would find numerous applications in military systems as well as commercial systems, for example, transportation radar systems.

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3. J. Teti, and F. Darreff, "MEMS 2-bit Phase-Shifter Failure Mode and Reliability Considerations for Large X-Band Arrays," IEEE Trans. Microwave Theory and Tech., Vol. 52, No. 2, pp. 693-701, 2004.

KEYWORDS: RF-MEMS, phase shifters, phased-array radar, switches, accelerated life test, reliability

MDA10-030 TITLE: Space Photonics Technology

TECHNOLOGY AREAS: Space Platforms

ACQUISITION PROGRAM: PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop (design, fabricate and demonstrate) innovative approaches for intelligent broadband space based optical networks that include the network architectures, communication protocols and optoelectronic components for space systems applications.

DESCRIPTION: In order to accommodate the broadband data handling requirements of Missile Defense Agency mission it is necessary to develop fiber optic intra-satellite networks and free-space optical networks that connect multi-satellite constellation with airborne, sea based and ground based nodes. The ideal network would manage both the free-space laser communication links and the intra-satellite fiber optic data handling networks to enable intelligent and adaptive broadband satellite communication networks. These networks must provide a seemless all-optical interface between the external and internal optical links, or alternatively, be designed with optical-to-electrical transceivers. In either case, the key to the success of a space based optical network is its efficiency in producing optimized high-speed data transfers and real-time multi-access across all platforms including multiple satellites in constellations and high-speed subsystems within individual satellites. Additional benefits expected from this optical network include reductions in weight, reduced EMI and improved EMC.

Special areas of interest for this topic include; space qualification of optical components developed for terrestrial applications, high sensitivity optical receivers, and precision pointing and vibration reduction for optical communications links.

The first area of emphasis seeks proposals to develop and demonstrate intra-satellite optical communications networks based on existing broadband commercial protocols including TM/SONNET and internet TCP/IP. These networks must be consistent with the use of high-speed fiber optic network protocols 1 and 10 Gigabit Ethernet, Firewire, or AS1393.

The second area of interest seeks proposals to develop, and mature space qualified optical photon counting receivers for laser communications.

The third area of interest seeks proposals for the development and demonstration of critical components required for the precision acquisition, tracking, and pointing of laser communication receivers and transmitters.

Space qualification requirements as well as the necessity of minimizing the size, weight, and power consumption of all spacecraft components must be part of the design trade for any successful proposal. The intent of this topic is not the development of generic radiation hard electronics and sensors. Other topics within this solicitation explicitly seek those solutions, however any solutions developed for this topic must meet a ten year life and a minimum of 300 Krad radiation requirements.

PHASE I: Develop a preliminary design for the proposed component or algorithm. Modeling, Simulation, and Analysis (MS&A) of the design must be presented to demonstrate the offeror understands the physical principles, performance potential, scaling laws, etc. MS&A results must clearly demonstrate how near-term goals will be met, at a minimum. Proof of concept hardware or software development and test is highly desirable. Proof of concept demonstration may be subscale or specific risk reduction activities associated with critical components, algorithms or technologies. Test results (if performed) should be used in conjunction with MS&A results to verify scaling laws and feasibility. Phase I will include the development of plans to further develop/exploit this technology in Phase II. Offerors are strongly encouraged to work with system, spacecraft, and/or payload contractors to help ensure applicability of their efforts and begin work towards technology transition. No specific contact information will be provided by the topic authors.

PHASE II: Complete critical design of prototype component or algorithms including all supporting MS&A. Fabricate a prototype or engineering demonstration unit (EDU) and perform characterization testing within the financial and schedule constraints of the program to show level of performance achieved compared to stated government goals. In addition, environmental testing, especially radiation testing, is highly encouraged in this phase. The final report shall include comparisons between MS&A and test results, including identification of performance differences or anomalies and reasons for the deviation from MS&A predictions. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort to which end they should have working relationships with, and support from system, spacecraft, and/or payload contractors.

PHASE III: The offeror is expected to work with other industry partners and DOD offices to modify and improve the design of the Phase II proof of concept prototypes to meet individual system applications. The first use of this technology is envisioned for the Persistent Tracking and Surveillance System (PTSS).

COMMERCIALIZATION: The optoelectronic devices and network / protocol designs will be of high interest to designers of both DoD and commercial satellite systems. The devices, firmware, software, subsystems and development tools represent a significant opportunity in both Government and commercial aerospace applications.

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KEYWORDS: optical networks, optoelectronic devices and interconnects, free space laser communications, space environment, radiation effects

MDA10-031 TITLE: Large Format Space Focal Plane Array Technologies

TECHNOLOGY AREAS: Materials/Processes, Sensors, Space Platforms

ACQUISITION PROGRAM: PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: The overall objective of this effort is to develop innovative solutions to support the growth, processing, fabrication and integration of large format (>25cm2) staring infrared focal plane arrays (FPAs) for space sensing.

DESCRIPTION: The Missile Defense Agency (MDA) is interested in technology developments in support of advanced space sensor systems. Because they operate in a space orbit, requirements for space based sensors are typically the most stressing seen in defense applications. BMDS space-based sensors track low signature targets against low background environments at ranges 10-1000 times greater than those in other defense application; sensitivity required is 100-1000000 times greater. Consequently acceptable noise must be 100-1000000 times less than for other BMDS applications. The sensor must also be sufficiently immune to radiation damage to maintain the mission-required sensitivity throughout their mission life in the harsh radiation environment of space. Furthermore, they must be robust enough to withstand space/nuclear-enhanced radiation, as well as optical radiation, that might be caused by adversary action. Large format infrared focal plane arrays based on mercury cadmium telluride (MCT) have been demonstrated at >25 cm2. However, to-date, several significant challenges to their manufacture exist including defects, uniformity, uniform processing, radiation and optically hardened ROIC designs, hybridization, packaging and testing. The Ballistic Missile Defense System (BMDS) requires reliable, high performance, high sensitivity and low noise space-based sensors which are affordable and producible. Specific technology areas of interest include:

Detector materials and processing techniques -- Both II-VI and III-V families of substrates and epitaxial materials for detection of SWIR, MWIR, MLWIR and LWIR radiation, leading to high quality, low damage occurrence, improved through-put and improved yield are of interest, but the greatest interest is in the MCT area. The current infrared industrial base relies on a single source of CZT (CdZnTe) substrates. CZT substrates >60 cm2 with high purity, excellent crystallinity, and excellent surface finish are needed to support large format MCT detectors. It is in the interest of MDA to develop an additional, reliable source of CZT substrates, to increase availability and reduce substrate costs. GaSb substrates for lattice matched Group III-V SLS detectors are also of continuing interest. There is a continued interest in optimizing current epitaxial growth techniques (molecular beam epitaxy and liquid phase epitaxy) and developing additional methods of epitaxial detector growth that can meet or exceed the quality produced by current methods over the large formats of interest. Ideally, these techniques would have lower capital expense, predictable repeatability and higher thru-put. Quality metrics include: capable of single wafer sizes up to 81 cm2, compound semiconductor materials growth with monolayer control and as thick as12 µm, with less than 2% non-uniformity in both composition and thickness. In addition, innovative technologies in substrate cleaning and reclamation processes, detector processing including diode formation, etching and surface clean-up, defect passivation, electrical passivation, low-loss hybridization techniques including both temporary and permanent methods and bump bond architectures. As optical components, the final polishing and A/R coating methods must produce uniform surfaces that are also optically flat, so that the component can be integrated into a sensor system. Current methods have been developed for much smaller arrays; there is a strong desire for innovative techniques that can be applied to these large areas. FPA polishing, planarization and radiation hard anti-reflective coatings/surface finishing techniques are of interest. Detection techniques enabling operation at higher temperatures without unduly sacrificing sensitivity or increasing noise is also of interest.

Characterization – The tools and non-destructive characterization techniques that can readily assess step-wise processed material for damage, thereby reducing the likelihood of a less than ideal wafer entering the detector growth and processing stages are of interest. New methods and/or new application of mature methods are of interest especially those that have both submicron resolution and can provide data collection mapped over >60cm2 in a timely (<< 8 hrs) manner. Wafer mapping techniques for determining composition, crystallinity, purity, etch pit density, micro and macro defect density and electro-optic properties are of high value.

Read Out Integrated Circuit (ROIC) -- innovative approaches to ROIC design and fabrication are of interest. ROIC designs typically constitute a significant portion of the non-recurring cost of FPA development. Methods of addressing functional design and design re-use could significantly reduce this cost. Approaches to enable close butting of FPAs, to decrease the real estate penalty associated with radiation hardening, to providing digital output directly from the FPA are of particular interest. Designs should seek to minimize power requirements to decrease cooling loads for the sensor system.

Integration and Testing -- ROIC and FPA testing are also significant cost drivers. Methods of streamlining the test process while retaining the ability to extract decision quality information is enabling for megapixel arrays. Currently the definitive pass/fail test for an FPA is after hybridization. Hybridization of large arrays is problematic due to the extreme size. Ideally all pixels will be interconnected and the pressure needed is quite high (several hundreds of pounds). Non-uniform pressure can cause slip of the two subcomponent bump bonds or cracking of the arrays. Methods to reduce loss are expected to increase overall FPA yields.

All proposed efforts must have/retain the intrinsic FPA capability of operation in a space/nuclear radiation environment (vacuum, ultraviolet, > 300Krads total dose of ionizing or proton radiation) for roughly 10 years, resulting in FPA performance sufficient for strategic systems to meet the requirements of BMDS; efforts must also offer system performance advantages over current sensor capabilities/approaches. Consideration of anti-jam/dazzle capability and laser hardening is desirable, but not required. Any proposal submitted must focus on one specific area: the detector material (single composition/wavelength, substrate and/or epitaxial growth), detector processing, detector characterization, hybridization, substrate removal, A/R coatings, ROICs , FPA fabrication, integration and test. An offeror may submit multiple proposals with unique approaches in one area, or in interrelated areas.

PHASE I: Identify and investigate unique lattice matched substrate growth, polishing techniques and/or reclamation methods, epitaxial growth methods, process designs, novel characterization techniques, and/or production process changes or additions suitable for FPA component fabrication that will result in significant improvement in the FPA size, while retaining performance and operational lifetimes. A deliverable or proof-of-concept design available to the government for additional characterization is highly desirable. Offerors are strongly encouraged to work with infrared component contractors to help ensure applicability of their efforts and begin work towards technology transition, by sale, license or service.

PHASE II: Using the resulting process, designs, techniques, architectures, and/or process changes or additions developed in Phase I, verify these changes in a prototype fashion, on or off a product line to demonstrate the feasibility and efficacy of the technique. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort, to which end they should have working relationships with, and support from, infrared component contractors.

PHASE III: Either solely, or in partnership with a suitable production foundry, implement, test and verify in full scale the Phase II demonstration item as an economically viable production technique. Demonstration would include, but not be limited to, demonstration in a real product line with the resulting FPA testable in a system level test-bed against system performance criteria. This demonstration should show near term application to BMDS systems, subsystems, or components.

COMMERCIALIZATION: Innovations developed under this topic will benefit both DoD and commercial space and terrestrial programs. Possible uses for these products and techniques include surveillance, astronomy, mapping, weather monitoring, and earth resource monitoring. Enhancements to imaging quality and higher product yields show significant potential for increased applications.

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KEYWORDS: infrared detectors; infrared focal plane arrays, radiation hardening, advanced sensor concepts, read out integrated circuit, FPA, ROIC

MDA10-032 TITLE: <u>Radiation Hardened, Low Power, Variable Bandwidth/Resolution Digital-to-Analog or Analog-to-Digital Converters</u>

TECHNOLOGY AREAS: Electronics, Space Platforms

ACQUISITION PROGRAM: PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: To identify concepts and architectures for radiation hardened sigma delta or other high resolution design technologies for developing DACs or ADCs for application in satellite systems.

DESCRIPTION: Satellite systems rely on numerous servo systems to control antennas, thrusters, gyros, and many other mechanical functions. Critical elements in many of these systems are high resolution DACs and ADCs. Typically, these applications require relatively low bandwidth (<10 MHz) but need high resolution (16 to 22 bits) with high signal to noise ratio (114 db). In many cases, there are opportunities for trading off resolution and bandwidth with higher precision available for lower bandwidth and vice versa. As with all space electronics, there is significant benefit in reducing the size, weight, and power in the DACs and ADCs. Proposals are requested for sigma delta architectures (or other high resolution architectures) for either DACs or ADCs that are optimized for space applications. The proposals shall indicate the provisions that have been incorporated to address the unique requirements of space applications and the environmental challenges of multi-year space missions.

General requirements for the rad hard, low power, variable bandwidth DAC or ADC:

The DAC or ADC proposal shall address the following: (a) the development of a design architecture capable of variable bandwidth/resolution while maintaining low power operation in a space environment; (b) the design and fabrication of either a DAC or ADC with the targeted characteristics; (c) provisions for radiation to the space environment (total dose hardness > 300 Krad(Si), no single event latch-up, no single event functional interrupts, and error management for single event upset from heavy ions or protons).

PHASE I: The contractor shall develop an architecture for a DAC or ADC consistent with the requirements described above. The effectiveness of the proposed architecture shall be demonstrated via simulation. The approach to design, fabricate, and test a radiation hardened version shall be clearly stated. Key risk items shall be identified and a detailed task description and schedule shall be developed. A radiation test effort on representative microcircuits or test structures from the target fabrication process is highly desirable as evidence that the target radiation performance can be achieved.

PHASE II: The contractor shall design, fabricate, and test either a DAC or ADC based on the architecture developed in the phase 1 activity. Testing shall include electrical verification of performance and demonstration of radiation hardness.

PHASE III: The contractor shall pursue qualification of the DAC or ADC under the provisions of Mil-Prf-38535 for Class V space electronics.

COMMERCIALIZATION: The radiation hardened DAC or ADC has clear applications for military satellites but is also required for NASA, and commercial satellites that require high precision and low power while being exposed to the space radiation environment.

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KEYWORDS: sigma delta, ADC, DAC, radiation hardened

MDA10-033 TITLE: Lightweight Components

TECHNOLOGY AREAS: Space Platforms

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this SBIR topic is to design, develop and test miniaturized, lightweight, space qualified components to support future MDA space missions. Although this is a broad topic area covering hardware components used in space applications, this year we are placing special emphasis on deployment mechanisms and structures and single chip GPS receiver solutions. Offerors may also propose other highly innovative component miniaturization efforts for consideration under this topic. Please contact the topic authors to discuss innovations outside the focus area.

DESCRIPTION: The Missile Defense Agency Space Segment consisting of the Precision Tracking and Surveillance System (PTSS) and the future Space Tracking and Surveillance System (STSS) architecture is the MDA passive late boost phase and mid-course tracking system. Future PTSS and STSS satellites will greatly benefit from the development of lightweight, power efficient systems. This year, we have two emphasis areas. Other ideas meeting the spirit of the topic are welcome, but you are highly encouraged to your ideas with the Topic Author during the open question phase.

The two emphasis areas are:

1. Lightweight deployment mechanism and structures. Of particular interest are small deployment mechanisms and structures (e.g. ~1 m booms) that can be used in the development of on-orbit calibration objects. Previous deployment mechanism efforts have included inflatable booms, shape memory alloy hinges on rigid structures, compressed composite truss structures, and deployable antennas. These efforts have been focused on supporting large spacecraft and deployment of larger instruments (such as magnetometers), solar arrays, and antennas. The emphasis on this topic is to develop a new class of deployment mechanisms to enhance the capabilities of small satellites (cubesats and microsats). As a result, these mechanisms need to be ultra-compact and lightweight with minimal power requirements to deploy.

This new class of deployment mechanisms are focused on supporting the development of small satellite calibration objects and are envisioned to be single use (non-retractable) systems. The stowed volume goal is < 50 cm^3 and < 150 grams. Final deployed length should be ~1m with widths between 1 and 3 cm. Passive, controlled deployment with minimal power requirements, shock generation, torque or disturbance loads impinging on the spacecraft are highly desirable. The deployment structure must be able to remain rigid once deployed, maintain orientation to the base once deployed and support lightweight appliques containing ultra-lightweight sensors or emitters with appropriate power and data traces and potentially miniature retro reflectors. Innovative solutions for conventional instrument deployments will also be considered.

2. Single chip, space qualified GPS receiver solutions. MDA is interested in single chip, space qualified, GPS receiver solutions to support a number of activities including small spacecraft, calibration objects, targets, and interceptors.

There are a large number of commercially available single chip GPS solutions that have emerged in the past several years such as devices from Epson, Infineon, Maxim and the u-blox. However, none of these efforts are targeted for space applications. The majority of solutions available today are restricted to terrestrial applications such as mobile handheld devices and a limited ruggedized market targeted at the automotive industry. NASA's Goddard Space Flight Center has been developing a space qualified GPS solution, however, it is still a multi-component, board level device16. General Dynamics has the Viceroy line of spaceborne GPS receivers, but these are too large for consideration on smaller satellites such as cubesats or microsats that could be used as free flying calibration objects.

The goal of this emphasis area is to develop a robust, radiation hardened, space qualified, single chip GPS receiver solution approaching current state of the art performance for use in small spacecraft (cubesats, microsats) that can be used as fly along calibration objects and for potential use in interceptors. Features should include multiple channels, low power consumption (< 75 mW) and an update rate approaching 5 hz while meeting the radiation and environmental requirements presented in Table 1.

In addition, all components proposed in this area must address space qualifiability. The following space environmental parameters listed in Table 1 below should be used as guidance.

Table 1: Space Environmental Parameters

Space Environment Parameters	Near Term Goal	Far Term Goal
Vacuum operations	Yes	-
Shelf life – years	5	7
On-orbit Service Life – years	7	17
Radiation Hardness (Proton - nominal 63 MeV)	>100 kRad	>300 kRad
Radiation Hardness (Ionizing)	>100 kRad	>300 kRad
Operating Temperature Range	-54 to 32°C	-
Survival Temperature Range	-60 to 71°C	-

PHASE I: Develop a preliminary design for the proposed component. Modeling, Simulation, and Analysis (MS&A) of the design must be presented to demonstrate the offeror understands the physical principles, performance potential, scaling laws, etc. MS&A results must clearly demonstrate how near-term goals will be met, at a minimum. Proof of concept hardware development and test is highly desirable. Proof of concept demonstration may be subscale or specific risk reduction activities associated with critical components or technologies. Test results (if performed) should be used in conjunction with MS&A results to verify scaling laws and feasibility. Phase I will include the development of plans to further develop/exploit this technology in Phase II. Offerors are strongly encouraged to work with system, spacecraft, and/or payload contractors to help ensure applicability of their efforts and begin work towards technology transition. No specific contact information will be provided by the topic authors.

PHASE II: Complete critical design of prototype component including all supporting MS&A. Fabricate a prototype or engineering demonstration unit (EDU) and perform characterization testing within the financial and schedule constraints of the program to show level of performance achieved compared to stated government goals. In addition, environmental testing, especially radiation testing, is highly encouraged in this phase. The final report shall include comparisons between MS&A and test results, including identification of performance differences or anomalies and reasons for the deviation from MS&A predictions. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort to which end they should have working relationships with, and support from system, spacecraft, and/or payload contractors.

PHASE III: The offeror is expected to work with other industry partners and DOD offices to modify and improve the design of the Phase II proof of concept prototypes to meet individual system applications. The first use of this technology is envisioned for the Persistent Tracking and Surveillance System (PTSS).

COMMERCIALIZATION: Commercial imaging satellites would greatly benefit from the technologies sought in this solicitation. Low cost, lower part count, energy efficient systems provide potential cost savings to commercial and small experimental satellite systems in terms of initial cost and assembly, integration and test expenses.

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KEYWORDS: Space Components, Spacecraft Components, deployment mechanisms, Single chip GPS Receivers

MDA10-034 TITLE: Advanced Space Power Technologies

TECHNOLOGY AREAS: Materials/Processes, Space Platforms

ACQUISITION PROGRAM: PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop advanced space power technologies for MDA satellite applications.

DESCRIPTION: The spacecraft Electrical Power System (EPS) performs a critical role for on-orbit operations by providing electrical power to spacecraft subsystems and payloads through a combination of several functions that include energy conversion, storage, management, and distribution. In performance of these functions, the EPS typically consumes more than one third of the spacecraft mass budget. In addition, the components of the EPS often determine the expected lifetime of the spacecraft. The goal of this topic is to develop advanced space power technologies that improve overall EPS performance as measured by EPS overall efficiency, environmental survivability, and manufacturability. Specifically, improvements are sought in technologies that perform the EPS function of energy storage, and power system technologies that perform this function and are of interest are listed below:

Aerospace-Grade Rechargeable Lithium batteries: Examples of the main interest area for space-based rechargeable lithium batteries are development of new, improved materials for all cell components to provide higher energy densities, allow for possible lower temperature (below -20°C) performance, allow for higher DoD in life cycling and in pulsing modes without significant loss of cycle life, and development of reliable, lower cost manufacturing processes for optimal cell designs with resulting battery configurations that can accommodate long duration space missions (e.g. low earth orbits (LEO) or medium earth orbits (GEO and MEO) for ten to fifteen years on-orbit calendar life). The R&D areas must result in provision of long-term sustainable and consistent materials which are used in rechargeable lithium cell production; beneficial materials developments for space-quality lithium rechargeable cells that enable them to accommodate higher energy densities (>200Wh/kg at the battery level); higher charge and discharge rates with suitable voltage characteristics (e.g. charge at C rates to >4.5 V EoC and discharge at 10C rates); improved calendar life (>10 yrs shelf-life); the possibility of long cycle life at greater depths of discharge (e.g. over 30K cycles at >50% DoD); improved charging and cell balancing methods; software that allows cell and battery life-cycle simulation (voltage decay, capacity fade, response to limited overcharging, thermal exposure, etc.) to help achieve confidence in cell and battery designs; and improvements in cell safety (e.g. benign response to abusive conditions like overcharge, overdischarge, and potential discharge to zero volts).

For the materials aspects of this topic, desired innovations must enable the manufacture of new cell materials suitable for currently used and advanced cell designs in rechargeable space batteries, including new, higher energy density anodes and cathodes, and separator materials as well as electrolyte solvents, electrolyte salts, conductive carbons, and binders which will accommodate the higher energy densities and higher charge voltages. The area of lower temperature operation of space cells encompasses innovations that will allow rechargeable lithium-ion cells to survive short to medium excursions (hours to days) to cold temperatures (<-20ºC) without sustaining unacceptable damage or excessive loss of capacity. An additional emphasis area encompasses development of cell balancing electronics and software programmatics for application to long on-orbit life (>10 yrs) under variable depths-of-discharge with possible pulsing operations.

PHASE I: Design and develop representative proof of concept hardware for the designated battery technology. This hardware will be tested to characterize performance and to assist in developing a Phase II design strategy. The hardware should be functionally tested in operationally driven modes and analyzed for a path to representative environments. The contractor will identify key technical challenges and establish a plan to address and overcome those challenges. The contractor will also develop a Phase II program plan, including (but not limited to) a development and integration strategy, potential flight demonstration opportunities, program schedule, and estimated costs. Proposing firms are strongly encouraged to work with MDA satellite payload and system contractors to understand the EPS requirements, to help ensure applicability of their efforts, and to begin work toward technology transition.

PHASE II: Using the lessons learned from fabricating and testing the prototype in Phase I, design and fabricate a prototype concept that can be integrated into an MDA requirement/system. The prototype will be tested in accordance with MDA/SS operational and environmental parameters. The contractor should keep in mind the goal of commercialization of the innovation for the Phase III effort, to which end they should have working relationships with, and support of, system and payload contractors.

PHASE III: :The technologies developed as a result of the Phase II contract(s) will be applicable to many other military and commercial applications that can benefit from the enhanced capabilities, as well as mass and cost savings associated with the new technology. The first use of the technology is envisioned for a space tracking and surveillance satellite.

COMMERCIALIZATION: The commercial potential for increased performance of EPS components is high. Commercial satellite providers are a significant fraction of the space market and are continually looking for ways to reduce system mass, decrease costs, and increase spacecraft reliability and lifetime. Rechargeable batteries are used in commercial aerospace applications for on-board power and innovations developed under this topic are likely to benefit various commercial spacecraft applications.

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KEYWORDS: Electrical Power, Space Power, Power Generation, Power Storage, Power Management and Distribution, Space Based Battery, Power Density, Energy Density, Lithium-Ion, Rechargeable Battery.

MDA10-035 TITLE: Enhanced Spacecraft Survivability

TECHNOLOGY AREAS: Space Platforms

ACQUISITION PROGRAM: PTSS

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 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop (design, fabricate and demonstrate) innovative approaches to enhance the survivability of MDA Space Systems to spacecraft anomalies occurring from either natural or manmade events.

DESCRIPTION: Survivability and resiliency to anomalies is critical in the design and analysis of MDA space systems. The Missile Defense Agency seeks innovative solutions to enhance the survivability of spacecraft to effects from natural and/or manmade origins. Special areas of interest in this topic are: environmental monitoring sensors, sensor protection, and techniques to allow operation through an anomaly and/or fast recovery. Space qualification requirements as well as the necessity of minimizing the size, weight, and power consumption of all spacecraft components must be part of the design trade for any successful proposal. The intent of this topic is not the development of generic radiation hard electronics and sensors. Other topics within this solicitation explicitly seek those solutions, however any solutions developed for this topic must meet a ten year life and a minimum of 300 Krad radiation requirements.

The first area of emphasis seeks proposals to develop sensors and sensor algorithms to detect, characterize (i.e., provide attribution), and report, in near real time, mission critical space environmental events or effects occurring from natural and/or manmade origins that could potentially inhibit performance of the Ballistic Missile Defense System.

The second area of emphasis seeks proposals to develop innovative mechanisms or algorithms to enhance the survivability of optical sensors from natural and/or manmade events or effects.

The third area of emphasis seeks proposals to allow for continued operations through anomalies and/or the fast recovery of the system afterward. The anomalies can include but are not limited to; the effect of abnormal electro-magnetic and particle irradiance that may affect the spacecraft sensors and/or onboard electronics, spacecraft power generation capability or thermal behavior of the space vehicle, space vehicle to ground communication, debris impact (mechanical damage), and/or other effects. Natural effects may also include stressing radiance perturbations on infrared sensors that may impact the ability of a sensor to detect and track small dim targets.

PHASE I: Develop a preliminary design for the proposed component or algorithm. Modeling, Simulation, and Analysis (MS&A) of the design must be presented to demonstrate the offeror understands the physical principles, performance potential, scaling laws, etc. MS&A results must clearly demonstrate how near-term goals will be met, at a minimum. Proof of concept hardware or software development and test is highly desirable. Proof of concept demonstration may be subscale or specific risk reduction activities associated with critical components, algorithms or technologies. Test results (if performed) should be used in conjunction with MS&A results to verify scaling laws and feasibility. Phase I will include the development of plans to further develop/exploit this technology in Phase II. Offerors are strongly encouraged to work with system, spacecraft, and/or payload contractors to help ensure applicability of their efforts and begin work towards technology transition. No specific contact information will be provided by the topic authors.

PHASE II: Complete critical design of prototype component or algorithms including all supporting MS&A. Fabricate a prototype or engineering demonstration unit (EDU) and perform characterization testing within the financial and schedule constraints of the program to show level of performance achieved compared to stated government goals. In addition, environmental testing, especially radiation testing, is highly encouraged in this phase. The final report shall include comparisons between MS&A and test results, including identification of performance differences or anomalies and reasons for the deviation from MS&A predictions. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort to which end they should have working relationships with, and support from system, spacecraft, and/or payload contractors.

PHASE III: The offeror is expected to work with other industry partners and DOD offices to modify and improve the design of the Phase II proof of concept prototypes to meet individual system applications. The first use of this technology is envisioned for the Persistent Tracking and Surveillance System (PTSS).

COMMERCIALIZATION: The successful development and demonstration of this technology is expected to result in continued use by MDA, other DOD organizations, NASA, and commercial spacecraft developers.

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KEYWORDS: space environment, threat protection, natural environment, atmospheric correction, limb radiance