MISSILE DEFENSE AGENCY (MDA)
12.B Small Business Technology Transfer (STTR)
Proposal Submission Instructions

INTRODUCTION

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

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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.

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 and that offer potential benefit to the BMDS prioritized technology gap areas will be funded. Only Government personnel will evaluate proposals.

Questions about STTR and Solicitation Topics
Refer to Section 1.5 of the DoD Program Solicitation at www.dodsbir.net/solicitation.

Federally Funded Research and Development Centers (FFRDCs) and Support Contractors
The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for MDA SBIR or STTR awards in the SBIR/STTR topics they review and/or on which they provide comments on to the Government.

All advisors are required to comply with procurement integrity laws. Non-Government technical consultants/experts will not have access to proposals that are labeled by their proposers as "Government Only." Pursuant to FAR 9.505-4, the MDA contracts with these organizations 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.

Non-Government advisors 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. 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.

Conflicts of Interest

Refer to Section 1.4 of the DoD solicitation at www.dodsbir.net/solicitation.

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 with a period of performance of 6 months and a base amount not to exceed $100,000. The Phase I Option may be submitted with a period of performance of 6 months and an amount not to exceed $50,000. A list of the topics currently eligible for proposal submission is included 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.

MDA acknowledges that universities engaging in fundamental research are free involve foreign researchers and to publish their research in a public forum except in cases where restrictions are placed for reasons of National Security. However, in accordance with Section 2.4 of the DoD solicitation, ALL offerors proposing to use foreign nationals MUST disclose this information regardless of whether the topic is subject to ITAR restrictions. To ensure only fundamental research is published, MDA requires the proposal to document specifically which portion of the SOW will be conducted by the university as fundamental research. MDA will review the SOW and provide approval \ disapproval of the designation of university work as fundamental research during the contracting process. The small business will remain responsible for control of information deemed ITAR on their contract and\or the passing of ITAR data to the university.

Please ensure the mailing address, e-mail address, and point of contact (Corporate Official and Principal Investigator) 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.

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

MDA is 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.

USE OF FOREIGN NATIONALS

See Section 2.4 of the DoD Solicitation for the definition of a Foreign National (also known as Foreign Persons.)

ALL offerors proposing to use foreign nationals MUST disclose this information regardless of whether the topic is subject to ITAR restrictions. See Section 3.5, b., (7) of the DoD Solicitation for required information.

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.

TECHNOLOGY DEVELOPMENT AND POTENTIAL FOR INVENTIONS

The DoD and MDA SBIR/STTR program includes goals of improving current known technology and developing new and novel technology leading to applications as BMDS improvements. Therefore, there is a potential for contractor generation of inventions during Phase I and Phase II contracts. In order for each contractor to understand DoD reporting requirements for inventions created with U.S. Government funding, it is encouraged that each contractor submitting a Phase I proposal, should become familiar with the requirements of Federal Acquisition Regulation (FAR) 52.227-11 (include web link), and DoD FAR Supplement (DFARS) 252.227-7018 (include web link).

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.

MAXIMUM PAGE LIMIT FOR MDA IS 20 PAGES

Any pages submitted beyond the 20-page limit, will not be evaluated. Your cost proposal and Company Commercialization Report DO NOT count toward your maximum page limit. Proposal coversheets, which will be added electronically by the DOD submission site as page 1 and page 2, DO count toward your maximum page limit.

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) 26 September 2012.

_____ 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. Proposal Coversheets DO 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 **(Online cost proposal form is REQUIRED by MDA)**

____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. Due to limited funding, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality, that offer potential benefit to the BMDS prioritized technology gap areas, and that have the ability to transition the technology into an identified BMDS will be funded. MDA is not responsible for any money expended by the proposer before award of any contract.

MDA will use the Phase II Evaluation criteria in Section 4.3 of the DoD solicitation in inviting, assessing and selecting for award those proposals offering the best value to the Government. Only proposals considered to be of superior quality, that offer potential benefit to the BMDS prioritized technology gap areas, and that have the ability to transition the technology into an identified BMDS will be funded.

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

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 Phase I selection and non-selection notifications distributed in the December 2012 timeframe. All questions concerning the evaluation and selection process should be directed to the MDA SBIR/STTR PMO.

All communication from the MDA SBIR/STTR PMO 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 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

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. Invitations for Phase II proposals 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 the 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.

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/STTR 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 $1,000,000 maximum, unless specified by the Director, Advanced Research.

- For companies that have never received a Phase II SBIR/STTR award from DoD or any other federal agency, the minimum matching rate is .25 cents for every SBIR/STTR 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/STTR funding that totals $750,000, it must obtain matching funds from the investor of $750,000.)

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.

2012 STTR 12.B Phase I Key Dates (Projection)

12.B Solicitation Pre-release	July 26 – August 26, 2012
12.B Solicitation Opens	August 27 – September 26, 2012
Phase I Evaluations	October-November 2012*
Selection and Non-Selection Notifications Distributed	December 2012*
Contract Award Goal	February 2013*

Phase II Transition Program Solicitation is ***generally*** announced via http://www.mdasbir.com in the Spring/Summer 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 STTR 12.B Topic Index

MDA STTR 12.B Topics by Research Area

CR-C2BMC (C2BMC)

MDA12-T004	EOIR Debris Management during ascent phase for C2BMC

DEF (DE-Future Capability)

MDA12-T005	Post Intercept Debris Predictions for EO/IR Scene Modeling

DES (DE-Modeling & Simulation)

MDA12-T006	Human-in-Control (HIC) Modeling
MDA12-T007	M&S Uncertainty Quantification

DVL (DV-Directed Energy)

MDA12-T008	High energy laser analysis tool with experimental verification of DPAL rate constants

MDA STTR 12.B Topic Descriptions

MDA12-T004 TITLE: EOIR Debris Management during ascent phase for C2BMC

TECHNOLOGY AREAS: Information Systems, Sensors, Space Platforms, Weapons

ACQUISITION PROGRAM: C2BMC S8.4

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 characterize pre-intercept debris fields and derive a technique which enables system understanding of the debris field to facilitate a fire control solution.

DESCRIPTION: During observation of a missile fly-out from airborne or space based electro-optic or infra-red, EOIR, sensors, a missile complex may present debris clouds which complicate the formation of a fire control solution. These clouds may appear as various geometric configurations from different sensors and if objects are detected in the clouds, it is important to describe to the system where the objects are in a manner that allows subsequent sensors to acquire them, enabling cross sensor track and correlation. Goals are to minimize the number of objects tracked by the system, while maximizing the positional accuracy as well as scene information content for subsequent fire control formation. This may involve development of what the optimal “object” is for transmission and any environmental characterization, or “cloud features” that could be developed.

Debris mitigation occurs at the sensor as well as at the Command, Control, Battle Management and Communications, C2BMC, node. To prevent leakage, the sensor cannot attempt to screen out all debris, so some will likely pass as tracks to C2BMC. However, some tracks may be clusters of objects and the “track” passed to the system may be only a centroid of an extended object or field. This problem is a higher dimensional challenge familiar to astronomers who characterize galaxies with embedded stars. The 2MASS sky survey focused on detection, identification, and characterization of stellar extended sources, including a discussion of the point-spread function (PSF) - a basic component of star-galaxy separation and for us, object-debris separation. Similarly, the WISE data processing pipeline handles galaxies with embedded point sources. However, these methods address, essentially, viewing from a single position. For our purposes, the distance between sensor and observed object is not so great, and additional information can be gleaned from the opportunity to view the scene from multiple (two or three) viewing angles.

In traditional image processing, or automatic target recognition, it is assumed that the object represented on the focal plane corresponds to a prototype stored in a database. Thus, the challenge is matching the observed image to the familiar prototype. In our case, the prototype could be as simple as a conic section, an ellipse or parabola, or slightly more complex shapes. Research has shown that a shape vector can be constructed that is a linear combination of prototypes that effectively tells how to warp the average shape of stored prototypes to match the observed image. Alternatively, multiple non-resolved point sources could be represented by the convex hull of the detections. For multiple sensors viewing the field, there may also be M clusters visible to one sensor and N clusters visible to a second, and reconciling the scene could pose difficulties.

Analysis needs to be performed on various ways to represent, and transmit across a network, irregular debris fields with embedded targets, and methods derived to combine this information between sensors, as well as determine where in the field a target of interest could exist, from alternate viewing angles.

The researcher may include multiple EOIR bands, however, targets will be at ranges that will cause them to appear on, at most, one pixel for the EO/IR focal plane. In general, multiple objects, targets and debris, or debris clouds may extend across numerous pixels.

Technical risk is moderate as this is, ultimately, a complex, dynamic, time stressing task. But image analysis is a mature field and there are many other applications where similar techniques have been developed and should be available. Expanding the imaging analysis to two or three sensors will require more development.

PHASE I: Develop and demonstrate through proof-of-principle tests debris cloud, or multiple non-resolved object, characterization and transmission methods, such that C2BMC understands the scene adequately to take action. The small business and the research institution need to demonstrate coherent and mutually supporting goals and plans.

PHASE II: Refine and update concept(s) based on Phase I results and demonstrate the technology in a realistic environment using data from multiple EOIR sensor sources. Demonstrate the technology's ability in a dense scene, with data from two or three spatially separated sensors.

PHASE III: Demonstrate the new technologies via operation as part of a complete system or operation in a system-level test bed to allow for testing and evaluation in realistic scenarios. Market technologies developed under this solicitation to relevant missile defense elements directly, or transition them through electro-optical/infrared sensor vendors.

COMMERICALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial and military uses in many areas including automated target and threat recognition, battle space surveillance, robotics, medical industry, and in manufacturing processes.

REFERENCES:
1. Michael J. Jones, Pawan Sinha, Thomas Vetter and Tomaso Poggio , (1997), Top–down learning of low-level vision tasks, Current Biology, Vol 7 No 12

2. T. H. Jarrett, T. Chester, and R. Cutri, S. Schneider and M. Skrutskie, J. P. Huchra, (2000), 2MASS Extended Source Catalog: Overview And Algorithms, The Astronomical Journal, 119:2498-2531, 2000 May

3. Mark Nixon, Alberto S Aguado, (2008), Feature Extraction & Image Processing for Computer Vision, Academic Press; Second edition (January 22, 2008)

4. Kenneth R. Castleman, (1995), Digital Image Processing, Prentice Hall; 2nd edition (September 2, 1995)

5. J. R. Parker, (2010), Algorithms for Image Processing and Computer Vision, Wiley; 2 edition (December 21, 2010)

6. Jurgen Jost, (2011), Riemannian Geometry and Geometric Analysis, Springer; 6th ed. edition (August 9, 2011)

7. Mark L. G. Althouse, Chein-I Chang, (1991), Chemical Vapor Detection with a Multi-spectral Thermal Imager, Optical Engineering, Vol. 30 No.11, November 1991

KEYWORDS: debris, shape identification, EOIR imaging

MDA12-T005 TITLE: Post Intercept Debris Predictions for EO/IR Scene Modeling

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: Missile Defense Agency Interceptor Program Elements, THAAD, SM3, Patriot, G

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 an innovative set of physics-based software tools and models to predict both prompt and late time electro-optical/infrared (EO/IR) signatures associated with the debris cloud generated after a missile intercept. The models should be fast-running, should address current and future missile intercept scenarios covering anticipated altitudes and closing velocities, and should be grounded in the critical physics interactions and phenomena.

DESCRIPTION: As the Ballistic Missile Defense System (BMDS) continues to mature through the Phased-Adaptive Approach (PAA), a key priority in the development process is the ability of the system to effectively defend against raid scenarios. Successful BMDS operation in raid scenarios relies upon a robust kill assessment capability at both radio and optical/infrared (EO/IR) wavelengths. The wide variety of threats, engagement conditions and sensor viewing geometries dictate the need for a robust modeling and simulation capability in this area. Although many advances have been made in the modeling of radar signatures for post-intercept scenes, the EO/IR scene has presented a greater challenge due to its dynamic intensity range, environmental dependencies and varied phenomenology. Standard first-principle, finite-element modeling approaches experience practical difficulties due to limitations on the element size that can be explicitly modeled in these calculations. Specifically, IR flash signatures are generally dominated by particulates in the micron size regime whereas most finite element models achieve a resolution of order cm or mm. The proposed solution should overcome these obstacles, and remain scalable, massively parallel, and provide rapid turnaround.

The debris prediction tool should be driven by first principle numerical modeling techniques and anchored to existing test data. Calculated post-intercept thermal signatures should reflect debris temperature, mass, surface geometry and emissivity. The required tools should calculate the heat generated in target and payload debris due to warhead impact and any subsequent reactions of high explosives that make up the payload.

PHASE I: Assess state-of-the-art tools and techniques for simulation of EO/IR emission and temperature profiles of post-impact target debris. Propose new approaches that would address identified deficiencies in existing codes. First-principles simulations that validate the fast running models are encouraged. A critical component of this phase is determining the best general approach to the simulation of heat generated from warhead impact and payload reactions, and the EO/IR radiation emissions that result. The culmination of Phase I would be a work plan for implementing proposed approaches for simulation of late-time thermal signatures of post-impact target and warhead debris.

PHASE II: Create numerical tools based on approaches identified in Phase I. This would include the algorithm and code development necessary to simulate temperature profiles and EO/IR signatures for propagating, evolving post-impact debris. Interactions with ambient material and the effects on the EO/IR signatures must be addressed. Demonstrate new algorithms using hypothetical intercept scenarios to show more clearly resolved lethal volumes. Validation will be done using existing MDA flight test data. The numerical tools produced in the stage must meet the requirements of being scalable, massively parallel, and offer quick turn around and analyses of flight test missions. Phase II validation work will be classified.

PHASE III: These simulation tools will be used to provide direct guidance to flight test mission execution and BMDS sensor development and performance testing. Specifically, these tools would support pre-test mission planning to include range safety and sensor performance estimates, post-flight reconstruction activities, performance assessments of EO/IR BMDS sensors for realistic threat engagements, and integration with the MDA simulation architectures (e.g. SSF and DSA).

DUAL USE/COMMERCIALIZATION POTENTIAL: Space Situational Awareness programs could benefit from this technology. This development effort would provide a fundamental improvement to an array of physics base simulation techniques, including heat generation due to high velocity impact, and coupled multi-body IR emission. Modeling of industrial processes such as welding, spray, sputtering deposition would also benefit from this topic's simulation development effort.

REFERENCES:
1) Jean, B., and Rollins, T. L., "Radiation from Hypervelocity Impact Generated Plasma," AIAA J. 8(10), 1742–1748 (1970)

2) Lawrence, R.J., Reinhart, W.D., Chhabildas, L.C., & Thornhill, T.F., "Hypervelocity Impact Flash at 6, 11, and 25 km/s", in Shock Compression of Condensed Matter – 2005, eds. M.D. Furnish et al. (AIP)

KEYWORDS: Impact Flash, IR Signature, Kill Assessment, Hit Assessment

MDA12-T006 TITLE: Human-in-Control (HIC) Modeling

TECHNOLOGY AREAS: Information Systems, Battlespace, Human Systems

ACQUISITION PROGRAM: MDA/DES

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 an effective, repeatable simulation capability of Human-in-Control (HIC) interactions with other simulated capabilities. Provide capability to represent HIC proficiencies, decisions, decision timeliness, variabilities and outcomes at each interactive system within a system of systems, in order to qualify and quantify impacts on overall system behaviors, capabilities and performance. Provide repeatable simulated HIC performance in order to analyze and isolate any impacts of HIC variabilities on overall system performance and other sources of overall variability. Provide capability to quantify objectively the confidence in simulation-based predictions of HIC behavior metrics and impacts on overall system performance. Provide a delivered solution extensible and applicable to any current and future system capabilities.

DESCRIPTION: Human operators are an essential part of BMDS, and their performance significantly shapes the capabilities of the entire BMDS. Warfighters currently participate in Ground Test, Training, Exercises and Wargaming. Simulation of Warfighter performance is additionally essential to Performance Assessment, Element Integration and Future Concept Analysis, but these typically constructive simulations often represent BMDS operators by only their respective "prescribed" Concepts of Operation (CONOPS); Tactics, Techniques and Procedures (TTPs); and Rules of Engagement (ROEs), without real-world variations in operator proficiency, timeliness, creativity, fatigue or morale. To this end, the BMDS Operational Test Agency (OTA) has made operator modeling one of its top priorities stating, "HIC (Human in Control) actions are not accurately modeled in Performance Assessments to assess BMDS performance" resulting in diminished credibility of the simulation.

Constructive or synthetic representations of BMDS operators and their performance are desirable in all BMDS M&S Stakeholder Applications. For example, representative simulated BMDS operators in Performance Assessment would address the Director of Test and Evaluation's specific concern regarding Warfighter performance impact cited in his annual report to Congress. Futuristic Concept Analyses could leverage these same simulated operators in BMDS performance trades analyses of battle management automation vice human operator tasking. Simulated operators can also significantly reduce event costs and lead times by supplementing "missing" human operators in Training, Exercises and Wargames. Simulated operators can extend the scalability of Ground Tests by replacing human operators in digital surrogate representations of BMDS tactical articles that are unavailable for the Ground Test.

Simulated operators offer the additional opportunity for full controlled variability of operator performance. For example, Tier 4 operator training could involve a single student with the remaining crew filled out by simulated operators. While the timing and tasks of simulated operator performance is somewhat dependent on the human student's actions, their variability is known and controllable by the training coordinator, so the coordinator can reliably measure and evaluate the single student's performance and variability.

MDA/DES seeks innovative simulated operator capabilities addressing the following needs and issues:
- Applicability and "tunability" to operators of any current BMDS Element or Component
- Representation of operator tasks, timelines, decisions, proficiencies, outcomes, variabilities

• Ability to adapt to unanticipated operational situations outside training and experience comparably as a human operator
• Extensibility to futuristic operator performance to support conceptual systems and human roles
• Validation, verification and accreditation
• Repeatability and controlled variability
• Objective quantification of confidence in simulation-based prediction of operator performance
• Affordability
• Ability to support both real-time and as-fast-as-possible M&S execution
• Scalability and portability across BMDS M&S architectures and Stakeholder Applications
• Usability by event conductors (e.g., training coordinators), including integration and scenario setup
• Integration with event scenario planning
• Representation of the effects of multi-mission activities on BMDS operator performance
• Insertion into existing and anticipated BMDS M&S architectures ("openness")
• Demonstrable innovation beyond existing human decision-making and performance modeling
• O&M considerations

PHASE I: Develop an innovative HIC Model design for the BMDS context. The HIC Model design should demonstrate the offeror's understanding of issues and principles of human decision-making and performance simulation in settings comparable to the BMDS context. The HIC Model design should incorporate the offeror's innovation extending current state-of-the-art and –practice. The HIC Model design should also clearly demarcate internally implemented functions from functionality provided by external services, such as time management provided by a BMDS M&S framework or integrated tool. Phase I work products should include HIC Model requirements, architecture artifacts and a HIC Model development plan addressing aspects of requirements allocation, design structure, anticipated behavior, functional completeness, limitations/exclusions/deferrals, extensibility, scalability, testing, technical risks, uncertainty quantification, VV&A, scenario planning augmentation, M&S tool insertion, intellectual property (IP) rights and O&M. IP ownership and use arrangements that would facilitate rapid and cost-effective integration and employment of the objective HIC Model capability are highly desirable.

PHASE II: Implement the Phase I HIC Model design in a prototype that will demonstrate the simulation capability of HIC behaviors on a simulated BMDS capability. Develop, demonstrate, and publish a lean process for integration and test of the HIC Model capability with both current and future BMDS element models (e.g. Aegis BMD, THAAD, Patriot, C2BMC). Support the Operational Test Agency (OTA) to develop a HIC model performance data collection plan that would support Phase III model validation. Improve and refine design, architecture and capability based on stakeholder feedback.

PHASE III: Scale the functional and runtime performance of the HIC Model capability to accommodate stressing operator workloads representative of dense ballistic missile raids in small battle spaces anticipated in future BMD conflicts. Support DSOs integrating, testing and employing the HIC Model capability with one or more simulated BMDS capabilities. Collaborate with COCOM Warfighter stakeholders to gauge the operational realism and military utility of the HIC Model capability in Joint exercises (of which BMD is only a part), and continue improvement responding to critical feedback from Joint Warfighter experience. Demonstrate capability to support excursions or scenarios on a scheduled BMDS M&S-supported Event (e.g., Wargaming, Exercise, Ground Test) to gauge user acceptance of the HIC Model capability. Demonstrate utility of the HIC Model capability in a mission-critical BMDS M&S-supported activity, such as the DoT&E Performance Assessment.

DUAL USE/COMMERCIALIZATION POTENTIAL: The contractor will pursue commercialization opportunities for the HIC Model in diverse related operator-in-the-loop, system-of-systems M&S contexts, such as battlefield, border and maritime ISR; Land, Air and Space control; and law enforcement.

REFERENCES: Following is a very limited sample of the large literature on simulation of human decision-making and performance.

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KEYWORDS: Human-in-Control (HIC) modeling, Operator Modeling, Simulated Operator, Human Modeling

MDA12-T007 TITLE: M&S Uncertainty Quantification

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: MDA/DESP

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 Uncertainty Quantification (UQ) capabilities for Ballistic Missile Defense System (BMDS) Modeling and Simulation (M&S). Include methods and tools for efficiently, effectively specifying, representing and analyzing both epistemic (known unknown) and aleatoric (unknown unknown) uncertainties affecting BMDS outcomes. Provide UQ capabilities addressing M&S input uncertainties; intrinsic errors in algorithms, implementation and residual errors; and convolution of input uncertainties and intrinsic errors to uncertainties of M&S outputs. Provide UQ facilities for integration with both legacy and new BMDS M&S, and for leveraging planned or existing M&S tool or framework capabilities to manage or control M&S experimentation across end-to-end runs. Provide UQ capabilities to augment M&S experimentation and scenario planning. Provide means to quantify confidence in M&S predictions of BMDS outcomes. Provide UQ capabilities for M&S to assist BMDS Test planning.

DESCRIPTION: M&S has traditionally chased modeling fidelity without a well based understanding of the uncertainty bounds associated with the underlying assumptions. UC facilitates an understanding of the parameters that the modeled system is sensitive to so that a sufficient resolution of input parameters can be quantified. Because M&S explicitly models (abstracts) the real world, M&S introduces intrinsic uncertainties and errors into the calculation of outcomes. Consequently, outputs of M&S contain uncertainties in inputs; intrinsic errors in algorithms; and residual errors in software or data (“bugs”). Recent developments in computational capacity and statistical approaches have facilitated the development of technology that could be used across the DoD, DoE and commercial market place.

Significant uncertainties complicate engineering, fielding and employment decisions about BMD. BMDS uncertainties include both aleatoric and epistemic uncertainties (vernacularly distinguished as “known unknowns” and “unknown unknowns”). Aleatoric uncertainties are “irreducible” in the sense that they are always present, while epistemic uncertainties are often “reducible” through investment, time or research. An example of aleatoric BMDS uncertainty is space weather. An example of epistemic BMDS uncertainty is a threat trajectory before launch.

UQ is the identification, characterization, propagation, analysis and reduction of all uncertainties in M&S [1]. Motivated by the treaty, legal, hazard, expense and impracticality of testing, the US Department of Energy (DOE) laboratories established a version of UQ to assess quantitatively the reliability and safety of the US nuclear weapons stockpile [1, 2]. Motivated by strongly analogous limitations and aspiring to the Objectives enumerated above, MDA seeks to adapt UQ methodologies to the BMDS M&S domain. To this point, MDA's BMDS M&S tools and frameworks embody very limited UQ facilities, such as pseudorandom number generators and Monte Carlo sampling from a limited selection of probability distributions. MDA seeks complete UQ processes and facilities enhancing a broad range of BMDS M&S products. BMDS M&S end users and stakeholders also explicitly call for UQ capabilities; for example, the BMDS Operational Test Agency (OTA) identified a need for "Monte Carlo capability" in support of BMDS Performance Assessment [3].

MDA/DES seeks innovative UQ capabilities addressing the following needs and issues:
• Characterization, propagation and analysis of all uncertainties associated with BMDS M&S
• Appropriate, effective, efficient and affordable methods for quantification of both aleatoric and epistemic uncertainties
• Provision of UQ capabilities to both legacy and future BMDS M&S tools and frameworks
• Support for both real-time and as-fast-as-possible BMDS M&S
• Support for live, virtual and constructive BMDS M&S
• Provision of objective, quantified metrics for confidence in predictions from BMDS M&S
• Support for joint experimentation planning of M&S and Test to improve prediction confidence
• Usability by both M&S developers and M&S-based event planners

PHASE I: Develop a M&S UQ capability architecture and roadmap. The offeror should specify and perform significant trade studies in selecting the best UQ methods for MDA's BMDS M&S context. The offeror should identify and suggest mitigations to significant technical risks for UQ implementation and use. The M&S UQ capability architecture should incorporate the offeror's innovation extending current state-of-the-art and -practice. The M&S UQ capability architecture should also clearly demarcate internally implemented functions from functionality provided by external services, such as a BMDS M&S framework or integrated tool. Phase I work products should include M&S UQ requirements, architecture artifacts and an architecture roadmap addressing aspects of requirements allocation, design structure, anticipated behavior, functional completeness, limitations/exclusions/deferrals, extensibility, scalability, testing, VV&A, scenario planning augmentation, M&S tool insertion, intellectual property (IP) rights and O&M. IP ownership and use arrangements that would facilitate rapid and cost-effective integration and employment of the objective M&S UQ capability are highly desirable.

PHASE II: Implement a prototype using the Phase I M&S UQ design and architecture that demonstrates the ability to efficiently represent and analyze both epistemic (known unknown) and aleatoric (unknown unknown) uncertainties affecting simulation based BMDS outcomes. Develop, demonstrate, and publish a lean process for integration and test of the UC capability with both current and future BMDS M&S. Improve the UQ design, architecture and capability based on stakeholder feedback.

PHASE III: Integrate, test and demonstrate the M&S UQ capability with one or more BMDS M&S products. Support DSOs integrating, testing and employing the UQ capability. Scale the functional and runtime performance of the UQ capability to accommodate both epistemic and aleatoric uncertainties characteristic of dense ballistic missile raids in small battle spaces anticipated in future BMD engagements. Demonstrate capability to support excursions or scenarios on a scheduled BMDS M&S-supported Event (e.g., Future Concept Analysis, Element Integration) to gauge user acceptance of the UQ prototype capability. Collaborate with COCOM Warfighter stakeholders to gauge the operational realism and military utility of the UQ capability in Joint exercises (of which BMD is only a part), and continue improvement responding to critical feedback from Joint Warfighter experience. Demonstrate utility of the UQ capability in a mission-critical BMDS M&S-supported activity, such as the DoT&E Performance Assessment. Develop, demonstrate, and publish a lean process for integration and test of the UQ capability with both current and new BMDS M&S tools (e.g. I-SIM, DSA-P, EADSIM).

DUAL USE/COMMERCIALIZATION POTENTIAL: The contractor will pursue commercialization opportunities for the UQ capabilities in diverse domains, such as Military Space, Space Exploration, Air Traffic Control, Homeland Security, Law Enforcement and other contexts in which the impracticality or impossibility of Test necessitates UQ with M&S.

REFERENCES:
1. Center for Applied Scientific Computing, "The PSUADE Uncertainty Quantification Project," Lawrence Livermore National Laboratory, US Department of Energy, https://computation.llnl.gov/casc/uncertainty_quantification.

2. Helton, Jon C., 2009, "Conceptual and Computational Basis for the Quantification of Margins and Uncertainty," Sandia Report SAND2009-3055, Sandia National Laboratory, US Department of Energy, Albuquerque, NM. http://prod.sandia.gov/techlib/access-control.cgi/2009/093055.pdf.

KEYWORDS: Uncertainty Quantification (UQ), aleatoric, epistemic, known unknowns, unknown unknowns, modeling and simulation, M&S

MDA12-T008 TITLE: High energy laser analysis tool with experimental verification of DPAL rate constants

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors, 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: Develop, or build upon existing models, a set of physics-based software tools to perform high fidelity modeling for MDA's high-energy lasers. This tool should allow MDA researchers to perform laser performance and sensitivity analysis tasks (e.g. power, beam quality, efficiency trades, etc.). Development includes university research to assist with model formulation and experimental verification of key rate coefficients relevant to MDA's laser systems.

DESCRIPTION: MDA's Directed Energy vision includes development of Diode Pumped Alkali Lasers (DPALs), and potentially other lasers. To assist in the development and assessment of these laser technologies, MDA requires a set of physics-based software tools to perform laser performance and sensitivity analysis tasks. Ultimately, a tool or set of tools is desired that can—with minimal future effort—be generalized to model nearly any high-energy laser. Development of these analytical tools should be leveraged with university research in model development and experimental verification of relevant rate coefficients.

In the final product, the offeror must assemble modular packages that incorporate but is not limited to the following capabilities:
1. Computational Fluid Dynamics (CFD)
2. Coupled kinetics with the best rate constants extant
3. Wave-optics to study alternative strategies for coupling pump diodes with the gain medium
4. The ability to study alternative strategies for suppression of parasitic modes, viz. amplified stimulated emission (ASE).

The goal is essentially to pair small businesses proficient in modeling CFD, optics, and laser resonators to collaborate with university personnel who have the expertise to measure rate constants; the final product should provide substantial insight in to laser efficiency and beam quality. Offerors are also encouraged to present solutions that leverage relevant existing tools / tool sets, and provide a capability that is scalable and massively parallel with reasonable turnaround times.

PHASE I: Demonstrate an understanding of the challenges associated with modeling the lasers identified previously, begin developing analytical tools, and identify & catalog relevant experimental coefficients required for the analytical tools. The university component of proposed efforts should identify parameters of interest to the modeling efforts and propose experiments for Phase II—or the end of Phase I—to verify key parameters that are not well known or understood. For example, coefficients for DPALS should focus on—but are not limited to—rate constants specific to Rubidium and Helium kinetics (and buffer gases for lower operating pressures), a pressure range 0-20 Atm, and a temperature range of: 100 °C - 300 °C. The Phase I work product should include a clear technology development plan, schedule, and transition risk assessment. These details should be presented in the Phase I final report along with progress on analytical tools development. Offerors are highly encouraged to interact with MDA/DVLD for feedback and input to ensure the final products are developing along a useful path.

PHASE II: Implement the selected solutions proposed/started in Phase I. The university component should execute proposed experiments for the key system parameters. The objective is to validate a robust and producible technology approach that MDA users and prime contractors can transition in Phase III for their unique application. The goal is to demonstrate technology viability and the offeror needs to have working relationships with MDA/DVLD to assist with analysis validation and architecture feasibility.

PHASE III: Finalize a product that can be used for multiple high-energy laser applications—e.g. the final product may be able to work with other high energy laser technologies with the insertion of additional appropriate laser kinetics subroutines and rate constants. The objective is to demonstrate the developed technology, and transition the technology. A major step in this Phase III will be developing a means to release the tools to appropriate organizations/ groups within the DoD community in a way the complies with ITAR restrictions. Additionally the contractor should demonstrate a secure means of protecting the software from misuse and/or improper release. A partnership with a current or potential supplier of MDA element systems, subsystems or components is highly desirable, as is interaction with the High Energy Laser Joint Technology Office modeling and simulation efforts.

COMMERCIALIZATION: The ability to model high-energy laser components has the potential for many commercial applications. High power lasers 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. The contractor is also encouraged to identify additional sources.

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4) R. Magnusson, Y. Ding, K.J. Lee, D. Shin, P.S. Priambodo, P.P. Young, T.A. Maldonado, Photonic devices enabled by waveguide-mode resonance effects in periodically modulated films, Proc SPIE, Vol. 5225, No.1, pp. 20-34, (2003).

5) B. Zhdanov and R.J. Knize, Diode-pumped 10 W continuous wave cesium laser, Opt. Letters, Vol. 32, No. 15, pp. 2167-2169, (2007).

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7) Aleksey M. Komashko; Jason Zweiback, Modeling laser performance of scalable side pumped alkali laser (Proceedings Paper) SPIE Proceedings Vol. 7581, High Energy/Average Power Lasers and Intense Beam Applications IV, 17 February 2010.

8) Boris Zhdanov, Thomas Ehrenreich, and Randall Knize, Optically pumped alkali-vapor lasers http://spie.org/documents/Newsroom/Imported/412/2006090412.pdf

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KEYWORDS: directed energy, high energy laser, alkali lasers, diode pumped alkali lasers