DEFENSE THREAT REDUCTION AGENCY
16.2 Small Business Innovation Research (SBIR)

Proposal Submission Instructions

The DTRA SBIR Program addresses development of innovative ideas against the DTRA mission to counter Weapons of Mass Destruction (Chemical, Biological, Radiological and Nuclear) threats and are consistent with the purpose of the SBIR Program. SBIR Topics reflect the current strategic priorities where small businesses are believed to have capabilities to address challenging technical issues. DTRA supports efforts to advance manufacturing technology through the SBIR program, where the challenges of such technology are inherent to technical issues of interest to the agency.

The approved FY 16.2 topics solicited for the Defense Threat Reduction Agency (DTRA) Small Business Innovation Research (SBIR) Program are listed in the Topic Index in this instruction. Offerors responding to this Solicitation must follow all general instructions provided in the Department of Defense (DoD) Program Solicitation. Specific DTRA requirements that add to or deviate from the DoD Program Solicitation instructions are provided below with references to the appropriate section of the DoD Solicitation.

For technical questions about specific topics during the Pre-Release period (22 April 2016 to 22 May 2016), contact the DTRA Technical Point of Contact (TPOC) for that specific topic. To obtain answers to technical questions during the formal Solicitation period, visit https://sbir.defensebusiness.org/. For general inquiries or problems with the electronic submission, contact the DoD Help Desk 1-800-348-0787 (Monday through Friday, 9:00 a.m. to 6:00 p.m. Specific questions pertaining to the DTRA SBIR Program should be submitted to:

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PHASE I PROPOSAL GUIDELINES

The TPOC leads the evaluation process of all proposals submitted for their topics. In this process, DTRA will make a determination as to whether the proposal is relevant to the topic solicited. Only relevant proposals will be evaluated against further criteria. DTRA will evaluate Phase I proposals using the criteria specified in section 6.0 of the DoD SBIR Program Solicitation during the review and evaluation process. The criteria will be in descending order of importance with technical merit being the most important, followed by qualifications, and followed by the commercialization potential. With other factors being equal, cost of the proposal may be included in the evaluation. DTRA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. Phase I contracts are limited to a maximum of $150,000 over a period not to exceed seven months. DTRA anticipates funding one or possibly two SBIR Phase I contracts to small businesses for each topic.

The DoD SBIR/STTR Proposal Submission system (https://sbir.defensebusiness.org/) provides instruction for preparation and submission of your proposal. Refer to section 5.0 at the front of this solicitation for detailed instructions and the Phase I proposal format. You must include a Company Commercialization Report (CCR) as part of each proposal you submit. If you have not updated your commercialization information in the past year, or need to review a copy of your report, visit the DoD SBIR/STTR Proposal Submission site. Please note that improper handling of the Commercialization

Report may have a direct impact on the review and evaluation of the proposal (refer to section 5.4.e of the DoD Solicitation).

Proposals addressing the topics will be accepted for consideration if received no later than the specified closing hour and date in the solicitation – **6:00 a.m. ET, Wednesday, 22 June 2016.** The Agency requires your entire proposal to be submitted electronically through the DoD SBIR/STTR Proposal Submission Web site (https://sbir.defensebusiness.org/). A hardcopy is NOT required and will not be accepted. Hand or electronic signature on the proposal is also NOT required.

DTRA has established a **20-page limitation** for Technical Volumes submitted in response to its topics. This does not include the Proposal Cover Sheets (pages 1 and 2, added electronically by the DoD submission site), the Cost Volume, or the Company Commercialization Report. The Technical Volume includes, but is not limited to: table of contents, pages left blank, references and letters of support, appendices, key personnel biographical information, and all attachments. DTRA requires that small businesses complete the Cost Volume form on the DoD Submission site versus submitting it within the body of the uploaded volume. Proposals are required to be submitted in Portable Document Format (PDF), and it is the responsibility of submitters to ensure any PDF conversion is accurate and does not cause the Technical Volume portion of the proposal to exceed the 20-page limit. **Any pages submitted beyond the 20-page limit, will not be read or evaluated.** If you experience problems uploading a proposal, call the DoD Help Desk at 1-800-348-0787, from 9:00 a.m. to 6:00 p.m. Eastern Time, Monday through Friday.

Companies should plan carefully for research involving animal or human subjects, biological agents, etc. (see sections 4.7 - 4.9). The few months available for a Phase I effort may preclude plans including these elements unless coordinated before a contract is awarded.

If the offeror proposes to use a foreign national(s) – refer to sections 3.5 and 5.4.c (8) in the DoD Solicitation for definitions and reporting requirements. Please ensure no Privacy Act information is included in this submittal.

PHASE II PROPOSAL GUIDELINES

Small business concerns awarded a Phase I contract will be permitted to submit a Phase II proposal for evaluation and potential award selection. The Phase II proposals must be submitted NLT 30 days AFTER the end of the period of performance of the Phase I effort.

All SBIR Phase II awards made on topics from solicitations prior to FY 13 will be conducted in accordance with the procedures specified in those solicitations.

DTRA is not responsible for any money expended by the proposer prior to contract award.

All Phase I awardees may apply for a Phase II award for their topic.

Phase II proposals will be reviewed for overall merit based upon the criteria in section 8.0 of this solicitation and will be similar to the Phase I process. The TPOC leads the evaluation process of all proposals submitted in their topics. DTRA will evaluate Phase II proposals using the criteria specified in section 8.0 of the DoD SBIR Program Solicitation during the review and evaluation process. The criteria will be in descending order of importance with technical merit being the most important, followed by contractor's qualifications, and followed by the commercialization potential. With other factors being equal, cost of the proposal may be included in the evaluation. DTRA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

SBIR Phase II proposals have 4 sections: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. As instructed in section 5.4.e of the DoD SBIR Program Solicitation, the CCR is generated by the submission website based on information provided by you through the "Company Commercialization Report" tool.

PUBLIC RELEASE OF AWARD INFORMATION

If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released via the Internet. Therefore, do not include proprietary or classified information in these sections. For examples of past publicly released DoD SBIR/STTR Phase I and II awards, visit https://sbir.defensebusiness.org/resources.

TECHNICAL ASSISTANCE

In accordance with the Small Business Act (15 U.S.C. 632), DTRA will authorize the recipient of a Phase I SBIR award to purchase technical assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on-line data bases, for the purpose of assisting such concerns as:

- making better technical decisions concerning such projects;
- solving technical problems which arise during the conduct of such projects;
- minimizing technical risks associated with such projects; and
- developing and commercializing new commercial products and processes resulting from such projects.

If you are interested in proposing use of a vendor for technical assistance, you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one-page description of the vendor you will use and the technical assistance you will receive. The proposed amount may not exceed $5,000 and the description should be included as the LAST page of the Technical Volume. This description will not count against the 20-page limit and will NOT be evaluated. Funding of the Technical Assistance will be in addition to the proposed R&D costs. Approval of technical assistance is not guaranteed and is subject to review of the contracting officer.

DECISION AND NOTIFICATION

DTRA has a single Evaluation Authority (EA) for all proposals received under this solicitation. The EA either selects or rejects Phase I and Phase II proposals based upon the results of the review and evaluation process plus other considerations including limitation of funds, and investment balance across all the DTRA topics in the solicitation. To provide this balance, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Following the EA decision, DTRA SBIR will release notification e-mails for each accepted or rejected offer. E-mails will be sent to the addresses provided for the Principal Investigator and Corporate Official. Offerors may request a debriefing of the evaluation of their not selected proposal and should submit this request via email to dtra.belvoir.J9.mbx.sbir@mail.mil and include "SBIR 16.2 Topic XX Debriefing Request" in the subject line. Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the EA decision.

For selected offers, DTRA will initiate contracting actions which, if successfully completed, will result in contract award. DTRA Phase I awards are issued as fixed-price purchase orders with a maximum period of performance of seven-months. DTRA may complete Phase I awards without additional negotiations by the contracting officer or opportunity for revision for proposals that are reasonable and complete.

DECISION AND NOTIFICATION

DTRA does not utilize a Phase II Enhancement process. While funds have not specifically been set aside for bridge funding between Phase I and Phase II, the potential offeror is advised to read carefully the conditions set out in this solicitation.

E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DTRA SBIR 16.2 Topic Index

DTRA162-001	Machine learning for standoff detection of Special Nuclear Material (SNM)
DTRA162-002	Bioinformatics: Data Integration for Biomonitoring Applications
DTRA162-003	Alternative Signature Detectors for Long Range Nuclear Material Identification
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DTRA162-005	Data-Driven Technology Discovery Methodologies
DTRA162-006	Advanced Solutions for Radiation Susceptibility Analysis & Prediction
DTRA162-007	Portable, Fieldable, Non- Helium-3 Based Neutron Multiplicity Counter

DTRA SBIR 16.2 Topic Descriptions

DTRA162-001 TITLE: Machine learning for standoff detection of Special Nuclear Material (SNM)

TECHNOLOGY AREA(S): Information Systems, Nuclear Technology, Sensors

OBJECTIVE: Develop a learning algorithm to use in conjunction with current spectral algorithms.

DESCRIPTION: Within the US Government, there are several select agencies with the task to detect the presence of SNM without revealing the search activity or the means of detection. This greatly limits the searcher's dwell time, the proximity of the searcher to the threat source, and the ability of the searcher to make multiple passes. Advances in this research would also benefit First Responders, Preventive Radiological Nuclear Detection (PRND) units, and General Purpose forces.

GENERAL REQUIREMENTS: DTRA/J10CE is interested in exploring the feasibility of using machine learning for standoff detection of SNM. This learning algorithm could be used in conjunction with gamma spectral algorithms in order to greatly improve performance. The learning algorithm could either be integrated into a given gamma spectral algorithm or be designed to work on its own. Instead of template matching or anomaly triggers, the learning algorithm could look for correlations within the gamma spectrum itself. Triggers could be learned and created by feeding the algorithm data sets and giving it feedback between benign and significant gamma alarms. The goal of this project is to create a learning algorithm that produces alarm criteria that the searcher would otherwise never see. For this project, J10CE will provide its Algorithm IPT data set. The Performer could then inject their synthetic data (for training) into this background data set.

PHASE I: Analyze and interpret search data. Develop a list of potential algorithms to evaluate. Demonstrate potential algorithms on a real or created data set.

PHASE II: Down-select from the list of potential algorithms. Write applications (or modules) that implement the algorithms in Java or Java Virtual Machine compliant language that can be run on the latest Android OS in order to support current R/N search sensors.

PHASE III DUAL USE APPLICATIONS: Incorporate selected algorithms beyond DTRA/J10CE to the US Government and Industry.

REFERENCES:
1. Radiation Detection Measurement, Third Edition, Glenn Knoll, New Jersey, 2000

KEYWORDS: machine learning, algorithm, standoff detection, SNM, gamma spectrum, search, PRND

DTRA162-002 TITLE: Bioinformatics: Data Integration for Biomonitoring Applications

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: The present topic seeks computational approaches that "mine" publicly available microbiome data to identify changes in natural soil-borne communities which can be uniquely and predictably associated with environmental presence of ionizing radiation, radioisotopes including those in the actinide series, heavy metals, and/or process chemicals associated with nuclear activities.

DESCRIPTION: Unilateral monitoring for nuclear activities in the post-Cold War era demands new strategies in light of what represents an unconventional threat. Current technologies are ill-suited for non-permissive environments where long periods of observation are required and telling events may be ephemeral. Further, they are

reliant upon key signatures which can be lost due to meteorological events and geochemical cycling. Of greater utility for the present purpose are monitoring approaches which provide near- to mid-field access to sites of potential interest and whose informational content is retained even when the original signatures are no longer present. Biological systems could fulfill such a role.

Biological systems are strongly reactive to the presence of pollutants in the environment and exhibit characteristic changes when exposed to specific classes. Biological sentinels thus are used routinely to track the health of "at risk" ecosystems, and associated information such as genomic and proteomic data are often archived in public repositories. Computational approaches can be used to analyze patterns (or lack thereof) in the wealth of available data in order to establish a valid starting point for evaluating impacts of contamination at a given site [1]. The increasingly more sophisticated algorithms developed to support bioinformatics can be used to interrogate indigenous organisms from sites of interest and determine whether there are distinctive changes which may be definitively and predictably linked to the presence of contamination whether or not it is still present [2].

Of particular utility are flora that inhabit routinely-sampled matrices. Soil, sediment, and water host a variety of microscopic life forms ("microbiomes") for which genomic, biochemical, and trait-based data are already accessible [3]. Microbiomes are composed of thousands of microbial species intricately linked to the health and functioning of systems in which they reside, and community composition is a consequence of the dynamic interplay between the resident species and the local environment [4]. Environmental changes can induce selective pressures which result in notable shifts to species composition and density as well as expression of characteristic traits (e.g., particular protein isoforms) even where the specific taxa may vary from site-to-site [5]. End-state community structure can be somewhat predictable, given the nature of the exogenous stressor, as is demonstrated, e.g., by interrogation of uranium mine tailings [6], industrial areas [7], and other contaminated environmental matrices [8, 9,10]. Certain genera and, in some cases species, are characteristically present in predictable relative proportions or communities exhibit functional similarities. Further proof-of-concept is available in the biomedical realm, where health conditions such as liver disease are associated with the presence of particular gut microbiome constituencies [11].

The present topic seeks development of robust computational tools to explore the phylogenetic and functional characteristics of microbial communities in natural soils contaminated by ionizing radiation, radioisotopes including those in the actinide series, heavy metals, and/or process chemicals from nuclear activities. The overarching goal is to demonstrate that soil microbiomes tend to converge upon a particular community constituency and/or functional state given the chronic or episodic presence of contamination and that the state is predictable. Ideally, algorithms developed to address the need described herein would be applicable to the evaluation of other microbiomes to similarly elucidate predictability of resident communities given a certain condition and thus could be used in biomedical, forensic, and other applications. The research is intended to produce a coarse-grained analytical method that guides more refined site assessments.

PHASE I: Proposed efforts should be purely computational and should make use of existent datasets available in archives such as QIME, MG-RAST, NCBI, and EBI. Proof-of-concept will be provided by demonstrating that the bioinformatics approach(es) developed for the application described herein can be applied to a small, well-defined dataset where the environmental parameter space can be accurately circumscribed. To support proof-of-concept, use of "model system" contaminated sites (e.g., Chernobyl) is acceptable, although the Phase II end-state goal is to support analysis of soil microbiomes where exposures may be low level chronic or episodic in nature. Sources of variation, including those associated with environmental variability, sample collection and archival, technical protocols, and analytical methods, should be taken into account. Likewise, sample sizes and controls should be adequate and appropriate to support meaningful statistical analysis and lay the foundation for future efforts conducted in the same vein. Competitive proposals will include subject matter experts who fully understand the implications and limitations of including particular data in the model and will incorporate sensitivity analysis and risk mitigation plans. Proposals should explain methods that will be used or developed to quantify uncertainties. Applicants should delineate assumptions, including those associated with hypothetical cause-and-effect relationships between proposed community indicators (whether taxonomic or functional) and presence of soil-borne contamination. Likewise, ample rationale should be provided for selection of data types. Although deriving mechanistic understanding is not the intent of this topic, building predictive capacity will require reasonably educated conjecture regarding anticipated presence of particular taxa or functional groups. Phase I deliverables include (1) a final report and (2) the formatted dataset used to test developed algorithms. The report should supply the information requested above, describe model development including parameterization, and provide preliminary

results on model fidelity The report should also include plans for development of a user interface which will address Phase II expectations. Operating system, software (where applicable), and data compatibility should be specifically addressed, as should proposed location of the interface.

PHASE II: Phase II efforts will focus on iterative improvement to the approach developed during Phase I. Efforts will be expanded to include additional datasets and to evaluate the predictive power of the model in terms of establishing that community constituency (whether taxonomic or functional) is commonly, and preferably, uniquely associated with presence of particular contaminants. Validation datasets will be included in order to assess model fidelity and performance in terms of retroactively identifying contaminated sites. Feasibility of extending the method to other microbiome types and stressors to support additional applications (e.g., biomedical applications) should be evaluated. The phase II deliverables are a report detailing (1) description of the approach, including optimization techniques and outcomes, (2) testing and validation data, (3) advantages and disadvantages/limitations of the method, and (4) potential for application to other problem sets; the source code; and a user interface and any associated executables.

PHASE III DUAL USE APPLICATIONS: Identify and exploit features that would be attractive for commercial or other private sector applications such as conducting "forensics" analysis to support development of diagnostics and therapeutics for illnesses whose interrelation with the human microbiome has been established. Examples include high-impact diseases such as cardiovascular disease, colorectal cancer, Alzheimer's, ulcerative colitis, and periodontal disease.

REFERENCES:

1. Pylro VS et al. 2014. Brazilian microbiome project: revealing the unexplored microbial diversity—challenges and prospects. Microb Ecol 67:237-241.

2. Gilbert JA et al. 2010. Meeting report: the terabase metagenomics workshop and the vision of an Earth microbiome project. Standards in Genomic Sciences 3:243-248.

3. Xu Z et al. 2014. Bioinformatic approaches reveal metagenomics characterization of soil microbial community. PLOS ONE 9:1-11.

4. Goodrich et al. 2014. Conducting a microbiome study. Cell 158:250-262.

5. Martiny JBH et al. 2015. Microbiomes in light of traits: a phylogenetic perspective. Science 350:aa93231-aa93238.

6. Choudhary S, Pinaki S. 2010. Identification and characterization of uranium accumulation potential or a uranium mine isolated Pseudomonas strain. World J Microbiol Biotechnol 27:1795-1801.

7. Hookom M, Puchooa D. 2013. Isolation and identification of heavy metals tolerant bacteria from industrial and agricultural areas in Mauritius. Curr Res Microbiol Biotech 3:119-123.

8. Abulencia CB et al. 2006. Environmental whole-genome amplification to access microbial populations in contaminated sediments. Appl Environ Microbiol 72:3291-3301.

9. Sobolev D, Begonia MFT. 2008. Effects of heavy metal contamination upon soil microbes: lead-induced changes in general and denitrifying microbial communities as evidenced by molecular markers. Int J Environ Res Public Health 5:450-456.

10. Belozerkaya T et al. 2010. Characteristics of extremophylic fungi from Chernobyl Nuclear Power Plant. Nuclear Power Plant. Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology, Mendez-Vilas A. (ed.), 88-94, Vol. 1, Formatex Research Center: Badajoz, Spain.

11. Kuczynski J et al. 2012. Experimental and analytical tools for studying the human microbiome. Nature Rev Genet 13:47-58.

KEYWORDS: Bioinformatics, biomonitoring, microorganisms, soil microbiome, biological sentinel

DTRA162-003 TITLE: Alternative Signature Detectors for Long Range Nuclear Material Identification

TECHNOLOGY AREA(S): Nuclear Technology, Sensors

OBJECTIVE: To develop a method for identifying nuclear materials at distances over 100m through the detection of alternative signatures.

DESCRIPTION: Current technology can reliably identify radioactive materials at close range (<50m) through the detection of ionizing decay products (beta, gamma, neutron). However, detecting many nuclear materials (e.g. Pu, HEU) with conventional detectors at distances over a few meters is difficult due to shielding, geometric considerations, and the inherent long half-lives of the radionuclides. New research has shown the potential to detect these materials through alternative signatures. In particular, gamma and neutron radiation creates a unique ionization signature in the surrounding air that can be used to detect the presence of radioactive material.
This topic seeks proposals to exploit these alternative signatures to detect Special Nuclear Materials (SNM) at distances over 100m, far greater than current detection limits. Although detecting other mid-mass isotopes may also be of interest (60Co, 137Cs), this study should focus on fissile isotopes: 239Pu and 235U. Designs should demonstrate sensitivity to radioactive sources equivalent to strategic SNM levels: 5kg 235U or 2kg Pu. The total detection time should be on the order of a few minutes. This topic will not address methods of active interrogation using ionizing radiation.

PHASE I: A trade study should be conducted to assess the best detection method using alternative signatures. The study should address the signal size produced by critical quantities of SNM and demonstrate sensitivity to these signals from >100m. A proof of principle experiment should be carried out to demonstrate the chosen detection method's viability.

PHASE II: Phase II projects should develop a prototype device. Although not necessarily hand-held, the prototype should be man-portable and capable of being used in a field test. The device should demonstrate the detection of radionuclides from >100m standoff distances.

PHASE III DUAL USE APPLICATIONS: PHASE III: Based on successful Phase II results, the final product design should focus on minimizing device form factor and increasing ruggedness for use in the field.
DUAL USE APPLICATIONS: In addition to SNM detection for national security purposes, this technology could also be used for environmental monitoring.

REFERENCES:
1. Kumarasiri Konthasinghe, Kristin Fitzmorris, Manoj Peiris, Adam J. Hopkins, Benjamin Petrak, Dennis K. Killinger, and Andreas Muller. "Laser-Induced Fluorescence from N2+ Ions Generated by a Corona Discharge in Ambient Air." Appl. Spectrosc. 69, 1042-1046 (2015)

2. Erin T. McCole Dlugosz, Reginald Fisher, Aleksey Filin, Dmitri A. Romanov, Johanan H. Odhner, and Robert J. Levis. "Filament-Assisted Impulsive Raman Spectroscopy of Ozone and Nitrogen Oxides." The Journal of Physical Chemistry A 2015 119 (35), 9272-9280
DOI: 10.1021/acs.jpca.5b06319

KEYWORDS: Alternative Signatures, Standoff Detection, Nuclear Detection, SNM

DTRA162-004 TITLE: Novel approaches for supporting plan recognition

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: DTRA is seeking research in the area of plan recognition from unstructured text sources.

DESCRIPTION: The area of plan recognition encompasses a set of tasks that identifies and relates sequentially time-based observed actions of an entity to a specified objective. Plan recognition presents a complex, multi-discipline challenge to elements of the Department of Defense as it incorporates human factors analysis for anticipatory analysis and modeling the goals of adversaries and machine learning in environments lack of information and uncertainty. This topic is of particular relevance for DTRA in the area of counter-proliferation.

Technical and challenges in plan recognition include: detecting and understanding complex speech acts; inferring changes in goals based on changes in plans; plan detecting based on layering multiple inference layers lossy data from intermittent interruptions; and identifying the temporal conditions. Other technical challenges relate to the generalizability of plan recognition across domains (e.g., plan recognition of a chemical event as opposed to a biological event or sub-events) and the temporal details of events in identifying plan elements and sequentially ordering them in the context of composing an adversary's plan and characterizing technical progress. At a system-level, technical challenges include the generalizability of the plan recognition systems into to other domains. Technical areas of interest include: Improvements over the state of the art in formal representation (logic-based rules) for plan recognition; natural language processing research related to the identification of task-oriented dialogues and sub-dialogues and understanding speech actions as they pertain to goal-directed behavior; hypothesis generation and co-reference of goal-directed behaviors across multiple data sets of disparate provenance; and abnormalities in plan formulation such as deception or changes in plans due to external stimuli. Respondents would propose novel research topics in response to one, but ideally, multiple technical areas of interest.

PHASE I: Investigate and identify plan recognition approaches and demonstrate proof of concept.

PHASE II: Develop and demonstrate a plan recognition prototype, test against identified plans and labeled data and integrate with current modeling capabilities. Characterize performance levels and assess utility to user-centric tasks in the context of evaluations that involve real data and operationally-relevant scenarios.

PHASE III DUAL USE APPLICATIONS: Plan recognition algorithms demonstrated and proven in operational settings would be valuable in a wide range of potential applications including law enforcement, counter-terrorism and counter international human-trafficking.

REFERENCES:
1. Carberry, S. (2001). Techniques for plan recognition. User Modeling and User-Adapted Interaction, 11(1-2), 31-48.

2. Litman, D. J., & Allen, J. F. (1987). A plan recognition model for subdialogues in conversations. Cognitive science, 11(2), 163-200.

3. Goldman, R. P., Geib, C. W., Kautz, H., & Asfour, T. (2011). 3.27 Coupling Plan Recognition with Plan Repair for Real-Time Opponent Modeling. Plan Recognition, 19.

4. Schmidt, C. "Introduction to Plan Recognition". Rutgers University. Retrieved from: http://www.rci.rutgers.edu/~cfs/472_html/Planning/PlanRecog.html accessed on 12/5/2014.

KEYWORDS: NLP, plan recognition, modeling, adversarial planning, logic-based rules, formal representation, goals, intention

DTRA162-005 TITLE: Data-Driven Technology Discovery Methodologies

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop sustainable and scalable data-driven methodologies to discover emerging or disruptive technologies before they have an innovative impact on WMD and the CWMD mission space. Employing discovery methodologies will enable continuous horizon scanning, and drive technology forecast analysis and reporting to assist the CWMD community of interest (CoI) in avoiding technological surprise.

DESCRIPTION: DTRA's R&D Directorate (J9) is seeking repeatable and scalable data-driven methodologies that will support a distributed technology forecasting framework for the discovery of emerging or disruptive technologies that may impact an adversary's WMD capabilities or the CWMD mission space in the two- to ten-year timeframe.

Current ad-hoc discovery efforts commonly leverage subject matter expertise to identify technologies of interest. These approaches are dependent on the span of knowledge of the individuals involved and limit the breadth of the discovery effort.

Data-driven approaches of interest to DTRA are anticipated to use tools for data collection, data correlation and trend identification to identify and highlight novel, emerging, and/or disruptive technologies. Initial emphasis will be placed on focused data-driven discovery – intended to assess a known technology or technology area – and aim at investigating the potential application of the technology within the WMD mission space. DTRA then intends to broaden the data-driven discovery process, using more of an "unknown / wide-lensed" aperature-based approach to discovery so that emerging technologies without obvious impact on the CWMD mission space might also be captured.

PHASE I: Develop a methodology for focused, data-driven discovery of emerging or disruptive technologies and execute a proof of concept deployment of the capability.
Effectiveness will be based on demonstration of the viability of the proposed methodology and the generation of initial outputs permitting further research or analysis on a known technology or technology area. As the challenges within the CWMD mission space range from nuclear, chemical and biological threats, Phase I vendors are encouraged to concentrate on discovery of emerging technologies relevant to future biological weapons threats.

PHASE II: This phase will consist of two components.

First, the vendor will fully deploy the Phase I developed methodology to discover technologies across the entire WMD spectrum and generate insights of interest to drive further analysis leading to a Technology Forecast to be produced by DTRA personnel.

Second, the vendor will expand the Phase I focused discovery to a broad, data-driven discovery methodology. Leveraging lessons learned from Phase I, the vendor is expected to prove the feasibility of evolving the capability to allow wide-aperture discovery of unknown emerging or disruptive technologies that may impact the CWMD mission space.

PHASE III DUAL USE APPLICATIONS: The contractor will deploy the complete methodology (with focused and broad functionalities) to provide scalable and sustainable horizon scanning services to DTRA J9. The final product will have potential commercial applications beyond DTRA, including other organizations within the CWMD CoI and other government agencies engaged in CWMD efforts.

KEYWORDS: Data, Analytics, Technology Forecast, Horizon Scanning, Emerging Technologies, Threat

DTRA162-006 TITLE: Advanced Solutions for Radiation Susceptibility Analysis & Prediction

TECHNOLOGY AREA(S): Electronics, Materials/Processes, Nuclear Technology, Space Platforms, Weapons

OBJECTIVE: Support the development of radiation susceptibility analysis and prediction capabilities in defense systems to reduce the design risks, schedules and overhead while resulting in significant savings in costs and high reliability radiation tolerant microelectronics for DoD missions.

DESCRIPTION: Reliable radiation tolerant microelectronics in modern technology nodes is critical to DoD missions. Development, however, is challenging, costly and requires long design cycles. The effectiveness of the radiation mitigation capabilities is only assessed after a device is manufactured adding significant risk to system development. As the vulnerability of microelectronics to radiation effects increases with modern technology, so does the challenge of implementing radiation tolerance in a strategic manner. Significant feature overhead in both the microelectronic device and supporting system is often necessary; furthermore, there is a limiting effect on the potential performance of a device relative to the capabilities of the technology used for implementation. There is a critical need for efficient approaches/capabilities for radiation susceptibility analysis and prediction that would enable developers to apply the appropriate amount of radiation mitigation to a design and, more importantly, help predict the resiliency of hardened microelectronics prior to device manufacturing.

Assessing radiation effects in microelectronics prior to fabrication currently broadly falls in to two approaches: physics based modeling simulations and fault injection simulations. Neither approach is suitable for assessing or predicting radiation effects on the scale of an entire microelectronics chip design. With both approaches, it is necessary to fabricate and test a design in a radiation environment to assess the performance of any implemented mitigation strategies. Furthermore, these approaches lack a direct means for reliable, direct correlation of the resiliency performance for a fabricated design to the effectiveness and contribution of specific mitigation implementations applied to specific regions of said design.
Of particular interest to this solicitation are new and efficient approaches capable of providing radiation susceptibility analysis and prediction for an entire microelectronic chip while using reasonable computing resources and within acceptable processing delays.

PHASE I: Demonstrate the feasibility of elements for a radiation susceptibility analysis and prediction capability through the development of a very basic radiation susceptibility and prediction compute platform. The outcome of the Phase I would include 1) Development of a basic analytical assessment classifier, 2) Design of a basic strike model library, 3) Development of a basic susceptibility classifier and 4) Integration of a basic radiation susceptibility and prediction accelerator.

PHASE II: Demonstrate a prototype level of a radiation susceptibility analysis and prediction compute platform capable of processing a full chip design. The outcome of Phase would include 1) Optimization of the analytical assessment classifier built in Phase I to increase and optimize processing throughput, 2) Development of abstraction modeling coupons to provide the necessary parameterization, 3) Development of the technology abstraction library and strike model library, 4) Optimization of the strike model library developed in Phase I by leveraging the feedback data provided with testing the abstraction modeling coupons and 5) Development of a susceptibility classifier and integration of a radiation susceptibility analysis and predictor accelerator into a prototype level and fully integrated. The Radiation susceptibility results of a full chip design will be compared to the results obtained by the radiation susceptibility analysis and prediction platform.
Industry and government partners for Phase III must be identified along with demonstration of their support. A roadmap that takes the program through Phase III must be part of the final delivery for Phase II.

PHASE III DUAL USE APPLICATIONS: Development and optimization of the radiation susceptibility analysis and prediction platform capability to commercial tool/services available and to DoD USERS.

REFERENCES:
1. R. Baumann, “Radiation-induced soft errors in advanced semiconductor technologies,” Device and Materials Reliability, IEEE Transactions on, vol. 5, no. 3, pp. 305–316, 2005

2. Dodd, P.E. and L.W. Massengill, "Basic Mechanisms and Modeling of Single-Event Upset in Digital Microelectronics," IEEE Trans. Nucl. Sci., vol. 50, no. 3, pp.583-602, June 2003

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KEYWORDS: Nano-technology, Nuclear Technologies, Single-Event Effect, Total Ionization Dose, Radiation Hardened Microelectronics

DTRA162-007 TITLE: Portable, Fieldable, Non- Helium-3 Based Neutron Multiplicity Counter

TECHNOLOGY AREA(S): Electronics, Nuclear Technology, Sensors

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

OBJECTIVE: To develop a portable, fieldable neutron multiplicity counter based on non-Helium-3 neutron detection technology. A Helium-3 replacement medium would have similar or better performance in the key areas of neutron detection efficiency and gamma-rejection while minimizing dead-time and double-pulsing. A new medium should also permit comparable or better size, weight, and power consumption to existing Helium-3-based systems.

DESCRIPTION: DTRA seeks to develop a neutron multiplicity counter based on non- Helium-3 neutron detection technology. A neutron multiplicity counter does not simply record that a neutron was counted, but also when. To be an effective medium when applied to neutron multiplicity counting, detection efficiency is of paramount importance. The threshold neutron absolute detection efficiency is 0.5% for either bare Cf-252 source or Cf-252 source with 1" polyethylene shield at 50 cm distance. At the same time, gamma-rays must be rejected and the twin toxic effects of double- pulsing (where a single neutron gets counted as two) and dead-time (any period after a neutron is counted when the detector is blind) must be thoroughly abated. The detector shall be insensitive to gamma-rays in 1 R/hr Ba-133 gamma field and shall be able to operate in presence of low dose radiography X-ray equipment (e.g. XRS-3@ 8 ft). A timing resolution on the order of tens of nanoseconds or less would also be highly desirable. The electronics shall be able to support data rate up to 500,000 neutron counts per second. Any Helium-3 replacement needs to permit construction of a rugged instrument for field-use that is physically robust, insensitive to adverse environmental conditions[1], and has reasonable size, weight, and power consumption. The detector shall be able to operate on battery power for a continuous 10 hours period at 20 ºC and capable of running from AC power. The charging time for rechargeable battery shall be less than 6 hours and the battery compartment shall be accessible without special tools. The detector shall be able to fit through an 18 inch opening, weighs less than 50 lb, and support removable Cadmium or Gadolinium shielding for optimal configuration.

PHASE I: Identify key operational components and develop the initial design of the multiplicity counting instrument. Extensive modelling studies must be performed to demonstrate detector sensitivity, meet the physical, power consumption, timing resolution and data rate requirements. Demonstrate pathways to meeting performance goals in Phase II.

PHASE II: Develop a prototype instrument that accomplishes the goals described above. The instrument shall not be dependent on post-acquisition analysis of data. Typical multiplicity counting requires list-mode data acquisition. Demonstrate the neutron multiplicity counting capability equivalent to the most advanced portable multiplicity counter based on Helium-3.

PHASE III DUAL USE APPLICATIONS: Team up with national laboratories or commercial partners to develop a commercial instrument, for military applications of interest to DTRA as well as domestic applications (FBI, Department of Energy, etc) to support missions responding to an improvised nuclear device (IND) deployed by adversaries using irregular means.

REFERENCES:

1. MIL-STD-810G, Environmental Engineering Considerations and Laboratory Tests.

KEYWORDS: Portable, field useable, neutron multiplicity counter