DEFENSE THREAT REDUCTION AGENCY
SBIR FY08.2 Proposal Submission

The mission of the Defense Threat Reduction Agency (DTRA) is to safeguard the United States and its allies from weapons of mass destruction (chemical, biological, radiological, nuclear and high-yield explosives) by providing capabilities to reduce, eliminate and counter the threat and mitigate its effects. This mission includes research and development activities organized into chemical/biological, nuclear, WMD counter-force, and systems engineering technology portfolios. From these activities, DTRA administers two SBIR programs. One is affiliated with the Chemical-Biological Defense Program and appears as a separate component under this solicitation. The other is drawn from the nuclear, WMD counter-force, and systems engineering portfolios and is described herein. Communications for this program should be directed to:

Defense Threat Reduction Agency
ATTN: Lt Col John Kelley, SBIR Program Manager
8725 John J. Kingman Drive, MSC 6201
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Use of e-mail is encouraged.

The DTRA SBIR program complements the agency's principal technology programs to detect/locate/track WMD; interdict or neutralize adversary WMD capabilities; protect against and restore following WMD use; attribute parties responsible for WMD attacks; and provide situational awareness and decision support to key leaders. 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 SBIR, where the challenges of such technology are inherent to technical issues of interest to the agency.

PROPOSAL PREPARATION AND SUBMISSION

Proposals (consisting of coversheets, technical proposal, cost proposal, and company commercialization report) will be accepted only by electronic submission at http://www.dodsbir.net/submission/. Paragraph 3.0 of the solicitation (http://www.dodsbir.net/solicitation/) provides the proposal preparation instructions. Consideration is limited to those proposals that do not exceed $100,000 and six months of performance. The period of performance may be extended up to six additional months following award, but such extensions may delay consideration for Phase II proposal invitation. Proposals may define and address a subset of the overall topic scope. Proposals applicable to more than one DTRA topic must be submitted under each topic.

PROPOSAL REVIEW

During the proposal review process employees from BRTRC, Inc. and Northrop Grumman Information Technology (NGIT) will provide administrative support for proposal handling and will have access to proposal information on an administrative basis only. Organizational conflict of interest provisions apply to these entities and their contracts include specifications for non-disclosure of proprietary information. All proposers to DTRA topics consent to the disclosure of their information to BRTRC and NGIT employees under these conditions.

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DTRA will evaluate Phase I proposals using the criteria specified in paragraph 4.2 of the solicitation with technical merit being most important, followed by principal investigator qualifications, and commercialization potential. Topic Points of Contact (TPOC) lead the evaluation of all proposals submitted in their topics.

SELECTION DECISION AND NOTIFICATION

DTRA has a single source selection authority (SSA) for all proposals received under one solicitation. The SSA either selects or rejects Phase I proposals based upon the strengths and weaknesses identified in proposal review plus other considerations including limitation of funds and balanced investment across all the DTRA topics in the solicitation. Balanced investment includes the degree to which offers support a manufacturing technology challenge. To balance investment across topics, 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 SSA decision, the contracting officer will release notification e-mails through DTRA's SBIR evaluation system 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 proposal. Debriefings would be viewable at https:\\www.dtrasbir.net\debriefing\ and require password access. 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 SSA 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 6-month period of performance that may be extended, as previously discussed. DTRA may complete Phase I awards without additional negotiations by the Contracting Officer or opportunity for revision for proposals that are reasonable and complete.

DTRA's projected funding levels support a steady state of 14 Phase I awards annually. Actual number of awards may vary.

DTRA Phase I awards for this solicitation will be fully funded with FY09 appropriation available on or after October 1st, 2008. Awards will be subject to availability of those funds. DTRA manages SBIR as an ongoing program and does not classify individual Phase I awards as new program starts for the purpose of Continuing Resolution Authority.

CONTINUATION TO PHASE II

Only Phase II proposals provided in response to a written invitation from a DTRA contracting officer will be evaluated. DTRA invitations are issued based on the degree to which the offeror successfully proved feasibility of the concept in Phase I, program balance, and possible duplication of other research. Phase II invitations are issued when the majority of Phase I contracts from the preceding solicitation are complete, typically early spring. Phase I efforts which were delayed in award or extended after award will be considered for invitation the following year.

DTRA's projected funding levels support a steady state of 7 new Phase II awards annually to meet an objective of continuing approximately 50 percent of Phase I efforts to Phase II. Actual number of awards may vary.

OTHER CONSIDERATIONS

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, DTRA does not preclude FAST TRACK Phase II awards, and the potential offeror is advised to read carefully the conditions set out in this solicitation.

Notice of award will appear first in the Agency Web site at http://www.dtra.mil. Unsuccessful offerors may receive debriefing upon written request only. E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DTRA SBIR 082 Topic Index

DTRA SBIR 082 Topic Descriptions

DTRA082-001 TITLE: The Characterization and Mitigation of Radiation Effects on Nano-technology Microelectronics

TECHNOLOGY AREAS: Sensors, Electronics, Space Platforms, Nuclear Technology

OBJECTIVE: The objectives of this task include:
1. Characterization of both ionizing and displacement damage radiation effects in nano-technology microelectronics to include, but not be limited to, Metal Oxide Semiconductor (MOS) ultra-deep submicron (< 90nm) silicon based circuits, silicon-germanium quantum functional circuits, compound semiconductor technologies, carbon nanotube, nanocrystal and quantum dot based technologies.
2. Development and demonstration of minimally invasive methods to mitigate radiation effects for these technologies, to include both digital and analog/mixed-signal applications.
3. Development and validation of system design science approaches to mitigate radiation induced faults.

The successful outcome of this task will support the use of ultra-deep submicron integrated circuits in DoD satellite systems that will result in very significant savings in weight, power and reliability for systems that include Space Radar, Space Tracking and Surveillance Systems, Transformational Satellite Communications System (TSAT) and others. Each new generation of microelectronics results in performance benefits that include > 2X in integration density, > 4X in power savings and > 2X in operating speed making possible very significant improvements in system capabilities.

In addition, this task will also support the use of compound semiconductor technologies (e.g. Antimony Based Compound Semiconductors, Indium Phosphide, and others) in these systems and their introduction into advanced spacecraft and missile systems with similar savings in both power and weight and coupled with increased performance.

DESCRIPTION: Current satellite systems are fabricated using a mix of commercial and radiation hardened circuits. However, the use of advanced commercial integrated circuits devices results in added complexity to mitigate radiation effects that can result in the mis-operation and/or destruction of devices. In many cases, the penalties in increased power, area, weight and added circuit complexity out-weigh any potential benefits and preclude the use of the advanced commercial technology. Moreover, these technologies have demonstrated a sensitivity to radiation effects.

The present methods to mitigate radiation effects, while proven to be effective at circuit geometries > 150nm silicon based technology, have been shown to be less effective when applied to integrated circuit feature sizes below 100nm silicon based and compound semiconductor technologies. In addition, the introduction of new technologies, e.g. quantum function circuits, will require the development of new mitigation approaches.

Thus, if minimally invasive methods such as the use of alternative materials, circuit enhancements, and other innovative approaches could be developed to reduce radiation effects sensitivity these devices could be used with little or no penalties.

Therefore, the basic approach to accomplish this task would be to leverage commercial microelectronics at the < 90nm nodes and augment these technologies with radiation mitigation techniques that would have minimal impact on the electrical performance and manufacturability. This same approach also applies to the radiation hardening of the compound semiconductor and other technologies.

Additionally, the development of such methods requires the development of cost effective methods to model and simulate the radiation response of these < 90nm, compound semiconductor and other technologies. Without a robust modeling and simulation capability it would be both technically and economically unfeasible to develop these mitigation methods.

PHASE I: Identification of minimally invasive methods, including material approaches, to mitigate radiation effects in < 90nm microelectronics technologies, III-V, SiGe and other materials systems. Development of cost effective radiation effects modeling and simulation methods for < 90nm microelectronics, compound semiconductor and other technologies for digital and analog/mixed-signal microelectronics applications. Identification of design science approaches to mitigate radiation effects.

PHASE II: Electronic Design Automation tools (programs) that can:
- Identify design sensitivities in complex integrated circuits.
- Design radiation insensitive integrated circuits.
- Perform trade studies to provide optimized integrated circuits with respect to radiation and electrical performance.
- Analyses the radiation response of complex integrated circuits

Technology Computer Aided Design (TCAD) tools that can:
- Provide cost effective 3-D models to support the simulation of the radiation response of nanotechnology microelectronics.
- Identify radiation sensitivities at the transistor level.

Mixed-Mode and Level Simulation systems that can effectively couple the radiation response at the transistor level to higher levels of circuit and subsystem integration (e.g. transistor response to small circuit to complex circuit to sub-system) to support the accurate radiation response simulation up to and including the sub-system level. Radiation effects Product Design Kits (PDK) that combine the electrical and radiation response design and modeling parameters for a specific technology. PDKs are provided by semiconductor manufacturers to their customers to support design activities. In general a semiconductor manufacturer will develop an electrical performance and design PDK that must be then augmented with radiation performance to support customers that require the technology to be used in a radiation environment. Development and demonstration of < 90nm radiation effects modeling and simulation methods for these technologies. Development and demonstration of design science approaches for radiation effects mitigation.

PHASE III: Dual use applications. Use of the mitigation, modeling and simulation methods developed through this effort to support the use of advanced microelectronics for terrestrial applications such as very high performance microprocessor, advanced servers, and very large cache memories.

REFERENCES:
1. IEEE Transactions on Nuclear Science; December 2007, Volume 54, Number 6, Session H: Single Event Effects Mechanisms and Modeling, pages 2297 - 2425.

2. IEEE Transactions on Nuclear Science; December 2005, Volume 52, Number 6, Session A Single Even Effects: Mechanisms and Modeling, pages 2104-2231.

3. IEEE Transactions on Nuclear Science; December 2005, Volume 52, Number 6, Session F Single Even Effects: Devices and Integrated Circuits, pages 2421-2495.

4. JEDEC 57, SEE Test and Characterization Guidelines and Test Method.

5. Military Test Method 1019, Steady State Total Ionizing Dose.

6. ASTM 1892 – Steady State Total Ionizing Effects Guideline.

KEYWORDS: Single-Event Effects, Single-Event Upset, Single-Event Transients, Total Ionizing Dose, Displacement Damage, nano-technology.

DTRA082-004 TITLE: <u>Alternative Detection Approaches for Nuclear Materials</u>

TECHNOLOGY AREAS: Nuclear Technology

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 alternative means for stand-off detection of radiological, and specifically fissile materials through their effects on, or interactions with, the environment. Potential approaches include, but are not limited to: electrostatic, thermodynamic, fluorescent, spectroscopic, magnetic or radiological.

DESCRIPTION: In DTRA's efforts to counter nuclear and radiological threats, sources must be located, classified and identified. Traditional approaches based on the detection of primary radiation from fissile or radiological material are approaching full exploitation and theoretical gains in standoff range and sensitivity are inherently limited. Alternative technologies are sought which will have significant advantage in standoff range and sensitivity or provide significant advantages in available deployment environments or time frames.

Proposals are sought to provide a capability rather than any specific technique. Some technological approaches which are potentially attractive include, but are not limited to, scintillation or fluorescence in surrounding materials, chemical analysis of surrounding materials or products of radioactivity, passive microwave, infrared or radar detection of SNM or the products of radioactivity through absorption or reflectance, laser induced fluorescence of products of radioactivity, thermal radiation signatures, or optically stimulated luminescence or thermoluminescence. Advantages of proposed work over current technologies, which can include increase in range, sensitivity, imaging, environment of use, or other clear advantage, should be outlined in proposal.

PHASE I: Determination of feasibility to perform as a stand-off sensor for nuclear materials.

PHASE II: Construction of a demonstration prototype.

PHASE III DUAL USE APPLICATIONS: Potential application of this technology include their use in the well-logging industry, medical imaging, and environmental monitoring.

REFERENCES:
1. Knoll, G.F. "Radiation Detection and Measurement" 2nd edition (1988).

2. Tsoulfanidis, N. "Measurement and Detection of Radiation" 2nd edition (1995).

KEYWORDS: alternative nuclear detection special nuclear fissile material

DTRA082-005 TITLE: High Fidelity Modeling of Building Collapse with Realistic Visualization of Resulting Damage and Debris

TECHNOLOGY AREAS: Information Systems, Materials/Processes, 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 a validated high fidelity physics based computational method to evaluate building performance and collapse under blast loading with the capability to show the resulting damage and debris fly-out in a realistic fashion. Key requirements for the developed method are: 1) sufficient fidelity to capture critical phenomena in building collapse and 2) an intelligent user friendly interface to allow practicing engineers to obtain accurate results faster than the current traditional high fidelity computational methods.

DESCRIPTION: The Defense Threat Reduction Agency (DTRA) seeks proposals for development of a high fidelity model for analysis of building collapse under blast loading. Realistic visualization of the damage and debris is an important aspect of the requirements in order to assess damage to Weapons of Mass Destruction (WMD) containers in a targeted building or to assess vulnerability of personnel and mission critical equipment in a protected facility.

Structural collapse under blast conditions involves an initially stable structure acted upon by gravity loads, followed by the imposition of blast loads (a relatively short duration event) which induce material and structural damage. The latter in turn, may lead to global structural instabilities which can result to the collapse of the original structure. Computational modeling of collapse entails three dimensional (3D) geometry, non-linear material and geometry, and highly dynamic events such as material breakup and ejection. In the past several decades the Finite Element Method (FEM) has been used successfully to model complex dynamic events including building collapse. FEM formulations have incorporated implicit, explicit or hybrid integration techniques to accurately model various phenomena in building collapse. To capture the results for visual presentations the FEM models typically run over the entire collapse event which may take several weeks to months of computer run time. Sophisticated mathematical formulations have been developed for more efficient computations and for fracture and breakup of materials. However, their proper implementation requires a highly educated and experienced scientist or engineer. Often times the results generated by the FEM model differ depending on the experience of the user with the FEM model of interest.

The extensive computation time and high level of expertise required to use existing FEM models for building collapse are barriers to wide use of the technology. To overcome these barriers an innovative computational method is sought that a practicing engineer can install on a single or dual processor personal computer and use it to model a collapse event within a couple of days of computer run-time. The ideal methodology should combine robust and time proven FEM formulations with more efficient integration methods and algorithms to keep track of material break up, flight and contact. To reduce the level of user expertise with the new computational method an intelligent and user friendly interface is sought that can generate the required models and process the results for video-like presentations within a short timeframe. The new method has to be able to model framed structures made of reinforced concrete and steel with curtain or in-fill walls and load bearing structures made of masonry, wood and steel with punched windows. Presets of models for structural framing connections should be made available for users to speed up the building model creation process.

PHASE I: The successful Phase I project should develop the outline for the proposed methodology in sufficient mathematical detail to show technical competency. If the methodology is already developed for other highly dynamic applications like vehicle crashes or building demolition the Phase I project should also include limited validation of the methodology against full-scale blast tests of building components like walls or columns.

PHASE II: The successful Phase II project will result in a blast test validated user friendly and fast running computational method for collapse analysis of buildings subjected to blast loading.

PHASE III: Dual use applications. Analysis for building collapse is a requirement for new construction within the government and increasingly in the commercial sector. ASCE 7-02, Minimum Design Loads for Buildings and Other Structures, added commentary on design alternatives for resistance to progressive collapse. Building code writing organizations, such as ASCE, SEI, ACI, IBC, ANSI, PCI, etc., have committees reviewing design for progressive collapse resistance, which will likely lead to national standards. Dual use applications would include a more robust, yet fast method for complying with emerging building codes' analysis requirements, building and bridge demolition, and forensic studies in support of accident investigations. A Phase III project would develop an end to end product with licensing for software releases, user manuals and training materials and worked out examples.

REFERENCES:
1. Kimiro Meguro and Hatem Tagel-Din, "Applied Element Simulation of RC Structures under Cyclic Loading", ASCE, November 2001, Vol. 127, Issue 11, pp. 1295-1305.

2. Ante Munjiza, "The Combined Finite-Discrete Element Method", John Wiley and Sons Ltd., 2004.

3. T. Belytschko, J. S. Chen, "Meshfree and Particle Methods", John Wiley and Sons Ltd., 2007.

4. Klaus-Jurgen Bathe, “Finite Element Procedures”, Prentice Hall, 1996.

5. "Flex Template System for Blast Modeling of Structures," by Vaughan, Nikodym, Xie and Ettouney, Sixth Asia-Pacific Conference on Shock and Impact Loads on Structures, 2005.

KEYWORDS: Structural Collapse, Blast, Computational Methods, Material Models, High Fidelity Techniques.

DTRA082-007 TITLE: Inexpensive, disposable radiation detectors

TECHNOLOGY AREAS: Sensors, Nuclear Technology

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: We seek proposals to develop, design and build inexpensive radiation detectors capable of crude gamma spectroscopy. Ideally these detectors will be simple and inexpensive enough to be deployed in large numbers and essentially disposable.

DESCRIPTION: In DTRA’s efforts to prevent the spread of Special Nuclear Material (SNM), gamma spectroscopy plays a key role in locating, identifying and imaging potential threats. Current research efforts are predominately aimed at materials having better energy resolution (e.g. CZT, $LaBr_3$) or greater efficiency (e.g. BiI_3) than currently deployed detectors as these parameters are generally perceived as having better capability.

These new materials are very expensive to grow and are available in limited quantities. In our mission to interdict SNM, a potential strategy under consideration is to deploy many (sometimes up to thousands) small, unobtrusive detectors in remote areas such as smuggling routes where persistent surveillance would be difficult for personnel. Clearly, the deployment of expensive detectors would prove prohibitively costly in great quantities so DTRA is looking for proposals to make small, robust, inexpensive gamma spectrometers that would fit this need.

In order to function to as a gamma spectrometer, photopeak efficiency would need to be moderately high in the energy range up to 1 MeV (for reference NaI(Tl) intrinsic efficiency is ~20% for a 1 cm thick sample). Cost and robustness are also key parameters as these detectors are expected to be essentially disposable and deployed in quantity by air, sea and ground vehicles. While not unimportant we would consider energy resolution secondary.

Proposals are sought to provide a capability rather than any specific technique. Among the possible solutions are new materials, as are novel methods of growing existing materials and inexpensive electronic solutions that can increase the capability of existing materials.

PHASE I: Determination of feasibility to perform as a radiation detector and perform gamma spectroscopy.

PHASE II: Construction of a demonstration prototype.

PHASE III: Dual use applications. Potential application of this technology include their use in the well-logging industry, medical imaging, and environmental monitoring.

REFERENCES:
1. Knoll, G.F. “Radiation Detection and Measurement” 2nd edition (1988).

2. Tsoulfanidis, N. “Measurement and Detection of Radiation” 2nd edition (1995).

KEYWORDS: Gamma spectroscopy nuclear detector.

DTRA082-011 TITLE: Autonomous Airborne Chemical/Biological Cloud Detection Sensor

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics

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

OBJECTIVE: Develop a small, low-power, and accurate sensor for in-situ detection of chemical and biological clouds by measuring one or more constituents of the cloud, such as the size and concentration of the particulates, their chemical composition, or other distinguishing characteristics. The sensor should be able to operate from a fixed or moving platform in volatile environments.

DESCRIPTION: Explosive destruction of suspicious targets with possible chemical or biological agents generates a dust plume that travels downwind. Immediate analysis of the dust cloud is needed to ascertain the cloud trajectory, size, and composition. Thus there is a need for a small, light and low-power sensor that can be deployed in moving platforms (such as UAV’s, military vehicles, and personnel) and can report back data containing this information in real time.

To meet these requirements, the sensor should additionally have a setup time no longer than 10 seconds. Processed data from the sensor should be available with less than 1 millisecond lag time and with an update rate of 100 Hz. The sensor should be operable in a variety of environments, temperatures, and conditions, be physically robust and reliable, and able to correctly analyze clouds of varying densities, including dense plumes. The sensors should be reusable with a reset procedure requiring a minimum number of steps that are easy to perform in the field in a short amount of time.

Many technologies exist that measure chemical composition, including optical techniques such as spectroscopy and phosphorescence and nano-mechanical methods. These optical techniques are typically limited to a few particular species and limited density ranges, and fail to distinguish species when the cloud is saturated with debris dust. Technologies for categorizing particle size typically suffer from poor dynamic range and would require adjustment a priori to set a measurement range and have limited capabilities in extremely dense plumes. Most of these solutions require an extensive amount of hardware not suitable for small UAV or unmanned helicopter deployment and require the user to set several parameters for detection to work.

PHASE I: Fabricate a proof-of-concept prototype and perform laboratory and field tests to demonstrate the performance characteristics such as dynamic range, accuracy and frequency response of the sensor

PHASE II: Fabricate six prototype sensor systems for integration and perform field tests.

PHASE III: Dual use applications. The proposed sensors may be used as remote and autonomous sensors for environmental studies and for the monitoring of pollution clouds downwind from chimneys.

KEYWORDS: Sensor, cloud detection, UAV, Chemical, Biological.