DEFENSE THREAT REDUCTION AGENCY

The Defense Threat Reduction Agency (DTRA) is actively involved in meeting current threats to the Nation and working toward reduction of threats of all kinds in the future. This covers a multiplicity of disciplines. As a result, the Agency is seeking small businesses with strong research and development capability. Experience in weapons effects, phenomenology, operations and counterproliferation are helpful. DTRA invites small businesses to send proposals to the following address:

Defense Threat Reduction Agency
ATTN: AM/SBIR
8725 John J. Kingman Drive, MSC 6201
Fort Belvoir, VA 22060-6201

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Threat Reduction Agency
ATTN: AM/SADBU, Mr. Bill Burks
8725 John J. Kingman Drive, MSC 6201
Fort Belvoir, VA 22060-6201
E-mail: billy.burks@dtra.mil

Use of e-mail is encouraged for correspondence purposes.

DTRA has identified 11 technical topics numbered DTRA 01-001 through DTRA 01-011. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included below. The DTRA technical offices, which manage the research and development in these areas initiated these topics. Several of the topics are intentionally broad to ensure any innovative idea fitting within DTRA's mission may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the topics should be submitted to Mr. Burks at the above address or to the topic POC identified with the topic.

Potential offerors must submit proposals in accordance with the DoD Solicitation document. Proposal selection will be limited to those proposals in Phase I which do not exceed $100,000 and six months of performance. For information purposes, Phase II considerations will be limited to proposals of %$750,000 and 24 months of performance or less.

DTRA selects proposals for funding based on the technical merit of the proposal, criticality of the research and the evaluation criteria contained in this solicitation document. As funding is limited, DTRA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DTRA may fund more than one proposal under s specific topic or it may fund no proposals in a topic area. Proposals that cover more than one DTRA topic must be submitted once, referencing the several areas of applicability.

While funds have not specifically been set aside for bridge funding between Phase I and Phase II successful proposals, the potential offeror is advised to read carefully the conditions set out in this solicitation for FAST TRACK Phase II awards.

In order to enhance Phase II efforts and to assist in assuring acquisition support from the DTRA SBIR program, the Agency may provide a Phase II Awardee with additional Phase II SBIR funding beyond the initial award sum. The additional funding is conditioned on the company matching the additional SBIR funds with DoD acquisition funds or monies provided from external sources. At the discretion of the DTRA requiring activity, additional dollars may be provided by DTRA activities with heavy interest in the areas of endeavor being pursued by the Phase II award recipient under the SBIR contract applying the same matching arrangement. These conditions will be applicable to awards made pursuant to this DoD Solicitation and subsequent solicitations, for a trial period of three years. This is the second of the three-year period.

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.

DEFENSE THREAT REDUCTION AGENCY FY 2001.1 TOPICS

DTRA 01-001 TITLE: New Innovative Technologies for the Development and Demonstration of Radiation Hardened Microelectronics and Photonics

TECHNOLOGY AREAS: Electronics, Battlespace

OBJECTIVE: Develop and demonstrate innovative and creative methods and materials for the radiation hardening and radiation effects characterization of semiconductor microelectronics and photonics devices, circuits and materials.

DESCRIPTION: Radiation effects from either nuclear weapons or the natural space environment can degrade or destroy semiconductor microelectronic and photonic devices, circuits or materials. Moreover, as microelectronics and photonics technologies continue to evolve their susceptibility to radiation effects increases in many cases. In addition the problems associated with the characterization of radiation effects in these advanced technologies also are becoming more difficult.

Therefore, to support the use of advanced microelectronics and photonics for both DoD and commercial space applications the feasibility of operating these devices in harsh radiation environments must be established and demonstrated. This will require the development of innovative and creative approaches that support both cost effective and minimally invasive radiation hardening and characterization methods to ensure the suitability of these advanced microelectronics and photonics devices for these applications.

This topic addresses the DoD key technology area of sensors, electronics and battlespace management.

Some specific areas of interest include, but are not limited, to the following examples:

1. Very deep submicron microelectronics has been shown to be extremely susceptible to radiation effects. These devices use small feature size and many new (to semiconductor fabrication) types of materials to achieve high performance to the detriment of radiation robustness. Thus, minimally invasive methods and materials to increase radiation hardness without loss of electrical performance or significant increase in cost must be developed and demonstrated. Moreover, methods to characterize the radiation response of the new materials and devices are required and also must be developed and demonstrated.

2. Very high-speed microelectronics and photonic devices and materials have been developed to facilitate the rapid transfer of data. However, these devices and the subsystems fabricated using this advanced technology have been shown to be very susceptible to radiation effects. Here again, minimally invasive and cost-effective methods and materials must be developed and demonstrated to reduce the susceptibility of these technologies to radiation effects and allow them to be used in DoD missile and space systems. In addition new methods to characterize the radiation response of these technologies must also be developed and demonstrated.

3. Very significant investments have been made by commercial semiconductor manufacturers and system designers to develop extremely high performance circuits such as microprocessors, digital signal processors, microcontrollers, etc. However, for the DoD to take advantage of these developments these devices must be redesigned such that they can be fabricated using radiation hardened processes and design rules. One method to accomplish this redesign is through the use of Electronic Design Automation (EDA). Thus, cost-effective EDA methods must be developed and demonstrated to support such an approach.

4. Traditionally the radiation response of microelectronic and photonic devices and circuits have been obtained through testing. However, such an approach is both costly and time consuming. A more cost-effective and accurate approach would entail the modeling and simulation of the basic response of a device or circuit starting with the initial fabrication parameters, e.g. material, temperature, time, etc. Thus, the development and demonstration of methods to simulate and model the radiation response of complex microelectronics and photonic devices must be developed and demonstrated to reduce our reliance on expensive and inaccurate radiation testing.

5. Presently used methods to ascertain the radiation hardness of a semiconductor device or circuit require destructive testing using a suitable radiation source. A more cost-effective approach would be to identify and correlate the electrical response of certain key device performance parameters to the radiation response. This would allow for the non-destructive characterization of device radiation performance and significantly reduce the need for expensive and

time consuming radiation testing. Thus, the development and validation of methods to support such an approach must be developed and demonstrated.

6. Certain classes of microelectronic circuits such as non-volatile memories and programmable logic devices have demonstrated extreme sensitivity to radiation effects. Thus, the development and demonstration of cost-effective and minimally invasive methods to harden these types of devices to support their operation in harsh radiation environments would be of significant value to both the DoD and commercial space systems.

During Phase 1 - Demonstrate the feasibility of the innovative methods and materials that address problems described in examples 1 through 6, above. .

During Phase II - Prototype, test and evaluate the innovative solutions developed to address the above noted issues.

Phase III Dual Use Applications: In addition to supporting DoD space and missile system applications that require hardened microelectronics and photonic devices, such as SBIRS-Low and Advanced EHF, the above-described thrusts will also serve to support commercial communications and scientific space system applications, e.g. Teledesic, GlobalStar and others, that must also operate in a harsh radiation environment. This support will be of significant value to DoD due to significant use of commercial space systems assets for DoD applications.

REFERENCES:
(1) Messenger and Ash, "The Effects of Radiation on Electronic Systems", Van Norstrand Reinhold Company, 1986
(2) Dressendorfor & Ma, "Ionizing Radiation Effects in MOS Devices & Circuits”, John Wiley & Sons,1989
(3) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(4) Transient Radiation Effects in Electronics Handbook,DNA-H-95-61

DTRA 01-002 TITLE: <u>New, Innovative Technologies for EMP/HPM Hardening of Military and Commercial Systems and Equipment</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: Develop and demonstrate innovative concepts, methods and technologies for hardening military and commercial-off-the-shelf (COTS) equipment, systems, and networks against the effects of nuclear Electromagnetic Pulse (EMP) and High Power Microwaves (HPM).

DESCRIPTION: Electromagnetic (EM) environments generated by nuclear and RF (radio frequency) weapons can degrade or destroy sensitive electronic and electrical devices. With improvements in integrated circuit technology, e.g., higher clock speeds, lower logic levels/gate thresholds, and smaller size, there is a trend towards greater susceptibility. This is exacerbated by component and equipment manufacturer's usage of non-conductive material (e.g., composites, plastics) to house the electronics. Thus, there is a need for innovative, cost-effective hardening technologies and methods for design, analysis, testing, maintenance and surveillance.

Integrated hardening and testing devices and techniques that address EMP, HPM, and other natural and man-made EM environments are desirable.

The military has mandated use of COTS (electronics) equipment to the maximum extent possible. A significant challenge is to ensure that COTS is survivable when integrated into military systems that must operate in and through EMP, HPM and other stressing EM environments found in the battlespace of the future. Methods, devices, and materials for characterizing and expediently/cost effectively hardening COTS are required.

The military is highly reliant on the commercial infrastructure for effectively accomplishing many of its missions. Innovative concepts and technologies for protecting critical elements of the U.S. infrastructure and tools/methodologies for use in assessing potential vulnerabilities are needed.

During Phase I, demonstrate the feasibility of the concept, method, or technology.

During Phase II, develop, test, and evaluate the concept, method, or technology.

Phase III Dual Use Applications: In addition to supporting DoD equipment, systems, and networks hardening applications, the above thrusts will also serve to support commercial electronics equipment protection applications. This support may be leveraged by DoD since a) OSD has mandated the use of COTS equipment, materials, and commercial standards to maximum extent possible and b) the military is highly reliant to the use of the U.S. commercial infrastructure for the completion of many of its critical missions.

REFERENCES:

(1) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(2) MIL-HDBK-423, High-Altitude electromagnetic Pulse (HEMP) Protection for fixed and Transportable Ground-Based C4I Facilities, Volume I Fixed facilities

KEYWORD LIST: EMP, HPM, hardening, environment, electromagnetic, protection, surveillance, COTS, infrastructure

DTRA 01-003 TITLE: New, Innovative Technologies for X-Ray Simulators and Other Pulsed Power Applications

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM:

OBJECTIVE: Develop innovative technologies for the efficient production of x-rays for nuclear weapons effects testing and for the application of compact pulsed power to military and civilian systems.

DESCRIPTION: X-ray nuclear weapon effects testing uses radiation sources that generate primarily cold x-rays (1-15 keV), warm x-rays (5-60 keV), or hot x-rays (30 keV). Soft x-rays are used for optical and optical coatings effects testing; warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. Future requirements for x-ray nuclear weapon effects testing will require improvements in existing radiation source capability, to increase yield and power, improve spectral fidelity, and increase predictability and experimental control. These improvements may require new concepts in source design, experimental and measurement techniques, data analysis and modeling, and methods to reduce facility system and operation costs. The proposer should be familiar with the present capability to produce x-rays for nuclear effects testing.

Plasma Radiation Source (PRS) devices are typically gas puffs or wire arrays that are imploded by conduction of large currents to generate soft x-rays. Present PRS designs for high-power DTRA simulators are limited by Rayleigh-Taylor and MHD instability growth, and active research is investigating innovative load designs. Greater understanding is needed of factors influencing instability growth. Such factors include geometry, coupling to the generator, plasma properties, ionization dynamics and radiation transport. Innovative load designs might also include novel methods for increasing radiation yield and spectral fidelity in a high-power, optically thick medium, as has been done by using mixtures. An important contribution could come from physics-based modeling of this complex system, particularly with the high-performance parallel computers now available.

PRS devices generate copious amounts of extraneous debris (material, atomic charged particles, sub-keV photons), from which test objects must be shielded. Better techniques and diagnostics are needed to characterize the debris impacting a test object. Debris shields must minimize particle flux and maximize exposure area without significantly reducing x-ray fluence. New methods, or a combination of methods, may be needed to stop, mitigate, and/or delay debris generated for radiation simulators.

Plasma opening switches (POS) are important for obtaining maximum performance from x-ray sources, particularly with the next generation of DTRA high-power generators. Interest is focused primarily on using POSs for pulse sharpening in order to drive high fidelity bremsstrahlung diodes. POS performance appears to be affected by plasma composition, plasma flow symmetry, current diffusion during conduction, and power losses, and innovative diagnostics are needed to quantify these factors. Better computer modeling is needed, especially to understand the opening process and its relationship to conduction dynamics.

Bremsstrahlung Radiation Source (BRS) devices generate hot x-rays by impinging an electron beam onto a target converter. Improved BRS converter and/or beam transport designs are needed to meet future test requirements, by increasing x-ray production (dose), better tailoring pulse width (increased dose rate), and improving spectral fidelity.

These improvements could be effected by innovative new BRS designs, or by better understanding and refinement of existing BRS designs. Comprehensive computer modeling (e.g., PIC codes) of cathode formation and electron emission, beam transport, and/or converter physics, could provide an important contribution.

Diagnostics are critical for understanding how radiation simulators (cold, warm, or hot) are operating and how their performance can be improved. For example, in a PRS machine, these diagnostics are needed during all of the phases of implosion: current build-up, run-in, pinch, and bounce. Diagnostics are required that can determine with good accuracy the electron density, neutral density, electron temperature, ion temperature, neutral temperature, radiation spectrum, and magnetic field structure. These quantities are required both spatially and temporally resolved. In addition, absolutely calibrated x-ray power measurements in different energy spectrums are necessary. In addition, innovative diagnostics are needed to accurately determine the fluence and spectrum of x-rays produced in both cold and hot x-ray simulations.

Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state of the art. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more energy efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power technologies include those that operate at kilovolts to megavolts and kiloamperes to megamperes, support repetition rates from single pulse to 10 kilohertz, and provide individual pulse risetimes in the nanosecond to millisecond range.

Current DoD pulsed power applications includes x-ray simulators, armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; electrical vehicle stoppers, and directed energy weapons; etc. Development of new and innovative applications requiring advanced pulsed power technology is also desired, especially applications that may expand a primarily DoD driven requirements base into the commercial sector and reduce component and system costs.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test and evaluate proof-of-principle hardware. In some cases this will be required to be demonstrated in its working environment on a radiation simulator that will involve coordination with DTRA to schedule testing in an above ground test simulator.

PHASE III DUAL USE APPLICATIONS: In addition to the applications cited for developing the environments for simulating the effects of nuclear weapons, the technologies could be useful with the commercial operations of advanced computer modeling of plasmas, nuclear instrumentation, very fast closing valves, material surface treatments, environmental clean-up and high brightness x-ray sources. In addition to the DoD applications cited, these pulse power component technologies will be useful in cleaning up smokestack effluents, general environmental pollution control, metal cutting, and electric vehicles.

REFERENCES:
(1) Inductive Energy Technology for Pulsed Intense X-Ray Sources, K. D. Ware, P. G. Filios, R. L. Gullickson, J. E. Rowley. R. F. Schneider, W. J. Summa, I. M. Vitkovitsky, IEEE Transactions on Plasma Science, Vol. 25, No. 2, April 1997.
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303 (also on web site: http://www.dswa.mil/dswainfo/es/hp.htm)
(5) J. C. Martin on Pulsed Power, Edited by T. H. Martin, A. H. Guenther, and M. Kristiansen, Plenum Press, New York and London, 1996, ISBN 0-306-45302-9.

KEYWORD LIST: Advanced Simulator, Above Ground Test (AGT), X-Ray, Debris, Pulsed Power, Radiation, Simulation, Modeling, Test, Electronics, Optics, Nuclear Weapon Effects, Electromagnetic, Electrothermal, Hybrid Electric Guns, High Coulomb Switches, Crowbar Diodes, High Energy Capacitors, Static Electrical Storage Devices.

DTRA 01-004 TITLE: Mitigation of Atmospheric Nuclear Effects on RF and Optical Communication and Sensor Systems

TECHNOLOGY AREAS: Sensors

OBJECTIVE: To improve the operational performance of RF and optical systems when exposed to atmospheric nuclear effects.

DESCRIPTION: Many DOD RF and optical systems need to be able to operate after a high altitude nuclear event. Such an event will generate and deposit radiation and electrons into the upper atmosphere, which will create scintillation and optical clutter. These effects (although much more severe) are similar to the effects seen during periods of high sun spot activity. Since these effects persist for long periods of time, systems need to use mitigation techniques to improve their performance. Over the years several techniques have been developed and utilized by system developers, which have been shown to improve system performance. Much remains to be done in this area to develop new approaches and to address the unique requirements of vastly different systems.

Phase I: Develop and demonstrate the feasibility of candidate methods/techniques for the mitigation of atmospheric nuclear effects on RF transmissions (communications and radar) and optical sensor systems.

Phase II: Develop algorithms and techniques of the proposed mitigation methods for use in specific systems such as X-band S-band and UHF radars, GPS communication links, etc.

Phase III Dual Use Applications: Translate approaches for use in commercial communication (satellite), optical and radar systems to improve operability under naturally disturbed atmospheric conditions (high sun spot activity). Mitigation techniques, which improve system performance in disturbed nuclear atmospheres will improve performance of systems under the less sever naturally disturbed atmospheres. Commercial satellite communication and sensor systems, and NASA systems, which must operate during solar storms, will benefit from the techniques developed.

Previous work in this area funded by DTRA has resulted in the development of the Nuclear Optical Dynamic Display System. Honeywell has developed and marketed a commercial version of this technology. This demonstrates that there is a commercial need for this technology.

DTRA 01-005 TITLE: Innovative Wide-Area Detection (WAD) and Mapping Technologies to Characterize Minefields Containing Antipersonnel Landmines (APL)
TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

ACQUISITION PROGRAM:

OBJECTIVE: Develop innovative technical capabilities to detect and map APL minefields for use in verification and monitoring regimes of potential APL agreement/ban treaties such as the Convention on Conventional Weapons (CCW) Modified Protocol II, the Ottawa Convention on APL Ban, the Conference on Disarmament (CD) Process for APL Ban, and others as appropriate.

DESCRIPTION: The US government has a long-range goal of banning the indiscriminate use, export, stockpiling, and production of APL to mitigate or eliminate post-conflict civilian casualties. The Defense Threat Reduction Agency (DTRA) is responsible for providing RDT&E support for all arms control treaties including the proposed ban on APL. To verify and monitor APL ban provisions and to provide requisite technical assistance in conducting APL mapping and demining operations, DTRA is seeking innovative and statistically meaningful technical capabilities for WAD that have the potential to minimize risk to inspection/remediation personnel. DTRA's review of other WAD technology R&D efforts sponsored by other US Government (USG) offices and Separate Operating Agencies (for example, see references) determined that technical efforts have concentrated on detecting and clearing individual mines rather than on WAD, mapping, and characterizing the extent of APL minefields. DTRA seeks truly innovative, "out of the box" WAD R&D technology developments to safely and rapidly satisfy provisions of future treaty/ agreement mission requirements associated with APL minefield verification and remediation efforts.

The potential needs of DoD and DTRA germane to an agreement banning APLs are focused on developing multiple innovative WAD technologies and proof-of-concept prototype systems for worldwide APL detection, verification, and mapping use. Multiple R&D technology developmental efforts may be funded. The following are desired constraints on the proposed innovative WAD and mapping technologies/systems:

- High probability of detection of minefields containing metallic and non-metallic APL.
- No real time requirement of display or processing of data
- Large area coverage
- No military threat during detection operations.

Current SBIR efforts are focused on hyperradar and laser vibrometer array technologies. It is recommended that potential offerors address technologies that are unrelated to current efforts.

PHASE I: Demonstrate feasibility of the proposed innovative WAD and mapping technologies. Provide logical approach and develop overall conceptual design of applicable WAD and mapping system that confirms the presence or absence of APLs.

PHASE II: Develop proof-of-concept prototype device/system that demonstrates the viability of the proposed innovative technologies, etc., to detect and map APL minefields. Submit final prototype design of the proposed WAD and mapping system.

PHASE III: Dual Use Applications: Detection of unexploded ordnance (UXO) as part of military base clean-up operations in the US as well as arms control treaty/agreement applications.

REFERENCES:
1. GAO Report on UXO, Report No. 95-197, 20 SEP 1995.
2. Review & Identification of DOE Laboratory Technologies for Countermine/Unexploded Ordnance Detection, Cyrus Smith, Oak Ridge National Laboratory, 2 DEC 1996 (Reissued 2 DEC 1997).

KEYWORD LIST: Anti-Personnel Landmine (APL), APL Ban Treaty, Stand-off Detection, Wide Area Detection, Minefield, Sensor, Data Fusion, Mapping

DTRA 01-006 TITLE: Methods of Locating Underground Nuclear Explosion Sites by an On Site Inspection Team

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: Develop innovative sensors and/or software (data fusion) to support an on-site inspection team's determining whether or not an underground nuclear explosion occurred.

DESCRIPTION: The Comprehensive Test Ban Treaty (CTBT) bans the testing of all nuclear devices. In order to verify the treaty, global networks of sensors have been, and are being, deployed to monitor for clandestine nuclear tests. If these sensors detect signals that can be attributed to an underground nuclear explosion, the U.S. or other countries can request an On-Site Inspection (OSI) of the area from which the signals originated in order to confirm the occurrence of a nuclear explosion. If the request is granted by the Executive Council of the Comprehensive Test Ban Treaty Office (CTBTO), the CTBTO must be allowed to be at the port of entry of the country to be inspected within six days of the request. Considering the time it takes for a country to request an OSI after detection of the signals, travel time to the port-of-entry and travel from the port-of-entry to the suspected site of the explosion, the inspection team would likely arrive eight days to several weeks after the suspected explosion took place. Based on analysis of remotely-sensed data (seismic, hydroacoustic, infrasound, and/or radionuclide), the inspection team will be responsible for searching a specified area up to 1,000 km2 (the maximum allowed by the CTBT). Innovative technology and techniques are required for precisely locating the site of a suspected explosion in order to collect (e.g. by drilling) irrefutable evidence that a nuclear explosion occurred.

If a country conducts a clandestine nuclear test in violation of the CTBT, it will also take steps to hide the fact of testing. The country will likely choose a geology and depth of burial that will not leave a crater or visible disturbance at the surface. Also, any evidence of preparation for the testing (such as drill rigs) would likely be removed and the surface above the site returned to as close to a natural condition as possible. However, the explosion may still leave telltale signs. First, the explosion creates a cavity and the surrounding materials are vaporized. These materials will condense and be at the bottom of the cavity (the melt). The cavity may continue as a freestanding cavity (such as could happen in salt) or it may start to collapse forming a chimney. The chimney will extend up toward the surface, but if the geology and depth of burial are correctly selected, the chimney will not reach the surface. A fracture zone will also surround the cavity. The explosion may also cause a ground heave at the surface and there can be some changes in surface features. Additionally, the explosion generates heat that will dissipate into the surrounding rocks. If a water table exists, the explosion may change the depth of the water table around the explosion site, and this change can persist for some time.

Technologies suitable for employment in on-site inspections include, but are not limited to, the following:

- The use of clutter analyses to detect man-made changes to the surface area or to detect the signs of ground heave;
- Ground penetrating radar that will penetrate deep into the earth (on the order of several hundred meters) and detect the rubble in the chimney, the cavity, the melt area, or the change in the depth of the water table;
- Thermal imaging to detect the subsurface residual heat from the nuclear explosion.

PHASE I: Carry out preliminary design of proof-of-concept test and show potential feasibility of the concept.

PHASE II: Build prototype/acquire sensor(s) or develop algorithms, conduct test sufficient to demonstrate proof-of-concept.

PHASE III DUAL USE APPLICATIONS: A successful proof-of-concept test could lead to deployment of a new sensor or new techniques to assist OSI teams in locating the site of a clandestine nuclear test. Other possible uses include the location of buried underground structures or caves/potential sinkholes. Some of these sensors may be used to locate people buried in avalanches or trapped in collapsed buildings.

REFERENCES: www.pidc.org for information on the CTBT.
The five-volume series published by the International Atomic Energy Agency between 1970 and 1978 on Peaceful Nuclear Explosions. See, for example, G. H. Higgins, Nuclear Explosion Data for Underground Engineering Applications, Peaceful Nuclear Explosions, Proceedings of a Panel, Vienna, 2-6 March, 1970, International Atomic Energy Agency, Vienna, 1970 and J. Toman, Results of Cratering Experiments, Peaceful Nuclear Explosions, Proceedings of a Panel, Vienna, 2-6 March, 1970, International Atomic Energy Agency, Vienna, 1970.

DTRA 01-007 TITLE: Improved Seismic Event Location Estimates

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Innovative Techniques for Developing Improved Hypocenter Location Estimates to Reduce the Area of Potential Search for Suspicious Events under the Comprehensive Test Ban Treaty (CTBT).

DESCRIPTION: Under the CTBT, all nuclear testing by the signatory states is prohibited. To enforce this ban, an international monitoring system is being developed to detect clandestine tests. It will consist of seismic, hydroacoustic, infrasonic, and radionuclide sensors. If an anomaly is detected with any of these sensors, member states have the right to demand an On-Site Inspection to obtain direct evidence of a treaty violation. The area to be inspected will probably be defined by the uncertainty ellipse obtained from seismic arrival data. The maximum allowable search area under the treaty is 1,000 km2. Because this is a relatively large area, and because exhaustive searches of such regions can be difficult and expensive, there is a need to develop new, innovative techniques for obtaining improved hypocenter estimates. These new techniques should both increase confidence in the coordinates obtained for the event and reduce the parameter uncertainty estimates to a minimum. Potential modes of accomplishing this improvement include, but are not limited to, using secondary seismic phases (such as pP, Sn, and Lg), using data from seismic stations that are not part of the CTBT International Monitoring Station (IMS) system, using data from non-seismic systems, and the development of new analytical approaches (such as Artificial Intelligence).
In the area of secondary phases, of particular interest is an automated process that will reliably identify when those phases arrive at each station, assign a meaningful reliability estimate to the determined arrival time, and relate this reliability to the model reliability and the primary phase arrival time reliability estimate. The desired research may involve multi-component processing and array processing.

Any proposed approach must consist of operations that can be accomplished within a relatively short time frame (a few days) and that will yield results with a high degree of confidence, both scientifically and politically.

PHASE I: Develop overall system design and demonstrate proof-of-concept.

PHASE II: Produce prototype software modules and conduct tests showing validity of approach.

PHASE III DUAL USE APPLICATIONS: Better and more rapid location of earthquakes, thereby allowing rapid determination of future seismic hazards.

REFERENCES: www.pidc.org

DTRA 01-008 TITLE: New Sensors to Discriminate Between Nuclear Explosions and Chemical Explosions or Natural Events

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop innovative remote sensing capability to distinguish among nuclear explosions, chemical explosions, and natural events.

DESCRIPTION: Global networks of sensors have been, and are being, deployed to monitor for clandestine nuclear tests. One processing center for data from such a network is being developed at the Center for Monitoring Research (CMR) in Arlington VA in support of the Comprehensive Nuclear Test Ban Treaty (CTBT). The sensor data streams at CMR include hydroacoustic, infrasound and radionuclide sensors as well as seismic, as specified in the CTBT. A potentially powerful means of identifying the type of source of events ("discrimination"), particularly small events, in the seismic stream is to combine the seismic signals with signals from one or more of the other sensor data streams ("data fusion"). Identification of these small events, however, can still be problematic, due to difficulties in distinguishing among small nuclear explosions, chemical explosions, and small earthquakes. Therefore, DTRA has a need for the development of sensors other than the ones currently being used (hydroacoustic, infrasound, and radionuclide) to assist in the identification of source type for small events in the seismic data stream. The CTBT does provide for additional types of sensors if these sensors would be useful in better identifying and locating events. Innovative approaches, such as sensors detecting changes in the Earth's gravity field or magnetotelluric fields, may be of interest. (This SBIR topic, however, is not restricted to these two approaches – other approaches may also be of interest.) These sensors should be capable of detecting these changes at distances of several thousand kilometers. Space-based sensors, however, will not be considered. The work should include appropriate algorithms to carry out the identification of source type.

PHASE I: Carry out preliminary design of proof-of-concept tests.

PHASE II: Build prototype/acquire sensor(s), conduct tests sufficient to demonstrate proof-of-concept.

PHASE III DUAL USE APPLICATIONS: A successful proof-of-concept test could lead to deployment of a new sensor network to assist in treaty compliance monitoring. Additionally, sensors based on measurements of the earth's gravity field or electromagnetic field could lead to improved scientific monitoring of the earth. These types of sensors, or sensors based on other principles, could be used to detect and monitor natural events (including those that are potentially hazardous).

REFERENCES: www.pidc.org
"A Fifty Year Commemorative History of Long Range Detection, The Creation, Development, and Operation of the United States Atomic Energy Detection System", HQ Air Force Technical Applications Center, Patrick Air Force Base, Florida, September 1997.

DTRA 01-009 TITLE: Sensor Fusion and Signature Exploitation

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop capabilities to detect and characterize underground facilities at denied sites and design prototype sensor system(s) for characterizing facility equipment and functions, performing bomb damage assessment and communicating this information to remote command sites. The sensor system might employ a range of observables (for example: seismic, acoustic, thermal, magnetic, electromagnetic or other observables). A suite or array of sensors may be the proposed solution, but only existing sensors should be considered in developing design and signal processing methodologies. The capability to emplace the sensors by means other than hand emplacement is desirable, i.e., insertion of a shock hardened system by dropping from aircraft or firing them from artillery or naval guns would be highly desirable. The system should be capable of monitoring underground facilities for long periods of time and should have communications capabilities for linking to remote command sites. The sensor system should also have the ability to accurately locate the position of the functions being performed in the underground facility.

DESCRIPTION: The collection of emissions (signals, effluents, etc.) from underground facilities is limited by difficulties in access, background noise, unknown propagation path characteristics, etc. Potential observable from underground facilities might include seismic, acoustic, magnetic, electromagnetic, chemical, and other signals. Recent advances in computation power may make some visualization approaches feasible and might build on current active seismic techniques such as those used in the oil and gas prospecting industry. Computational advances might also allow for the rejection of false and noise signals that could have hampered these techniques in the past. The purpose of this topic is to solicit new, different and unique approaches for detecting, characterizing and reporting significant characteristics of underground facilities in denied areas as well as conducting bomb damage assessments.

PHASE I: Develop overall sensor system design that includes specification for the particular technology of interest and the probability of successful exploitation.

PHASE II: Design tests to challenge the feasibility concepts of Phase I, demonstrate capabilities, and to establish operator requirements and fusion needs. Conduct limited testing to demonstrate sensor system feasibility.

PHASE III: Systems developed for applications against active underground facility construction or operation should also be useful to military and civilian security operations where enemy intrusion tunneling is suspected. Some sensor technologies may be applicable to inactive or passive underground sites. Applications to archaeology and civil engineering are also possible. Example dual use applications would be for discovering secret burial sites and for locating buried evidence in criminal cases. Commercial applications are likely in the areas of mapping, agricultural assessment, mining, resource exploitation and urban patterns/trends assessments.

DTRA 01-010 TITLE: Advanced Computational Techniques for Counterproliferation Problems

TECHNOLOGY AREAS: Information Systems, Weapons

INTRODUCTION: The proliferation of weapons of mass destruction (WMD) is one of the most critical problems facing the United States today. The DOD has established a concentrated program to apply force to counter the proliferation of these weapons if it becomes necessary. However the application of such force carries the risk of the release of the WMD material into the surrounding population. These demands put a very high demand on the capability of current generation computational tools. Current advanced computational tools fail to address all the necessary physics, do not incorporate emerging computational techniques, or take full advantage of the latest scaleable computer hardware.

DESCRIPTION: Since, current advanced computational fluid dynamics and/or computational structural dynamics codes such as the many large scale finite element or finite difference codes fail to address all the necessary physics, do not incorporate emerging computational techniques, or take full advantage of the latest scaleable computer hardware. The objective of the effort is to capture emerging technologies and to apply them to advanced computational tools for counterproliferation problems. The technologies fall into three broad categories:

Physics enhancements: The technologies appropriate include but are not limited to developing more realistic material models for structural materials addressing fracture, or high strain rate, large deformation response, numerical implementation of equations of state for non-ideal explosives and other energetic materials such as bi-metallics, inter-metallics, etc. including afterburning, improved chemical kinetic models for neutralizing WMD materials, low-mach number flow approximations, turbulence modeling, premixed and non-premixed combustion modeling, atmospherics dispersion modeling, meso-scale weather modeling, urban wind field prediction, human effects prediction, etc.

Emerging computational techniques: The emerging technologies focus on enhancement to advanced computational fluid dynamics and/or computational structural dynamics such as the many large scale finite element or finite difference method are required. Theses include but are not limited to adaptive mesh refinement, mesh-free techniques such as element free galerkin or free lagrangian techniques, integration of weather observations into numerical weather models, and transport and diffusion models, etc.

Code implementation on advanced scaleable computers. Two issues dominate the fully scaleable computations. The first issue deals with the development and implementation of scaleable and coupled algorithms consistent with all pertaining governing differential equations implemented in the finite element, finite difference or other solution technique. Technologies to develop adaptive mesh refinement or other advanced numerical techniques on parallel computers while maintaining scalability are sought. The second technology is mostly associated with data movement, data management, and visualization associated to enhance computational tools for counterproliferation problems.

These technologies may utilize standard Hierarchical Data Formats (HDF5), heterogeneous shared memory system, high performance scientific visualization, and simple object oriented and Extensive Markup Language (XML) tools.

PHASE I: Demonstrate that the technology and innovative research can substantially improve the capability of computational tools for in the above areas. This may be accomplished by implementing the model/technique in an existing tool or by developing special purpose prototype software. A limited number of demonstration problems will be run.

PHASE II: Develop working prototype of the technology that includes the appropriate pre/post processing and realistic modeling capability. This may be accomplished by modifying an existing tool as the prototype or by developing unique prototype software. A limited number of realistic demonstration problems will be run.

PHASE III/DUAL USE COMMERCIALIZATION: In Phase III this capability will provide the DOD S&T user a fully capable advanced computational tool that can be used for weapon development trade studies or for application of force to real-world problems. Dual use commercialization may consist of spinning-off the components of the tool such as: material models by the earthquake and anti-terrorism industry, combustion models to the engine developers, neutralization and dispersion models to the hazardous material remediation industry, mesh-free and adaptive mesh techniques to the automobile industry, and weather modeling to the weather industry. Additionally, the integrated tool could be applicable to governmental organizations such as FEMA and EPA for hazard prediction for natural or terrorist events. It could also be used by state or local emergency response organizations to respond to hazardous material incidents. Finally the tool could be used by the petroleum/chemical industry to predict hazards from chemical incidents,

KEYWORDS: Numerical methods, computational mechanics, weapons effects, material models, combustion, weather mode, urban wind fields, numerical weather prediction, human effects, transport, diffusion

DTRA 01-011 TITLE: Critical Feature Defeat for Underground Facilities

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop a concept for a weapon system capable of destroying the critical functions of underground facilities. Depending on the damaging effects the weapon system might employ, it may need to be precisely delivered (few meter CEP) with the ability to penetrate through geologic or protective materials to the critical feature location. Ideally, the damaging effect utilized by the weapon would have a readily observable signature to allow for reliable bomb damage assessment.

DESCRIPTION: Current weapons systems need to be expanded from conventional high-explosive, earth penetrating approaches to develop more effective weapons that might possibly utilize more exotic effects tailored to specific classes of underground facilities. For instance, weapons for attacking underground communications facilities might utilize individualized effects such as electromagnetic pulse or radiation effects or even unique effects to directly attack the electronic systems in the underground facilities. Weapons for attacking underground missile operations tunnels might utilize unique chemical compounds or incendiary devices. The weapons solicited by this topic should offer unique approaches for damaging underground targets.

PHASE I: Develop weapon system concept.

PHASE II: Develop a prototype weapon system design. Conduct limited testing to demonstrate feasibility for realistic field conditions.

PHASE III DUAL USE APPLICATIONS: Systems developed for applications against active underground facility construction or operation might also be useful in hostage situations. They could be used to disable the personnel holding the hostages, disrupt the operation of their electronic devices or to gain access to the buildings/facilities where the hostages are being held. These weapons could also be used to counter enemy attempts to tunnel into and under our facilities.

KEYWORDS: Conventional weapons, advanced weapons concepts, incendiary devices, electromagnetic weapons.