DEFENSE THREAT REDUCTION AGENCY

BROAD AGENCY ANNOUNCEMENT

HDTRA1-11-16-BRCWMD-Service Call for DoD Degree-Granting Academic Institutions

Amendment 4 (December 2014)

Research and Development Directorate

Basic and Applied Sciences Department

Basic Research for Combating Weapons of Mass Destruction (C-WMD)

Original Posting Date: March 2011

TABLE OF CONTENTS

1. Introduction and Scope

1.1. This solicitation is an intramural endeavor focused on the basic research needs of DTRA. DTRA has the mission to safeguard America and its allies from WMD and provide capabilities to reduce, eliminate, and counter the threat and effects from chemical, biological, radiological, nuclear, and high yield explosives (CBRNE). DTRA seeks to identify, adopt, and adapt emerging and revolutionary sciences that may demonstrate high payoff potential to counter WMD threats.

1.2. This Service Call solicits white papers for long-term challenges in specific fundamental areas of basic research that offer a significant contribution to the current body of knowledge or further the understanding of phenomena and observable facts and may have impact on future capabilities that support DTRA. Responses to this Service Call must be unclassified and must address **only basic research**. White paper and proposal submissions that address applied research, advanced technology development, or combine basic research with applied research and/or advanced technology development will be considered non responsive and will not be evaluated further.

Basic research is the systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high-payoff research that provides the basis for technological programs.[1]

In contrast to basic research, applied research is the systematic study to understand the means to meet a recognized and specific need. It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. The boundary between basic research and applied research occurs at the point when sufficient knowledge exists to support a hypothesis involving a specific application.[2]

2. Purpose and Research Topics

2.1. DTRA seeks unclassified, basic research across five major functional counter WMD research thrust areas. Specific research topics that align to one or more thrust areas are presented in Section 10. The five thrust area descriptions are outlined below.

- ***Thrust Area 1—Science of WMD Sensing and Recognition:*** The basic science of WMD sensing and recognition is the fundamental understanding of materials that demonstrate measurable changes when stimulated by energy, molecules, or particles from WMD in the environment. This research thrust involves exploration and exploitation of interactions between materials and various electromagnetic frequencies, molecules, nuclear radiation or particles. These interactions and the specific form of recognition they provide are used for subsequent generation of information that provides knowledge of the presence, identity, and/or quantity of material or energy in the environment that may be significant.

[1] DoDI 3210.1, September 16, 2005

[2] DoD Financial Management Regulation Volume 2B, Chapter 5

- ***Thrust Area 2—Network Sciences:*** The basic science of network science is the convergence of computer, information, mathematical, networks, natural, and social science. This research thrust expands our understanding of social networks and advances knowledge of adversarial intent with respect to the acquisition, proliferation, and potential use of WMD. The methods may include analytical, computational or numerical, or experimental means to integrate knowledge across disciplines and improve rapid processing of intelligence and dissemination of information.
- ***Thrust Area 3—Science for Protection:*** Basic science for protection involves advancing knowledge to protect life and life-sustaining resources and networks. Protection includes threat containment, decontamination, threat filtering, and shielding of systems. The concept is generalized to include fundamental investigations that reduce consequences of WMD, assist in the restoration of life-sustaining functions, and support forensic science.
- ***Thrust Area 4—Science to Defeat WMD:*** Basic science to defeat WMD involves furthering the understanding of explosives, their detonation, and problems associated with accessing target WMDs. This research thrust includes the creation of new energetic materials or physical approaches that enhance the defeat of WMDs by orders of magnitude, the improvement of modeling and simulation of these materials and various phenomena that affect success and estimate the impact (lethality) of defeat actions, including the assessment of event characteristics using various dynamic analytical methods.
- ***Thrust Area 5—Science to Secure WMD:*** Basic science to support securing WMD includes: (a) environmentally responsible innovative processes to neutralize chemical, biological, radiological, nuclear, or explosive (CBRNE) materials and components; (b) discovery of revolutionary means to secure components and weapons; and (c) studies of scientific principles that lead to novel physical or other tags and methods to monitor compliance and disrupt proliferation pathways. The identification of basic phenomena that provide verifiable controls on materials and systems also helps arms control.

2.2. In Period E, DTRA seeks unclassified, basic research ideas that are responsive to the goals and objectives of the topics outlined in Section 10. The topics labeled "PerE" are only valid for Period E of this Service Call. Only white papers responsive to the topics posted for Period E and submitted by the Period E deadline by eligible applicants will be considered. A new list of topics will be developed for subsequent periods with corresponding white paper due dates.

2.3. Topics for future periods with corresponding white paper due dates will be accomplished via amendments to this solicitation. Topics from previous period(s) may or may not be repeated. DTRA will not provide additional information regarding the posting of future topics, including dates for posting, the potential for a topic to be repeated in out years, the potential for similar topics to be posted, and/or topic details in advance of issuance of an amended Service Call.

2.4. This Service Call, in addition to any amendments issued in conjunction with this Service Call, will be posted to the DTRA Submission Website (www.dtrasubmission.net), the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal) and to the DTRA website (www.dtra.mil).

2.5. The DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal) is available to all applicants. Information available at the portal includes, but is not limited to, the following: a detailed timeline for this Service Call, templates that may be used when preparing white papers and invited proposals, and an update on the status of

submission(s).

3. Award Information

3.1. Resulting awards from this announcement will be Military Interdepartmental Purchase Requests (MIPRs). The final number of projects and funds allocated will be determined after all proposals are received and evaluated.

3.2. The period of performance (POP) for the Single Scope Awards, the Multidisciplinary Awards, and the Young Investigator Awards (all types of awards are detailed in Section 3.2) may be up to five (5) years. Awards may be for a base period of one (1) year with up to four (4) additional years as possible options, a base period of two (2) years with up to three (3) additional years as possible options, or a base period of three (3) years with up to two (2) additional years as possible options. The base period and option combination(s) will be specifically detailed in each and every topic. White papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable

3.3. There are three categories of awards, which are detailed below. The applicant does not need to specify the type of award sought. It will be inferred by the dollar amount requested and/or the topic to which the white paper is submitted.

- Single Scope Awards: Research projects that focus on exploratory aspects of a unique problem, a high risk approach, or innovative research in a subject with potential for high impact to C-WMD science. Research must support undergraduate and/or graduate students, and/or postgraduate students.

  Single Scope Awards may have Co-Principal Investigators (Co-PIs), sub-awards, and/or sub-contracts. Single Scope Awards will be made by a single MIPR to the lead organization. Sub-awards, including all sub-contracts, are the responsibility of award recipient; exceptions will not be made.

  Single Scope Awards will average $150K per year.

  The predominance of awards will be Single Scope Awards.

- Multidisciplinary Awards: Research Projects that involve a comprehensive program of innovative research in an interdisciplinary area with potential for high impact. The proposed research must involve fundamental contributions in research by multiple investigators from diverse disciplines (proposal **must** be multidisciplinary). Investigators may be from a single institution or multiple institutions. Research must support multiple undergraduate and/or graduate students, and/or postgraduate students.

  Authors of these white papers and invited proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.

  Proposals submitted under this category must have a single lead organization and single submission for the white paper and the invited proposal. Multidisciplinary Awards will be made

by a single MIPR to the lead institution. Sub-awards, including all sub-contracts, are the responsibility of award recipient. Exceptions will not be made.

Multidisciplinary Awards will average $350K per year.

- Young Investigator Awards: Research projects that focus on exploratory aspects of a unique problem, a high-risk approach, or innovative research in subjects with potential for high impact to C-WMD science from individuals currently employed by a U.S. accredited DoD degree-granting academic institution who received a Ph.D. or equivalent degree within five (5) years of the date of the pre-application white paper submission.

  Young Investigator Awards may have subawards; however, subawards that transfer substantive programmatic activity will be considered non-responsive to the Young Investigator topics. Young Investigator Awards will be made by a single MIPR to the lead organization. Subawards, including all sub-contracts, are the responsibility of the award recipient; exceptions will not be made.

  Young Investigator Awards will average $100K per year.

3.4. Funding for participation in this program is highly competitive and the cost of proposed research should strictly be maintained in the award amounts outlined for each award type and for each topic. Under no circumstances will awards exceed 10% of the averages as outlined for each award type and for each topic. Exceptions will not be made.

3.5. Sub-awards are permitted. Sub-awards may be used to carry out a portion of the research. DTRA will review and consider the proposed sub-awards for all applications on a case-by-case basis.

Any applicant submitting a proposal for an award that has subcontracting possibilities must submit a subcontracting plan in accordance with FAR 19.704(a) (1) and (2). This information, if applicable, must be included in Volume III, Supplemental Information, of the Phase II full proposal. The plan format is outlined in FAR 19.7.

3.6. Funding Restrictions. Indirect costs may be restricted to less than 35% of the total award value. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds. This restriction does not apply to awards made using fiscal years 2011to 2015 Basic Research funds but **may** apply to future awards.

3.7. The Government will not provide any hardware or software to execute the proposed research.

3.8. The Government reserves the right to fund all, some, or none of the proposals submitted; may elect to fund only part of any or all proposals; and may incrementally or fully fund any or all awards under this Service Call. All awards are subject to the availability of funds.

4. Eligibility

4.1. DoD degree-granting academic institutions that are Federal government organizations, e.g. United States Military Academy at West Point, The Air Force Institute of Technology, etc., are eligible to submit white papers and proposals in response to this intramural Service Call.

4.2. There is no limit on the number of white papers and invited proposals that an applicant (PI/Co-PIs) may submit in response to this Service Call.

- Applicants (PI/Co-PIs) may submit white papers and invited proposals to one or more topics.
- Applicants (PI/Co-PIs) may submit white papers and invited proposals to one or more periods under this Service Call, regardless of a previous submission's disposition.
- Applicants (PI/Co-PIs) are **strongly** encouraged to minimize overlap in scope and level of effort if multiple projects are submitted for white papers and invited proposals. Further, individual PIs and Co-PIs are discouraged from repackaging research and submitting multiple redundant Phase I submissions in any given period of this Service Call.

5. Submission Information

This solicitation will be conducted in two phases: Phase I is for submission of white papers. Phase II is by invitation only and is based on the evaluation results of Phase I. The invitation to submit a Phase II proposal will be based on the evaluation results in Phase I.

The submission deadline for Period E Phase I white paper receipt is listed in Section 6.

5.1. General Application and Submission Information.

5.1.1. All applicants interested in submitting proposals must register on the DTRA proposal submission website, http://www.dtrasubmission.net, prior to submission of a white paper(s) and proposal(s). Each institution may establish procedures for the management of registration and submission of proposals. Detailed registration instructions are available at the website. Failure to register in accordance with instructions will prevent submission of the required documents and render applicants ineligible for participation in this Service Call. Prior registration at any other proposal submission site other than at http://www.dtrasubmission.net does not fulfill registration requirements for participation in this Service Call.

5.1.2. Proposals must be submitted electronically through the DTRA proposal submission website, http://www.dtrasubmission.net. Do not submit any classified materials to the Service Call or to the proposal submission website. Unclassified proposals submitted by any means other than the DTRA proposal submission website (e.g., hand-carried, postal service mail, commercial carrier, or e-mail) will not be considered. Detailed submission instructions are available at the website.

5.1.3. Applicants are responsible for ensuring compliant and final submission of their white papers and/or proposals, and can verify the submission of the white paper and/or proposal package with the electronic receipt that appears on the screen following compliant submission of a proposal to the DTRA proposal submission website.

5.1.4. Using the DTRA proposal submission website, all applicants must prepare cover sheets for each Phase I white paper and invited Phase II proposal submitted. All data point requirements must be completed in every cover sheet. Once the cover sheet is saved, the system will assign a unique proposal number for each Phase I submission and a different unique proposal number for each invited Phase II submission. Cover sheets may be edited as often as necessary until the submission period

closes.

5.1.5. If multiple proposals are being submitted by the same institution, separate cover sheets must be generated for each white paper and proposal as the required documents must be uploaded with the associated cover sheet, since a unique document number will automatically be assigned to each submission by the electronic proposal tracking system. All documents submitted to the DTRA proposal submission website are considered works in progress and are not eligible for evaluation until the applicant submits the final proposal package for consideration. Applicants are responsible for ensuring compliant and final submission of their white papers and proposals; applicants can verify the submission of the white paper and proposal package with the electronic receipt that appears on the screen following submission of a white paper and proposal to the DTRA proposal submission website.

5.1.6. The white paper and all parts of the proposal must be uploaded in a Portable Document File (PDF) format compatible with Adobe Acrobat ® version 9.1 or earlier. DO NOT encrypt or add security layers to the file. The file must be self-contained, i.e. all figures and tables should be in the same file. Do not add other attachments or embed other files (other than fonts).

Applicants are responsible for performing a virus check on each submitted document. Each submitted electronic document will be scanned for viruses. If a virus is detected, the file will be deleted and this may cause rejection of the application.

5.2. DTRA will not review any of the following:

- White papers that attempt to address multiple topics.
- White papers that are submitted to topics from previous periods.
- Proposals for Phase II submissions that were not invited.

5.3. Phase I White Paper Submission and Content. Interested applicants are required to submit a four-page white paper. Each white paper must address only one of the Period E research topics detailed in Section 10.

5.3.1. Cover Sheet Information: The following information is required to complete a Cover Sheet for each white paper and proposal:

- Topic Number under which white paper/proposal is being submitted for consideration
- Title of proposed effort, which must be different than the topic title
- Applicant Institution name and address (this is based on the registrant submitting the proposal, and should be the institution, not the individual)
- Estimated Cost per year of performance
- Information on other submissions of same proposed effort
- Contact Information for PI and Business Points of Contact – Name, Title, Phone, Fax and Email

- Identification of proprietary information included in proposal submission (page numbers)
- Technical Abstract. The project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
- Key Words/Phrases (limited to 8 key words)

The Cover Sheet is automatically populated with the following information:

- DUNS, CAGE and Tax ID numbers, as entered during registration (cannot be changed)
- Applicant, as entered during registration (cannot be changed)
- Address (can be updated)

5.3.2. White Paper Narrative Format: The white paper itself should provide sufficient information on the research being proposed (e.g., the hypothesis, theories, concepts, approaches, data measurements, and analysis, etc.) to allow for an assessment by a technical expert.

Any pages submitted for the white paper that exceed the limit of four pages will not be read or evaluated. A page is defined as 8 1/2 x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The white paper must be provided in portrait layout.

At minimum, the white paper should address the following:

- Potential scientific impact to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts, including how the research contributes to the C-WMD science needs outlined in the topic.
- The impact of the research on C-WMD science must be clearly delineated.
- Cost estimate by year and total dollars required to accomplish the research as presented in the white paper (no details or breakout of costs is required).
- Potential team and management plan, including details on student involvement.
- Multidisciplinary white papers should carefully detail each of the institutions/departments involved and the contribution that will be made by each of the investigators.
- Do NOT include corporate or personnel qualifications, past experience, or any supplemental information with the white paper.
- The topic number and name should be included as a header on the white paper and in the text of the white paper.

5.4. Phase II - Full Proposal Submission and Content. The full proposal must be prepared in three separate volumes: Volume I – Technical Proposal; Volume II – Cost Proposal; and Volume III – Supplemental Information, to include an SOW and a Quad Chart.

5.4.1. Cover Sheet Information: The information described above in Section 5.3.1 is required to complete a Cover Sheet for each proposal in Phase II.

5.4.2. Technical Proposal: The technical proposal must not exceed 20 pages (including references). If the proposal exceeds 20 pages, only the first 20 pages will be reviewed. A page is defined as 8 ½ x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The proposal must be provided in portrait layout. A **template** for the technical proposal format may be found online at www.dtrasubmission.net/portal (Microsoft Word format).

The technical proposal must include the following components:

- ***Abstract.*** The project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
- ***Scope.***
- ***Objective.*** A clear and concise objective of the proposed project.
- ***Background.*** Provide the necessary technical and scientific background to support the scientific and/or technical merit of the proposed project.
- ***Programmatics***. Describe your organization's management plan for the proposed project; list supporting and collaborating centers, and the roles/responsibilities of each identified academic and/or industrial sub-contractor supporting the project. Authors of multidisciplinary proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.
- ***Relevance.*** Describe the relevance of the proposed project in terms of advancing the state of the science and the anticipated scientific impact on capabilities to potentially reduce, eliminate, counter, provide greater knowledge or understanding of the threat, and mitigate the effects of WMD fundamental aspects of phenomena and of observable facts.
- ***Credentials.*** Describe the PI's qualifications and the organization's qualifications to perform the proposed work. Summarize the credentials of the primary performing center, and supporting academic and industrial partners to perform the work. Describe specific examples of equipment and/or facilities available to perform the proposed work. Focus on information directly relevant to the proposed work.
- ***Work to be Performed.*** Provide details of the work to be performed by task and subtask. Tasks must be grouped by project year.
- ***Performance Schedule.*** Provide a table of tasks and sub-tasks and the duration of performance of each in a Gantt or other suitably formatted chart.
- ***References.*** List any relevant documents referenced.

5.4.3. Volume II – Cost Proposal: The Cost Proposal should contain cost estimates sufficiently detailed for meaningful evaluation with a break-down of costs on an annual basis and by task. A narrative supporting the costs should also be included. The Cost Proposal does not have a page limit and may be provided in the applicant's preferred format. The Cost Proposal must be uploaded as a separate Portable Document File (PDF) compatible with Adobe Acrobat ® version 9.1 or earlier. A PDF is requested to ensure formatting remains consistent and appropriate.

The Cost Proposal should include the following information:

- Individual labor categories or persons (principal investigator, graduate students, etc.), with associated labor hours and unburdened labor rates.
- Benefits and labor burden costs.
- Subcontract costs and type (the portion of work to be subcontracted and rationale). Submit a detailed description of the proposed subcontracted effort(s) and the projected cost(s). Note that separate cost proposals should be provided and incorporated into Volume II for any subcontracts.
- Consultant fees (indicating daily or hourly rate) and travel expenses and the nature and relevance of such costs. Note that separate cost proposals should be provided and incorporated into Volume II for any consultants.
- Travel costs and the relevance to stated objectives; number of trips, destinations, duration, if known and number of travelers per trip. Travel cost estimations should be based on the Joint Travel Regulations (JTR).
- Publication and report costs.
- Estimate of material and operating costs.
- Cost of equipment, based on most recent quotations and itemized in sufficient detail for evaluation. Clearly delineate any computer or IT equipment purchases.
- Communications and publications costs not included in overhead.
- Other Direct Costs.
- Indirect costs.[3]

Applicants shall plan and budget for travel to accommodate the two meetings outlined as follows:

- National Conferences/Workshops/Symposia: Applicants are strongly encouraged to attend a nationally recognized conference, workshop, or symposium in the field of research each calendar year (1 at minimum). Research should be presented as soon as adequate data are available to support posters and presentations. Conferences/workshops/symposia should be attended by the PI and students supporting the research, as appropriate.
- Annual Technical Review: Applicants should plan to attend an annual technical program review meeting. For planning purposes the review will be for five days and will be held in Northern Virginia. DTRA encourages graduate students to attend the Annual Technical Review.

5.4.4. Volume III – Supplemental Information: This volume contains supplemental data. This volume must contain the items detailed as follows:

- A Quad chart for the effort must be uploaded. Please see below for details.

[3] Indirect costs may be restricted to less than 35% of the total award value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds. This restriction does not apply to awards made using fiscal years 2011to 2015 Basic Research funds but may apply to future awards.

- A Statement of Work defining the major tasks and timelines for the effort must be uploaded. Please see below for details.
- A brief summary of any proposed Human Subjects research, or a confirmation that the proposed effort does not include Human Subjects research, must be entered.
- A brief summary of any proposed Animal Subjects research, or a confirmation that the proposed effort does not include Animal Subjects research, must be entered.
- A brief summary of any proposed Biosurety and Select Agent research, or a confirmation that the proposed effort does not include Biosurety and Select Agent research, must be entered.
- A statement of any potential Organizational Conflicts of Interest, or a confirmation of no conflicts, must be entered.
- A statement of Intangible Property Assertions.
- Authorized Offeror Personnel: Applicants must include the name, title, mailing address, telephone number, fax number, and e-mail address of the company and business point of contact regarding decisions made with respect to the applicant and who can obligate the proposal contractually. Also, identify those individuals authorized to negotiate with the Government.
- A statement outlining any current and pending support related to the proposed effort must be entered. This information must be included for each investigator listed in the proposal. This statement requires that each investigator specify all grants and contracts through which he or she is currently receiving or may potentially receive financial support.
- A Cost Summary, which is a form that captures the following total costs by year (this summary includes total numbers only; supporting detail is included in the Cost Proposal):
    - □ Direct Labor
    - □ Fringe Benefits
    - □ Subcontract Costs
    - □ Domestic Travel Costs
    - □ Foreign Travel Costs
    - □ Tuition Costs
    - □ Direct Materials and Supply Costs
    - □ Direct Equipment Costs
    - □ Publication Costs
    - □ Other Direct Costs
    - □ Indirect Costs[4]

[4] Indirect costs may be restricted to less than 35% of the total award value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied

Quad Chart: The quad chart must be presented on 1 page. The quad chart must not contain any proprietary data or markings. The quad chart must be provided in landscape layout. A **template** for the quad chart format may be found online at www.dtrasubmission.net/portal (Microsoft PowerPoint format). A pictorial representation of the quad chart is provided in Figure 1 and includes the relevant fields that must be included in the Phase II proposal submission. The inclusion of the DTRA logo is not required.

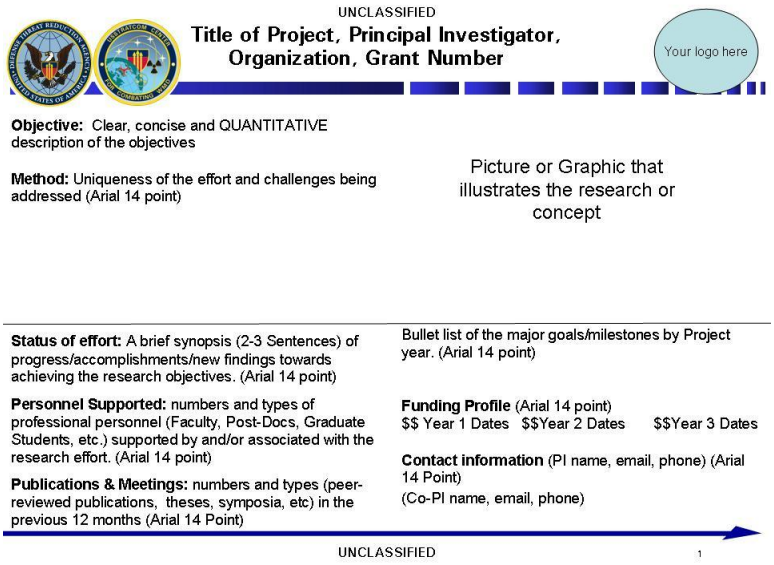

Figure 1: Pictorial representation of the quad chart.

SOW: SOW does not have a page limit, but should be approximately 3-5 pages in length and suitable for incorporation into the award document. The SOW should not contain any proprietary data or markings. Pages should be numbered and the initial page should have a date (document date) shown under the title (the title of the SOW should match that of the proposal). The SOW must be provided in portrait layout. A **template** for the SOW format may be found online at www.dtrasubmission.net/portal (Microsoft Word format).

The proposed SOW must accurately describe the research to be performed. The proposed SOW must also contain a summary description of the technical methodology as well as the task description, but not in so much detail as to make the SOW inflexible. The SOW format/guidance is as follows:

- ***Objective:*** Brief overview of the specialty area. Describe why the research is being pursued and what knowledge is being sought.

- ***Scope:*** Include a statement of what the SOW covers including the research area to be investigated, objectives/goals, and major milestones and schedule for the effort.

---

this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds. This restriction does not apply to awards made using fiscal years 2011 to 2015 Basic Research funds but may apply to future awards.

- ***Background:*** The applicant must identify appropriate documents, including publications that are applicable to the research to be performed. This section includes any information, explanations, or constraints that are necessary in order to understand the hypothesis and scientific impact on capabilities needed to reduce, eliminate, and counter the threat, and also mitigate the effects of Weapons of Mass Destruction (WMD). It may also include previously performed relevant research and preliminary data.

- ***Tasks/Scientific Goals:*** This section contains the detailed description of tasks which represent the research to be performed that are contractually binding. Thus, this portion of SOW should be developed in an orderly progression and presented in sufficient detail to establish the methodology and feasibility of accomplishing the overall program goals. The work effort should be segregated by performance period for all tasks to be performed and anticipated milestones realized in that year (e.g., Year 1, Year 2, etc., should be detailed separately). Identify the major tasks in separately numbered sub-paragraphs. Each major task should delineate, by subtask, the research to be performed by year and each task should be numbered using the decimal system (e.g. 4.1, 4.1.1, 4.1.1.1, 4.2, etc.). The sequence of performance of tasks and achievement of milestones must be presented by project year and task in the same sequence as in the Technical Proposal. The SOW must contain every task to be accomplished to include a detailed schedule.

  The tasks must be definite, realistic, and clearly stated. Use "the awardee shall" whenever the work statement expresses a provision that is binding. Use "should" or "may" whenever it is necessary to express a declaration of purpose. Use "will" in cases where no applicant requirement is involved; e.g., power will be supplied by the Government. Use active voice in describing work to be performed. Do not use acronyms or abbreviations without spelling out acronyms and abbreviations at the first use; place the abbreviation in parenthesis immediately following a spelled-out phrase. If presentations/meetings are identified in your schedule, include the following statement in your SOW: "Conduct presentations/meetings at times and places specified in the award schedule."

- ***Deliverables:*** The deliverables must include the following:

  - Annual Research Performance Progress Report(s): Annual progress reports will be due no later than 1 July of each year. Awards effective after 31 January will not require a progress report until 1 July of the following year. A Technical Reporting Guide may be found online at the www.dtrasubmission.net/portal.

    The Annual Report is *not* a cumulative report. The first Annual Report shall only include actions that occurred from the Period of Performance start date up to submission of the first Annual Report. Each subsequent report shall only include actions that occurred during the 12-month period following the previous year's Annual Report.

    In brief, awardees should plan to report on the following information in the annual Research Performance Progress Report: Accomplishments, Products, Participating/Collaborating Organizations, Impact and Changes/Problems. This information will be provided in a format to be directed by DTRA.

- □ Annual Quad Chart(s): At the direction of DTRA, an updated Quad Chart must be submitted. DTRA will provide instructions not later than 1 May of each year on how the Quad Chart is to be submitted

- □ Annual Metrics Survey: At the direction of DTRA, a Metrics Survey must be completed. DTRA will provide instructions not later than 1 May of each year on how the Metrics Survey is to be submitted. Note that the Metrics Survey is not a cumulative survey. The first Metrics Survey shall only include actions that occurred from the Period of Performance start date up to submission of the first Metrics Survey. Each subsequent report shall only include actions that occurred during the 12-month period following the previous year's Metrics Survey. Metric categories include, but may not be limited to the following: Personnel Supported; Publications; Interactions/Transitions; Participation/presentations at meetings, conferences, seminars, etc.; new discoveries, inventions, or patent disclosures; Honors/Awards; courses taught; etc.

- □ Research Performance Final Report: A comprehensive final technical report is required at the end of an effort, due before the end of the period of performance. A Technical Reporting Guide may be found online at the www.dtrasubmission.net/portal.

  The final report will always be sent to the Defense Technical Information Center (DTIC) and reports may be available to the public through the National Technical Information Service (NTIS).

- □ Invention Reports: Invention reports must be filed annually, due no later than 1 July of each year. The recipient shall use DD Form 882, Report of Inventions and Subcontracts in accordance with the published instructions for the form **IF** the awardee has a reportable event. Negative reports are not required. The submission of the DD Form 882 is required at the conclusion of all awards.

- □ The Federal Financial Report, SF425 is due quarterly, no later than 30 days after the end of the reporting period. Reporting periods are as follows: 1 January – 31 March, 1 April – 30 June, 1 July – 30 September, and 1 October – 31 December. First year reports shall have a reporting period of the start date of the MIPR through 30 June. Final reports shall be submitted no later than 90 days after the project or MIPR period end date. Applicants should note that Section 11 of the SF425 "Indirect Expense" must be completely in its entirety.

5.5. Marking of White Paper and Proposal and Disclosure of Proprietary Information other than to the Government. The white paper/proposal submitted in response to this Service Call may contain technical and other data that the applicant does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation. Public release of information in any white paper/proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, is provided by an applicant in a white paper/proposal, it will be treated in confidence, to the extent permitted by law, provided that the following legend appears and is completed on the front of the white paper/proposal: "For any purpose other than to evaluate the white paper/proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided

that if an award is made to the applicant as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the agreement. This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) _____ of this White Paper/Proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the Proposal from further consideration without assuming any liability for inadvertent disclosure.

The Government will limit dissemination of properly marked information to within official channels. In addition, the pages indicated as restricted must be marked with the following legend: "Use or disclosure of the white paper/proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the front page of this white paper/proposal."

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event that properly marked data contained in a white paper/proposal submitted in response to this Service Call is requested pursuant to the Freedom of Information Act (FOIA), 5 U.S.C. § 552, the applicant will be advised of such request and, prior to such release of information, will be requested to expeditiously submit to DTRA a detailed listing of all information in the white paper/proposal which the applicant believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the applicant will ensure that any information released by DTRA pursuant to the Act is properly identified.

By submission of a white paper/proposal, the applicant understands that proprietary information may be disclosed outside the Government for the sole purpose of technical evaluation. The Program Coordinator will obtain a written agreement from the evaluator that proprietary information in the white paper/proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

5.6. Export Control Notification. Applicants are responsible for ensuring compliance with any export control laws and regulations that may be applicable to the export of and foreign access to their proposed technologies. Applicants may consult with the Department of State with any questions regarding the International Traffic in Arms Regulation (ITAR) (22 CFR Parts 120-130) and/or the Department of Commerce regarding the Export Administration Regulations (15 CFR Parts 730-774).

5.7. White papers and proposals may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Program Coordinator via the e-mail address listed in Section 9.

6. Submission Dates and Times

6.1. White papers will be accepted based on periods as outlined in Table 1 (below). The due date for the Phase II invited proposal submissions will be provided in the letter of invitation. Applications will be reviewed under very limited circumstances if they are received after these deadlines. Additional timeline details are available to all applicants at www.dtrasubmission.net/portal, e.g. notification date

for proposal invitations. Applicants are responsible for checking the www.dtrasubmission.net/portal for changes and updates to the schedule.

6.2. Applicants are responsible for submitting white papers and invited proposals so as to be received by the DTRA submission site by the time and dates listed in Table 1 (below) and the letter of invitation for proposals, respectively. When sending electronic files, the applicant should allow for potential delays in file transfer from the originator's computer server to the Government website/computer server. Applicants are encouraged to submit their proposals early to avoid potential file transfer delays due to high demand encountered as the submission deadline approaches.

6.3. Please note 15 USC 260a establishes daylight saving time as the standard time during the daylight saving period.

6.4. Additional opportunities for white paper submissions with applicable topics, due dates, and application packages will be posted as amendments to this Service Call. Schedules of future amendments, topic information and due dates will not be provided and questions requesting information relevant to future amendments, schedules and/or topics will not be answered in advance of an amendment.

Date	**Event**
1 March 2011	Service Call announced on www.dtrasubmission.net/portal
Period A, Period B, Period C, and Period D are CLOSED	
Period E	
1 December 2014	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period E topics and white paper receipt deadline
30 January 2014	Phase I white paper receipt deadline
11:59pm EST, Not prior to 3 April 2015, and not later than 1 May 2015 *	Phase II invitation-only proposal receipt deadline
October—December 2015	Period E MIPRs scheduled to be awarded
Period F	
TBD	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period F topics and white paper receipt deadline
TBD	Phase I white paper receipt deadline
TBD	Phase II invitation-only proposal receipt deadline
TBD	Period F MIPRs scheduled to be awarded
Period G	

Period H
……
Period 'n'

Table 1: List of important dates.

6.5. Acceptable evidence to establish the time of receipt at the Government office includes documentary and electronic evidence of receipt maintained by DTRA. Applicants should also print, and maintain for their records, the electronic receipt following submission of a white paper and proposal to the DTRA submission site.

6.6. If the white paper and invited proposals are submitted to the DTRA submission site after the exact time and date specified in this Service Call for the white paper and the letter of invitation for the invited proposal, the submission is "late" and will be reviewed at the discretion of DTRA.

6.7. If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be submitted to the DTRA submission site by the exact time specified in this Service Call for the white paper and the letter of invitation for the invited proposal, and urgent Government requirements preclude amendment of the Service Call closing date, the time specified for receipt of submissions will be deemed to be extended to the same time of day specified in the Service Call on the first work day on which normal Government processes resume.

7. Application Review Information

7.1. Evaluation Criteria. The evaluation criteria to be used for review of applications are listed below. Only the first two criteria will be used to evaluate white papers; all four will be used to evaluate invited proposals.

1. Technical/Scientific Merit. This area addresses the technical approach and the contribution of the research to advancing the scientific body of knowledge. It evaluates what research will be performed and how it will be accomplished. Three factors will be considered. The factors are listed in the order of importance.

    - *Soundness of Approach.* This factor addresses whether the proposal clearly identifies and demonstrates an understanding of the scientific challenges and whether the project has a well-designed methodology, based on sound scientific principles, and how technical risks are addressed, mitigated, and managed.
    - *Degree of Innovation.* This factor addresses the originality of the concept, its scientific merit, its creativity, and/or the novelty of the approach and the potential of the project to advance the scientific body of knowledge. The degree of innovation will be judged based on the innovation or originality that is appropriate to the proposed project.
    - *Anticipated Scientific Impact.* This factor addresses the potential of the proposed work to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts and the anticipated impact on the state of the science.

2. Responsiveness to Topic Area and Program. This area evaluates the extent to which the proposed research supports specific topic areas. It also considers the derivative benefit that

may be realized by the performer and its organization through performance of the proposed research. The two factors are weighted equal to each other.

- *Responsiveness to Topic Area.* This factor addresses the responsiveness of the proposal to the objectives in the specific topic area and the contribution to the C-WMD science needs outlined in the topic.
- *Derivative Benefit.* This factor considers training of students in science, engineering, and/or mathematics through the proposed research.

3. Program Capabilities. This area addresses key personnel, facilities, and major equipment required to accomplish the research. The two factors are weighted equal to each other.

   - *Qualifications.* This factor will be scored based on the qualifications and availability of the proposed PI, co-PIs and other key personnel who are critical in achieving proposed objectives.
   - *Capabilities.* This factor considers the applicant's current or planned facilities and equipment that support achieving the proposed objectives. Capabilities evaluation will be based on the total capabilities of the assembled team that will be brought to bear as part of the proposed project.

4. Cost Realism and Reasonableness. This factor considers the adequacy and reasonableness of resources applied to each project task. This includes labor (in terms of time and mix), equipment, other direct costs, and indirect costs.

7.2. Review and Selection Process. The white paper and proposal selection process will be conducted based upon a technical review and includes the use of non-government peer-reviewers. Each white paper and invited proposal will be reviewed within the period to which it was submitted.

7.2.1. White paper (Phase I) evaluation will be based on 2 equally weighted criteria described in Section 7.1: 1.) Technical/Scientific Merit and 2.) Responsiveness to Topic Area and Program, which will each be scored as Green (acceptable), Yellow (acceptable with minor issues), or Red (unacceptable). The Government reserves the right to limit the number of Phase II invited proposals requested depending upon the volume of white papers submitted, the results of the Phase I evaluation, and the specific needs of the Agency.

7.2.2. Invited Proposal (Phase II) Evaluation will be based on the 4 criteria described in Section 7.1. Criteria 1. Technical/Scientific Merit and Criteria 2. Responsiveness to Topic Area and Program are equally weighted and are more important than Criteria 3. Program Capabilities which is more important than Criteria 4. Cost Realism and Reasonableness. All 4 criteria receive a numerical score ranging from 1 (unacceptable) to 5 (outstanding).

7.2.3. Other factors that may be considered during the selection process are the possible duplication with other research currently funded by the Government, program balance across research topics, and budget limitations. Accordingly, proposals may be selected for funding which are not reviewed as highly as others, which are of higher risk and/or which may be of a higher cost.

7.2.4. The Government reserves the right to select all, some, or none of the proposals, or any part of any proposal, received in response to this Service Call and to make awards without discussions with

applicants; however, the Government reserves the right to conduct discussions if determined necessary.

7.2.5. Additional details, including the due date, for Phase II submissions may be provided to applicants in the invitation email.

7.3. Technical and Administrative Support by Non-Government Personnel

7.3.1. It is the intent of DTRA to use non-government personnel to assist with the review and administration of submittals for this Service Call.

7.3.2. All invited proposals will be reviewed by subject matter experts (peer reviewers) who are non-government personnel.

7.3.3. Participation in this Service Call requires DTRA support contractors to have access to white paper and invited proposal information including information that may be considered proprietary. Existing DTRA contractors include but may not be limited to the following: TASC Inc. (advisory and assistance services) and their subcontractors, Suntiva Executive Consulting (contract specialist support) and their subcontractors, SBG Technology Solutions and their subcontractors, and Terremark Worldwide Inc. Each contract contains organizational conflict of interest provisions and/or includes contractual requirements for non-disclosure of proprietary contractor information or data/software marked with restrictive legends.

7.3.4. All individuals having access to any proprietary data must certify that they will not disclose any information pertaining to this Service Call including any submittal, the identity of any submitters, or any other information relevant to this Service Call.

7.3.5. All applicants to this Service Call consent to the disclosure of their information under these conditions.

8. Award & Notification Information

8.1. Applicants of white papers that are not selected for invitation will be notified of the decision by e-mail at all of the addresses provided at the time of submission.

8.2. An invitation to submit a proposal will be extended to those applicants whose submissions were selected in Phase I. The invitation will be transmitted via e-mail to all of the email addresses provided at the time of submission.

8.3. Applicants will be notified by DTRA of their selection/non-selection for award from the Phase II invited proposals via email to all of the email addresses provided at the time of submission. Notification of proposal selection is not an authorization to begin work.

8.3.1. A notice of selection should not be construed as an obligation on the part of the Government; only duly authorized procurement personnel may commit resources, this will be done by issuing a MIPR document to the selected applicant. Also, this notification must not be used as a basis for accruing costs to the Government prior to award. Selected applicants are not authorized to begin work, as any award is subject to successful negotiations (if determined necessary by DTRA) between the DTRA contracting division and the selected organization, and to the availability of funds.

8.4. A debrief summary will be provided as part of all notification emails.

8.5. All notifications will be made from notification@dtrasubmission.net. **E-mails to this e-mail address will not be answered or forwarded.**

8.6. The applicants must be aware that it is their responsibility to ensure 1.) correct emails are provided at the time of submission, 2.) this e-mail notification reaches the intended recipient, and 3.) the email is not blocked by the use of 'spam blocker' software or other means that the recipient's Internet Service Provider may have implemented as a means to block the receipt of certain e-mail messages.

8.7. If for any reason there is a delivery failure of these e-mail notices, **DTRA will not further attempt to contact the applicants.**

9. Agency Contacts

9.1. All administrative and programmatic correspondence should be directed to HDTRA1-BRCWMD-SC@dtra.mil.

Every effort will be made to provide a timely response to all inquiries; however, e-mails may not receive a response. Attachments will not be reviewed.

9.2. Specific technical correspondence regarding the thrust areas as well as the topics corresponding to the thrust areas may be directed to the following e-mail addresses:

Thrust Area 1: BRCWMD-TA1@dtra.mil

Thrust Area 2: BRCWMD-TA2@dtra.mil

Thrust Area 3: BRCWMD-TA3@dtra.mil

Thrust Area 4: BRCWMD-TA4@dtra.mil

Thrust Area 5: BRCWMD-TA5@dtra.mil

9.2.1. Please note that technical correspondence e-mails may or may not be reviewed and responded to; **attachments will not be reviewed.**

9.2.2. Please reference the topic in the subject line of the email, as applicable.

9.2.3. Dialogue that assists the applicants in developing better white papers and invited proposals is encouraged.

9.2.4. Questions regarding debriefing summaries for white papers that are invited to full proposals are encouraged.

9.2.5. Requests to reconsider white papers and/or full proposals, requests for additional information beyond the debriefing summaries for non-invites/non-selections, and rebuttals to the debriefing summary (e.g., additional data, further explanation, etc.) WILL NOT be considered under any

circumstances.

10. Period E Topics

DTRA Basic Research Needs

PerE-Topic 1: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Average Award Amounts for PerE-Topic 1:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 1:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Sensing of short range radiological signatures in limited access environments is a difficult problem. Because most direct radiological signatures can often only be detected at close range (< 100 m), mechanisms to employ autonomous platforms permitting close, discrete information collection is desirable. Further, the ability for these platforms to successfully select between a range of detection algorithms and methods based on information gained from secondary signatures also likely to be present (such as magnetic, optical, infrared, seismic, acoustic, or others) is also potentially necessary. Rapid ability to choose among these disparate methods may require automatic action in a disturbed and quickly changing environment.

Impact: Autonomous platforms capable of using minimal data exchange between each other and/or support from reachback or other command resources will reduce the limitations that may be introduced by dependence on human reaction times. Furthermore, such platforms will be able to successfully navigate a wide range of terrain either on their own or via collaboration with a variety of heterogeneous land/air platforms. Detection systems would also be enhanced by capabilities to collect from challenging environments and return samples to staging points. Additionally, the ability to identify and deploy sensors as part of long dwell (mission dependent, but may extend to months or longer) "leave behind" capability improves persistent surveillance.

Objective: The focus of this topic is on identification of the key scientific obstacles to the deployment of autonomous counter-WMD search assets especially useful for detection of radiological signatures. This topic investigates the identification of approaches towards this kind of autonomous search capability, and does not focus on the development of hardware for platform mobility or sensors. Proposals that engage government laboratory institutions are also encouraged.

Research areas may include but are not limited to the following areas:

- The investigation of appropriate autonomous search algorithms, communication-minimal cooperation schemes, and detection algorithm/method decision logic supporting the employment of multiple autonomous search platforms against a radioactive source located in a large (~km^2) complex area that may contain obstacles, including shielding structures
- The exploration of multi-mode, one mode being a radiological signature, detection summary reporting methods suitable for employment over long latency small bandwidth wireless communications links
- The identification of methods to deploy long dwell detectors from these platforms as needed, and the identification of methods (i.e. hierarchically distributed sensors) for such platforms to autonomously choose deployment locations for these long dwell detectors based on radiological (i.e. varying signal to noise environments), or operational constraints
- The investigation of autonomously assigning roles to assets, self-organizing techniques, and the optimization of resources for radiological signature sensing

---

PerE-YIP-Topic 1: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Average Award Amounts for PerE-YIP-Topic 1 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 1.

PerE-Topic 2: Advancing Nuclear Forensic Methods for Collecting and Analyzing Post-Detonation Debris (Thrust Area 1)

Average Award Amounts for PerE-Topic 2:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 2:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: This topic explores ways to enable accurate post-detonation analysis of debris from a nuclear event on a short time scale. The DoD provides the capability to collect and analyze post-detonation debris. DTRA is responsible for research and development that will enable this post-detonation forensics. The current methodology includes a radiochemical assay that requires time to obtain statistically accurate results. The advancement of analytical techniques could lead to the ability to accurately analyze debris on time scales shorter than this current methodology. Of interest are innovations that identify and quantify elemental and isotopic constituents of a fresh radioactive fallout debris sample. Of particular interest are accurate and timely measurements of major, minor, and trace constituents, including actinide species, fission products, and activation species. Ideally, novel methodologies to perform these measurements would be field-adaptable and

non-destructive, allowing for additional confirmation analysis on the same sample. Furthermore, improvement within the capability of sample collection is needed, as well as improvements in predictive modeling of the quality of airborne debris collection; novel methods are sought which have the potential for greater robustness under a wider variety of adverse conditions. Combining novel collection and analysis techniques is of interest where the analysis provides either identification or quantitative isotopic composition of the debris. Other areas of interest include understanding phenomenology that govern novel analysis methodologies, methodologies for compiling, assessing, and interpreting large sets of data, as well as understanding the treatment of data uncertainties. Disciplines which may advance the science for post-detonation nuclear forensics include but are not limited to chemistry, nuclear physics and engineering, materials science, instrument development, mathematics and statistics, computer science and modeling and simulation.

Impact: The development of advanced post detonation forensics addresses DTRA's counter-WMD need to enable: prevention of future detonations, identification of those responsible, and improvement in response and recovery efforts. Such research has the potential to lead to a field-deployable system with a real-time analysis capability.

Objective: This topic explores novel methods and advancements in the ability to collect samples of material, analyze radioactive debris, and identify signatures from debris analysis in a post-detonation environment. Specific interests include the investigation of non-destructive analytical techniques, fundamental phenomenology of analytical measurements, and innovative data-set handling. Laser-Induced Breakdown Spectroscopy (LIBS) and LIBS-like technologies are not sought at this time and will not be considered. Proposals that engage government laboratory institutions are permitted and encouraged.

Research areas may include but are not limited to the following areas:

- Novel methods that enable rapid and cost-effective isotopic identification and measurement after a nuclear detonation
- Field-adaptable analytical techniques
    - Non-destructive methodologies are preferred
- Exploration of waterborne sample analysis
- Investigation of historic waterborne sample data and possible correlation to historic particle or gaseous sample forensics conclusions for the same events
- Investigations to improve databases of physical constants and their uncertainties
    - Constants such as cross sections, decay branching ratios, or nuclear energy levels relevant to nuclear forensic analysis
- Investigation of techniques with the potential to eliminate the need for time-consuming separative radiochemistry on a gross vs. net timeline
    - Techniques that reduce the overall timeline are preferred over techniques that have a short timeline but require multiple measurements, lengthy calibration procedures, etc.
- Techniques or methodologies for repetitively validating and verifying measurements made on samples that have components inherently disappearing and changing with time
- Novel methods to create realistic debris standards for collection and analysis validation
- Mathematical and statistical treatment methods of large, complex data sets relevant to radiological analyses
    - Exploration of methods with the potential to enable remote characterization and quantification of airborne debris
- New methods for targeted sample collection after a nuclear event
    - Novel methodologies for determination of collection locations in a post-detonation environment
    - Combined airborne and ground collection and analysis methods
    - Exploration of combined meteorological models with nuclear fallout models

    - Novel tool for quality prediction of airborne debris collection
- Advanced methods of sample pre-concentration for higher signal output

---

PerE-YIP-Topic 2: Advancing Nuclear Forensic Methods for Collecting and Analyzing Post-Detonation Debris (Thrust Area 1)

Average Award Amounts for PerE-YIP-Topic 2 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 2.

PerE-Topic 3: Development of Models for the Time Evolution of Realistic Multilayered Networks in Response to Large-Scale Damage (Thrust Area 2)

Average Award Amounts for PerE-Topic 3:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 3:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: The dependence of military and national capabilities on increasingly complex and layered networks requires the development of models which can provide realistic representations of these networks, in particular to the effects of large-scale damage resulting from a WMD attack. The development of technologies which can provide real-time data on large multilayered networks allows for modeling of real networks in order to simulate and study WMD effects on real networks. The modeling of these effects is not limited to the initial damage but requires the modeling of the propagation of this damage through and across the multiple layers of the networks. A particular difficulty arises in modeling the large size of realistic networks and the propagation of effects across multiple networks and network layers.

Impact: The results of this research are intended to produce methods and models capable of simulating the time evolution of effects of large-scale damage across multiple layers of large communication, control, and power networks. These models can then be used to analyze the immediate and long-term damage and recovery of real networks in response to the large-scale damage of WMD effects. This analysis can be used for command and control evaluation involving tasks such as identifying critical points within a network or development of methods to prevent or mitigate the propagation of damage throughout a network.

Objective: The objective of this research is to develop the mathematical underpinnings suitable for network models which can provide accurate representations of real networks over time in response to large-scale damage. The mathematical representations should look at the evolution and propagation of damage over time

and across multiple network layers. This should include multiple time scales of short-term damage propagation and long-term restoration and recovery. In order to verify and validate the functionality of the network models to produce realistic simulation of large networks, real data should be used. This includes use of the data to verify that models can provide accurate representations of real historic events and validate that they can provide representations of real world networks in response to large-scale WMD damage.

Suggested model development could include these features:

- Multiple large (greater than 10,000 nodes) multilayer networks (communication, control, and power) and their interactions, not just on a single layer
- Use of realistic, large datasets to produce results
- Validity and usefulness of any assumptions within the model of real networks should be clearly explained
- Explain how the model deals with uncertainties in the data
- Cover the time evolution of the network across multiple time scales in response to large-scale damage. This would include transient rapid behavior on the order of seconds to outages that may persist for hours.
- Preliminary verification and validation schemes
- Reflect analysis of real failure events and nominal data from many different interdependent systems, including investigation of complex cases of multiple failure modes
- Identify key interconnected system features which lead to fragility or robustness, perhaps starting with single point failures then leading to multi-point failures
- Identify and quantify methods to improve robustness of critical infrastructures
- Development of innovative mathematical tools
- Model should reflect an understanding of the spatial and temporal distribution of damage
- Identification of minimal data sets required for meaningful decision analysis and estimates of associated uncertainties, for pre-event protection as well as post-event recovery
- Identification of data which, if public, would enable effective WMD attacks or better protection
- Quantification of impacts of hidden failures of network components on overall network responses
- Assure awareness of current worldwide literature on network effects, societal impacts, and robustness

---

PerE-YIP-Topic 3: Development of Models for the Time Evolution of Realistic Multilayered Networks in Response to Large-Scale Damage (Thrust Area 2)

Average Award Amounts for PerE-YIP-Topic 3 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 3.

PerE-Topic 4: Machine Learning Methods for Network Analysis (Thrust Area 2)

Average Award Amounts for PerE-Topic 4:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 4:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.

- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: WMD-related activity is difficult to detect because evidence tends to be low observable and ambiguous. Combinations of evidence tend to be critical to detection of WMD-related activity. Networks relating observations and representing interactions provide additional evidence that can demonstrate patterns to expose WMD-related activity long before it would be evident by other means.

DTRA's data has structure not present in many applications.

- Much of the data available to us is rich, heterogeneous, and interlinked.
- Information about people, events, places, and interactions, whether extracted from text, communications, transactions, or a variety of sensor networks, often requires reasoning about the network (the entities and relationships) while taking into account noise, uncertainty, and ambiguity in the observational data.
- In social networks, links and nodes may be intentionally obscured or missed, not only making inference more difficult but also altering the underlying probabilistic model.
- The model can also change over time as the social network in question changes.
- Even constructing the network, by integrating the multiple data sources, is a challenging problem that requires inferring the correspondence between nodes and entities and the mappings between observational relationships and linguistic links.
- Impact of cultural factors (cultural practices and social norms) can influence the social network statistics and must be individualized in the learning and inference process.

Impact: Advanced network algorithms that can incorporate the above issues will enable DTRA to add additional evidence in detecting and analyzing low footprint activity involved in the development or acquisition of WMD. This will be particularly important in the many instances where there is no direct evidence and only patterns of activity are observed.

Objective: The objective of this program is to advance the foundational elements of network analysis upon which algorithms, which can address problems of high priority to combating WMD threats, can be developed. These capabilities should have a large and broad impact.

Key motivating problems are node characterization, link prediction, and general inference of network phenomena (e.g. detect latent causes), all of which require probabilistic reasoning. The thrust of this topic is the incorporation of structured leaning and related forms of probabilistic reasoning to address the above network problems. Methods that also have broader applicability to secondary problems will be preferred. Examples of second tier problems include anomaly detection, overlapping community detection, node change prediction, temporal analysis, and prediction of how networks adapt to external induced changes.

The primary problems are driven by the problem of detection. Methods explicitly not of interest under this research program include social problems such as exerting influence within the network or ascertaining the power structures within the network.

The core of the proposed effort should address probabilistic representation, learning, and inference methods needed to represent uncertainty and reason collectively across network data. Desirable extensions of these methods are the ability to:

- Exploit novel representations schemes (examples include: embedded or hyperbolic geometry, network decomposition, network grammars, new matrices, and spectral graph theory)
- Develop faster versions of existing methods that still maintain the integrity of the result
- Represent, analyze, and reason on hypergraphs (i.e. multipartite graphs)
- Capture multiple node and edge types, each potentially with attribute information including text, image and other multimedia data
- Capture socio-behavioral interactions, taking into account temporal and spatial information where applicable, causal information where available, and discover latent structure
- Develop inference algorithms that are able to infer missing values, discover anomalies, and make predictions about unknowns at the node and link level, not just about the aggregate properties of the network

Attention should be given to computational speed and scaling. The anticipated order of computation should be discussed in the proposal. Empirical validation should also be part of the proposer's plan. The proposals should briefly comment on what data will be used or how data will be found. Data need not relate to WMD but ideally would have comparable network structure and behavior. It is not essential to work on extremely large networks, but the concepts should be testable on a network on the order of at least 10,000 nodes. Comments on the scalability both in speed and memory should be included.

Proposals should: make clear what distinguishes the approach from other possible approaches and provide the reason as to why the approach was chosen over other potential approaches; and identify risks and considerations that would mitigate risks. Failure to consider risks may be taken as an indication of a failure to anticipate them. The proposals should also lay out a case as to why there is a reasonable expectation of success and detail what results might be expected. Proposals involving collaboration between different key experts or institutions should provide an indication of level of effort among the participants.

PerE-YIP-Topic 4: Machine Learning Methods for Network Analysis (Thrust Area 2)

Average Award Amounts for PerE-YIP-Topic 4 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 4.

PerE-Topic 5: Semantic Representation (Thrust Area 2)

Average Award Amounts for PerE-Topic 5:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 5:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.

- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: There is currently a failure in DTRA's ability to extract evidence of preparation of development of WMD and WMD attacks. Sixty percent of sentence-level events are missed or misclassified. However, post hoc analysis indicates that evidence of WMD incidents was usually manifest in reports and other communications available at the time. This evidence for instances of WMD-related activities is buried in a sea of background data that is so vast that advanced machine reading capabilities are required. Often the individual pieces of WMD evidence are low observable and ambiguous. It is only when multiple pieces of evidence are collectively assessed, that detection can be made. This requires a high probability of detecting each piece of evidence, as small chances of failure compound exponentially when multiplied across the large quantity of necessary data.

WMD-related evidence takes the form of extracted sentence-level events. These events have a predicate-argument structure that provides the basis of meaning for a sentence. While these events are contained within sentences, there are limitations to understanding the events on the semantic level. Identifying semantic indicators such as verb sub-categorization, meaning components, selectional preferences, and semantic roles are poorly developed to varying degrees, and in some cases poorly understood. For example, ambiguous word senses and semantic roles are difficult to label. These limitations translate to the current limited ability to detect WMD-related activity.

Operational demands may occur in data scarce environments, thus data must be deeply analyzed with detection rates in a computationally demanding environment that has a high flow of information. The information is expressed in poor grammar and using diverse and irregular language, which increases the demands on the representations used. Discourse analysis to find informational relationships between sentences is insufficient. Research in the commercial sector has mainly focused on maximizing precision, not recall. A primary driver to properly analyze events is to convert text to meaning, which depends on the semantic tools available (WordNet, VerbNet, FrameNet, etc). Methods must automatically find semantic representations for words in their textural context.

Impact: This research will advance the theoretical understanding and methods necessary to improve existing natural language processing. Specifically, it will enable a new class of algorithms that will allow DTRA to move from the term level to the semantic level. Fundamentally it will enhance event analysis from its current unacceptable failure level of 60%. Improving this means improving detection of evidence relevant to WMD. Beyond text analysis, progress in representational learning will impact DTRA's pattern recognition systems across all types of data. In a broader sense, this research will enable many operational requirements that use text, such as information retrieval, question and answering systems, reasoning systems, machine translation and the semantic web, and other semantically encoded applications.

Objective: To develop improved methods to determine and incorporate semantic information to accurately analyze events. Proposed research may be an extension of existing approaches, but it could also develop innovative methods that mirror linguistic structures in new ways. The main thrust of this topic is to bring distributional semantic analysis on the meaning component level. The research should ultimately support areas such as:

- *Representation*: Develop semantic representation schemes to unambiguously express meaning. For "terms", example representations could include structures and components. For "relative meaning", example representations could include location or weights within some semantic space.

- *Identification*: Develop automatic processing of corpora to identify both lexical semantics and semantic relationships involved in predicate-argument or some alternative to represent semantic structure for sentences.
- *Interpretation*: Develop automatic processes to translate words (and potentially phrases or sentences) to a form that provides semantic characterization. The process should take into account contextual cues.

Research areas should be in one or both of the following two areas:

Research Area 1: *Automatic determination of semantic components across multiple languages*. Distributional semantics works at a finer level, but does not use an explicit representation of semantic components. Only a small number of words have been decomposed into components. The different languages often vary in meaning at the word level, but are consistent at the semantic component level. This is especially true for unrelated languages. These variations can provide a means to automatic determination of semantic components. Proposals should identify a small set of unrelated languages (minimum of three) to be used to find semantic components. Components should be at broad applicable concepts not nuances between one or two terms. Examples are orientation, topology, force dynamics, possession, causality, and various state changes. Inspiration for this topic comes from previous work by Beth Levin and Leonard Talmy in semantic components.

Two issues should be addressed specifically in this research area. First, many methods discover semantic information that is syntagmatic in nature; whereas often the more valuable information is paradigmatic. Can the proposed method find paradigmatic relations or alternative forms of meaning to syntagmatic relations? Moreover, how can the representation reflect meaningful semantic structures in contrast to mere statistical correlations that have no linguistic basis? Second, distributed semantics exhibit a news bias, i.e., finding information that is reported, but missing common real world information that is typically known. Can the proposed method mitigate or address this issue?

Research Area 2: *Development of distributed semantic methods.* Development of more effective distributed semantic methods or better ways of working with existing distributed semantic methods. Many of these methods (e.g. deep learning) lack transparency and interpretability. Of high interest are methods that improve these attributes or alternative methods that exhibit these attributes. Development could include insights from comparison of methods, improving performance, and understanding best practices of using such methods. The model used to encode the information (e.g. vector space, hierarchy, network, etc.) should be justified. There are a number of starting points for the investigation. Ideally, a proposal might include multiple research areas.

These proposals could focus on:

- Advances in distributional analysis representations of input or within the algorithm. This could include input in a syntactic form, semantic features (e.g. Jackendoff's conceptual functions), selectional preferences, or semantic components. Methods that capitalize on a semantic representation such as semantic components within the method are also of particular interest.
- Methods that can better utilize textual evidence information for input. Currently textual evidence information is not in co-occurrences, but it is in nonlocal features that might span one or multiple sentences involving technical key words such as the names of special equipment, materials, or organisms.
- Methods that use underlying latent information or incorporate background knowledge since WMD-related data tends to be sparse.
- Methods to encode and fuse contextual or syntactic information with semantic information.
- Innovative methods to map or transform the data to an alternate form. For example, superior ways to map words to data structures (e.g. vectors, networks, feature structures, hypergraphs, hybrid approaches, etc.).
- Ways to augment semantic distributional analysis with other data analysis methods such as dimensionality reduction, e.g. compressed sensing theory, manifold learning, hashing, etc.

Later in the investigations, areas such as the following may be addressed (for Research Area 1 or 2):

- Development or improvement of contributing components that enable distributional semantic methods such as similarity measures.
- Incorporation of real world and linguistic knowledge.
- Hybrid discrete and distributional processing that exploit the strengths of each. Consideration will be given to approaches that have application to verb sub-categorization, parsing, word sense disambiguation, semantic role labeling, identification of selectional preferences, or other forms of semantic representation of sentences. Demonstration of applicability might be given in later phases of the research.
- How to get composable representation of meaning without parametric burden of current methods such as representing combination of words and phrases vector as tensors.

Proposals should: specify both the method to infer representation and also the representational basis (e.g. vector space, network, hierarchical, word clustering or other similarity metrics); make clear what distinguishes the approach from other possible approaches and provide the reason as to why the approach was chosen over other potential approaches; and identify risks and considerations that would mitigate risks. Failure to consider risks may be taken as an indication of a failure to anticipate them. The proposals should also lay out a case as to why there is a reasonable expectation of success and detail what results might be expected. Proposals involving collaboration between different key experts or institutions should provide an indication of level of effort among the participants.

PerE-YIP-Topic 5: Semantic Representation (Thrust Area 2)

Average Award Amounts for PerE-YIP-Topic 5 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 5.

PerE-Topic 6: Model Framework for Societal Responses to Nuclear Events (Thrust Area 2)

Average Award Amounts for PerE-Topic 6:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 6:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Global defense postures require greater specificity of higher order WMD effects on population dynamics. Such higher order effects may include complex cascading behavior between various social systems/networks that have traditionally been too complex to easily describe. However, current planning is largely devoid of WMD effects considerations beyond direct physical damage and contamination. The current body of theory for WMD damage largely focuses on direct physical damage, and less so on complex societal impact. Increased fidelity of additional societal consequences from post WMD scenarios is required to allow decreased recovery time. Moreover, increasing globalization, with concomitant industrial and political linkages, exacerbate the cascading effects of a WMD event beyond borders and direct physical damage. Recent studies and exercises indicate that models require a more complete understanding of societal influence in analyzing the consequences of execution when WMD events occur; and that efforts to specifically model population behaviors in response to WMD events either rely on natural disaster data[1], or assume uniform human behavior responses[2]. Analogous to behavioral differences by disaster type, representativeness of behavioral dynamics to a sudden WMD event cannot be assumed.

Underscored by the dearth of holistic current research on socio-cultural factors within the context of a WMD event, DTRA's investment is requisite to improving the present-day understanding of higher order effects on human behavior across distinct cultural and regional characteristics. To be relevant to DTRA, WMD higher order effects modeling must become more dynamic by taking into account the behaviors of the affected populace and the social impacts in the context of the preexisting conditions in a region. Demographic factors such as population density, degree of urbanization, age, gender, sex, ethnicity, culture, education, previous military training, etc. can yield nuanced differences in the non-directed (i.e., no government entity is directing the population where to relocate) migration patterns. Because coordinated plans beyond the regional level have been shown to expedite a region's ability to recover from high-impact events and minimize global cascading effects, it is important to both map the socio-cultural and geo-political terrain by region, as well as incorporate the inter-regional human ties and infrastructural interdependencies, with concomitant consideration of situational preconditions or existing stressors.

Impact: After a WMD event, decision makers need to know how the affected population can effectively respond and recover. Delivering information of this nature is critical for: directing troop movement to avoid congested areas which would hinder mission success; directing appropriate types and levels of aid to the incumbent, displaced and migrating population; and engaging the correct local government officials and agencies to manage humanitarian efforts. The primary impact of this research will be the future development of new capabilities for national decision support. A framework to capture the affected population's behavioral dynamics, coupled with their underlying regional socio-cultural and geo-political conditions, will lend greater fidelity to decision making, as well as expand the constrained strategic planning tool-kits in use today. A successful multi-dimensional model will need to overcome the significant challenge to integrate the various layers to be represented in the model.

Objective: Research conducted under this topic will develop a mathematical framework to predict non-static societal response following a WMD event. Proposals must identify relevant data sources that will be used. Only proposals that develop mathematical frameworks will be considered.

Research proposals should cover one or more of the following:

- Develop a mathematical framework to model non-directed, local/regional migration for various segments of a society reacting to a WMD event
- Determine which societal, political, environmental, economic, military, etc. factors and preconditions are relevant to the developed mathematical framework and their respective sensitivities
- Methods to incorporate information from local infrastructure and social networks into comprehensive response models

- Develop computational algorithms and methods that allow for a variety of WMD scenarios, model extensions, and validation
- A thorough description of the proposed data sources required to make the models tractable

[1] Kanno, Taro, Tatsuya Shimizu, and Kazuo Furuta. "Modeling and simulation of residents' response in nuclear disaster." *Cognition, Technology & Work* 8.2 (2006): 124-136.

[2] Parikh, Nidhi, et al. "Modeling human behavior in the aftermath of a hypothetical improvised nuclear detonation." *Proceedings of the 2013 international conference on Autonomous agents and multi-agent systems.* International Foundation for Autonomous Agents and Multiagent Systems, 2013.

PerE-YIP-Topic 6: Model Framework for Societal Responses to Nuclear Events (Thrust Area 2)

Average Award Amounts for PerE-YIP-Topic 6 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 6.

PerE-Topic 7: Epigenetics of Response to Radiation (Thrust Area 3)

Average Award Amounts for PerE-Topic 7:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 7:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options. Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Studying the effects of ionizing radiation on biological systems relates to the DTRA mission for mitigating the consequences of WMD, particularly in terms of (#1) providing c-WMD situational awareness and preventing proliferation of WMD, and (#2) protecting the warfighter from deleterious effects from ionizing radiation (IR) exposure. In terms of (#1) providing c-WMD situational awareness, the warfighter may encounter environments where the exact nature and extent of radiological contamination is unknown. Naturally occurring indicator species, or bioindicators, may act as an orthogonal means of identifying radiological contamination if they undergo a readily observable and specific stress-induced response to IR and/or absorption/adsorption of radionuclides[1-3]. Studying how epigenetic processes influence phenotypic plasticity may lead to improved identification or design of radionuclide bioindicator species. In terms of (#2) protecting the warfighter from deleterious effects of IR exposure, there is a growing body of evidence that some diseases are dominated by epigenetic processes[4-5]. Therefore a better understanding of underlying epigenetic processes may lead to the development of novel and efficacious pre and post treatments for IR exposure and can aid in establishing reasonable exposure limits. Several mechanisms have been shown to play a role in IR-induced changes including DNA damage as well as epigenetic-associated mechanisms such as DNA methylation, modification to histones, and RNA-associated silencing[6-7]. While there has been a substantial amount of research on IR-induced DNA damage, a systems biology (holistic) understanding of the role epigenetic mechanisms play in phenotypic

plasticity is still lacking. Additionally, the relative contribution genetic versus epigenetic processes make to induction of phenotypic plasticity in response to IR exposure is not known.

Impact: Research conducted under this topic will lead to the identification and holistic understanding of IR-stress induced mechanisms and pathways that lead to phenotypic changes in bioindicator species. This research may lead to improved identification or design of radionuclide bioindicator species as well as protection of the warfighter from the deleterious effects from IR. Additionally this research may lead to an orthogonal means for early warning of environmental contamination with radionuclear materials as well as a means to detect undeclared nuclear activities. The proposed research is responsive to the Department of Defense Strategy for Countering Weapons of Mass Destruction (2006) with regard to minimizing WMD effects to sustain military operations in a "WMD environment[8]."

Objective: The proposed research seeks to identify and characterize epigenetic mechanisms of IR stress-induced phenotypic changes in previously characterized bioindicator species. Proposals using genetically modified organisms or cancer studies will not be considered. Of particular interest to DTRA are low-level radiological environments where exposures between 0.1-1 Gray to the warfighter may occur. Ideal bioindicators will have the following conditions met:

- There is a reasonable amount of biological information already available on them that can guide development of testable hypotheses regarding use as environmental indicators.
- They are amenable to future research in order to obtain missing or imprecise data.
- They are either ubiquitously distributed or, if indigenous, present in some abundance in particular ecosystems of interest.
- Their geographical ranges are limited and/or well-defined.
- They are likely to be exposed to radiation as a result of their own natural ecology (e.g., feeding habits).
- Their life cycles are likely to be of some relevance for evaluating radiological contamination events from a temporal perspective.

Research areas may include but are not limited to the following:

- Development and execution of systematic approaches to determine the relative extents to which genetic versus epigenetic processes are responsible for morphological/physiological changes.
- Theoretical development and testing of holistic temporal models of genetic and epigenetic processes involved in phenotypic plasticity in response to IR.
- Identification and characterization of protein receptors involved in “sensing” IR and their connection with epigenetic reprogramming.
- Determination of whether epigenetic mechanisms resulting in phenotypic changes may be extrapolated to other species.

[1] Bräutigam, Katharina, et al. "Epigenetic regulation of adaptive responses of forest tree species to the environment." *Ecology and evolution* 3.2 (2013): 399-415.

[2] Hiyama, Atsuki, Wataru Taira, and Joji M. Otaki. "Color-pattern evolution in response to environmental stress in butterflies." *Epigenomics and Epigenetics* 3 (2012): 15.

[3] Møller, Anders Pape, and Timothy A. Mousseau. "Efficiency of bio-indicators for low-level radiation under field conditions." *Ecological Indicators* 11.2 (2011): 424-430.

[4] Egger, Gerda, et al. "Epigenetics in human disease and prospects for epigenetic therapy." *Nature* 429.6990 (2004): 457-463.

[5] Feinberg, Andrew P. "Phenotypic plasticity and the epigenetics of human disease." *Nature* 447.7143 (2007): 433-440.

[6] Geras' kin, S., T. Evseeva, and A. Oudalova. "Effects of long-term chronic exposure to radionuclides in plant populations." *Journal of environmental radioactivity* 121 (2013): 22-32.

[7] Kovalchuk, Olga. "Epigenetic Effects of Ionizing Radiation." *Environmental Epigenomics in Health and Disease*. Springer Berlin Heidelberg, 2013. 99-126.

[8] United States. Office of the Chairman of the Joint Chiefs of Staff. *National Military Strategy to Combat Weapons of Mass Destruction*. Washington, DC: Chairman of the Joint Chiefs of Staff, 2006.

PerE-YIP-Topic 7: Epigenetics of Response to Radiation (Thrust Area 3)

Average Award Amounts for PerE-YIP-Topic 7 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 7.

PerE-Topic 8: Determining the Mechanistic Basis for Surface Interactions and Effects on Catalytic Efficiency in Tethered Enzyme Systems (Thrust Area 3)

Average Award Amounts for PerE-Topic 8:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 8:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: DTRA is charged with providing for sustainment of operations in CBRNE environments. At present, detection technologies are inadequate to fully characterize contaminated sites and provide sufficient early warning so that warfighters can use avoidance and protection strategies to prevent or mitigate exposures. The development of "remote detection" technologies (i.e., those removed from areas marked by high levels of contamination) is desirable in order to empower field commanders to make real-time or near-real-time decisions regarding appropriate protective postures prior to site entry.
The present topic seeks novel solutions for detection of signatures indicating proximity of processes associated with nuclear proliferation. Signatures are not limited to radioactive residues but can also include industrial solvents, heavy metals, and other chemicals such as those which denote production of explosives and propellants. The anticipated end-state capability is reliable differentiation of key signatures at low concentrations within complex aqueous matrices. Herein, the specific focus is on basic research to interrogate enzyme-based interfacial materials that will lead to development of highly selective and sensitive detection motifs.

Researchers continue to evaluate the use of enzymes as interfacial materials in detection platforms, primarily because of superior ability to bind specific analytes to the exclusion or near-exclusion of others. Their work further demonstrates that enzymes can be incorporated into well-characterized platforms, such as optical and electrochemical platforms, and establishes utility of those systems under specific conditions. However, enzymes are frequently labile (e.g., prone to chemical change) outside of the narrow range of conditions that promote activity in living systems, thus more recent research efforts have sought to increase durability in broader operational environments by tethering or immobilizing enzymes on synthetic substrates.

Proof-of-concept experiments indicate that enzymatic activity can be retained by engineering enzymes with precisely-placed chemical linker molecules which promote favorable active site orientations. Retention of activity for enzymes tethered to simple, well ordered substrates like self-assembled monolayers is demonstrated, and the work provides important insights regarding surface-enzyme interactions that lead to reduced catalytic efficiency. However, it is not substantially predictive of enzyme behavior in more complex strata. While the combination of enzymes and complex substrates offers far greater capacity for manipulation and, ultimately, development of more powerful detection systems, recent work shows that use of disordered substrates (e.g., polymers) leads to localized destabilization and changes in surface loading that can alter material properties in an unpredictable fashion. It is therefore desirable to expand upon current research efforts in order to investigate interactions among complex substrates, linker molecules, and enzymes with the end goal of developing interfacial materials that optimize the desired attributes of selectivity, sensitivity, and stability.

Impact: The fundamental knowledge generated as a result of conducting the research described here will be broadly applicable to core DTRA requirements for supporting the warfighter during CBRNE operations. In addition to addressing existent capability requirements, detailed characterization of enzymatic systems will provide the baseline understanding necessary to rapidly engineer enzyme-based defense technologies in response to novel and emerging threats. Finally, the development of enzyme-based technologies to address a number of diverse mission needs is of paramount interest to the DoD and is critical to maintaining technological advantage.

Objective: The overarching goal is to interrogate complex substrate-linker-enzyme interactions that alter stability and/or efficacy of enzyme-based systems in order to elucidate contributing mechanisms. Model enzymes may serve as the basis for preliminary work, but those with relevance to detection of signatures discussed in the background section should be evaluated in studies proposed for the latter stages of the work plan.

Research areas may include but are not limited to the following:

- Alterations to enzyme activity and stability resulting from differences in chemical linker attachment points
- Impact of length and composition of chemical linker groups on enzymatic structure, activity, and stability
- Localized unfolding/disruption to enzyme conformation due to interactions between side-chain residues and substrate
- Other electrostatic, stereochemical, and electrochemical effects that impact catalytic efficiency or enzyme stability
- Sequential modification to substrate properties due to surface loading and/or other factors

Experimental conditions (e.g., pH, temperature, and so on) should be well-delineated *a priori* so that systematic evaluation of possible contributing factors and combinations of factors can be investigated. Although computational modeling is recognized as a necessary component of the above research, a purely computational approach is not considered competitive.

PerE-YIP-Topic 8: Determining the Mechanistic Basis for Surface Interactions and Effects on Catalytic Efficiency in Tethered Enzyme Systems (Thrust Area 3)

Average Award Amounts for PerE-YIP-Topic 8 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 8.

PerE-Topic 9: Understanding X-ray Interactions that Lead to Arc Formation in Solar Arrays (Thrust Area 3)

Average Award Amounts for PerE-Topic 9:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 9:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Space systems are used to coordinate mission-critical information in all operational systems which impact the mission performance of the U.S. warfighter; policy, logistics, operations, reconnaissance, planning. Photovoltaic arrays are the components which power these systems in orbit around the Earth. To guarantee support when it is needed, these arrays and the systems they power must have very high reliability which includes robustness against nuclear radiation prompt doses.

Most modern satellites employ solar arrays that consist of multiple III-V (e.g., InGaAs/GaAs/InGaP2/etc.) three-junction cells connected in series to form "strings" to achieve the desired voltage. The strings of cells are constructed in parallel connections to achieve the necessary current and the solar cells are typically protected by anti-reflective coated (e.g.: MgF2) cover glasses. The space radiation environment (high energy electrons, X-rays, gamma rays, etc.) generates a spatially varying net charge across the surfaces of the solar array resulting in large electric potential differences between the surfaces. This, in combination with the high voltages of the strings of cells, can cause a dielectric breakdown of the array materials allowing electric arcing.

Arc formation is assisted by the presence of conductive plasma, created either by the environment or by another arc. Primary arc formation is typically caused by a dielectric breakdown between the over-charged cover class and the high voltage solar array. The plasma generated by this primary arc facilitates the formation of secondary arcs between adjacent strings of cells. These secondary arcs can become self-sustaining by feeding off both the power of the solar array as well as the generated plasma, diminishing or destroying the array.

How the prompt dose radiation environment from a nuclear event in space affects the arc formation in satellite solar arrays is currently not well understood. There is much room for exploration of how cold X-rays generate high-density blow-off plasma due to the very high prompt dose of radiation to the first few microns of surface materials. The subsequent potential to support arc formation in the presence of plasma, the nature of the plasma, the behavior of the plasma in a high voltage environment are also not well understood or modeled.

As an example, the blow-off of a highly conductive plasma layer has been observed in experiments using the Omega laser at the University of Rochester Laboratory for Laser Energetics. The Omega laser was used to drive an aerogel target to generate ~2 nanosecond long x-ray pulses. Langmuir probes biased at 10-30 V and solar cells biased at 100 V were used to measure the effects of plasma blow-off. The fluence at the probes and cells

of x-rays with energies below ~1 keV ranged from 0.03 – 0.3 Joule/cm^2. In all cases, the probes and solar cells exhibited the effects of a conductive surface plasma.

Impact: Understanding the mechanisms which govern arc formation and its scaling will direct future design efforts to manage these events and their consequences on space systems. The expectation is that this will eventually result in better, more cost-effective ways of designing future space system solar arrays that are not vulnerable to natural and nuclear radiation effects.
Objectives: The overall objective of this topic is to explore the fundamental physics of the generation and properties of the warm, dense plasma that may drive primary and secondary arc formation under enhanced radiation conditions. Experimental, theoretical, modelling, and computational efforts that accurately describe, predict, and replicate the phenomenon are of interest to DTRA. All efforts should be focused on discovering the fundamental science that drives the arc formation in the enhanced radiation environment, not on engineering approaches that seek to develop new method for mitigation or new solar array designs.

Research areas may include but are not limited to the following areas:

- The time-dependent interaction of x-rays (with a range of effective blackbody temperatures from 100 to 1000 eV) with a variety of metallic and insulating materials that drive the blow-off and ionization of surface layers
- The nature of electrical conduction properties of the surface plasma generated in the aforementioned range. Models should be validated with experiments using laser- or pulsed-power-driven x-ray sources

---

PerE-YIP-Topic 9: Understanding X-ray Interactions that Lead to Arc Formation in Solar Arrays (Thrust Area 3)

Average Award Amounts for PerE-YIP-Topic 9 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 9.

PerE-Topic 10: Techniques, Methods, and Structures for Characterizing Radiation Effects in Emerging Nanoscale Memory and Logic Materials and Devices (Thrust Area 3)

Average Award Amounts for PerE-Topic 10:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerE-Topic 10:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Commercial microelectronics (memory and logic devices) continue to decrease in size, increase in complexity, and incorporate emerging electronic materials. There are a wide variety of emerging electronic materials (III-Vs, 2D materials, high-k dielectrics, and carbon-based materials) and new device structures (FinFETs, MTJs (magnetic tunnel junctions), nanowire (gate all around) FETs, single layer/few layer devices) that are of potential interest for DoD systems. Before these materials and devices can be incorporated in DoD systems the effects of radiation (total ionizing dose, displacement damage, and single events effects) must be well understood and adequately modeled. While many characterization techniques, methods, and structures have been developed to understand these effects in silicon devices, these techniques are not sufficient to fully characterize emerging memory and logic devices. New techniques, methods, and test structures are needed to both increase the fundamental understanding of radiation effects in these materials and devices as well as allow for quicker and earlier determination of a device's potential utility in high radiation environments.

Recently techniques such as high resolution transmission electron microscopy (HRTEM), atom probe tomography, and Raman spectroscopy have been applied to characterizing fundamental radiation effects in microelectronic materials and devices. There has been significant progress in the development of new, or refinement of established, analytical characterization techniques in other fields such as nanotechnology, biotechnology, and materials science that could potentially be adapted to the study of radiation effects in emerging memory and logic devices.

It is also critical that these characterization techniques, methods, or test structures be integrated with or connected to models (e.g. molecular dynamics, energy deposition, device function, or circuit function) to ensure that improved physics understanding is rapidly transitioned to device, circuit, and component design.

Impact: New and improved characterization techniques, methods, and test structures for identifying and understanding radiation effects in emerging nanoscale memory and logic materials and devices will shorten the timeline for adopting promising microelectronic technology while reducing the risks of unknown radiation effects. It is expected that these emerging technologies will improve the speed and power of microelectronics in DoD systems while reducing power consumption and increasing device reliability.

Objective: To develop new or improved techniques, methods, or test structures for identifying and characterizing the effects of radiation (gamma, neutron, ion, and high energy electron) on emerging electronic materials and devices (memory and logic). This topic is not focused on a particular technology or material, but rather on broadly applicable techniques, methods, and structures. This topic is **not** interested in radiation detection or dosimeters.

Of particular interest are techniques, methods, or test structures that can:

- Characterize radiation effects in emerging memories including but not limited to resistive random-access memory (RRAM), magnetic RAM (MRAM), spin torque transfer MRAM (STT-MRAM), phase change memory, and three dimensional RAM
- Address the challenges of characterizing radiation effects in nanoscale structures, thin (down to monolayer) films, and two dimensional materials including but not limited to charge collection, interface effects, and environmental/passivation effects.
- Use of novel test devices to characterize single event effect vulnerability in small geometry, advanced devices where only single-channel devices can be fabricated
- Provide a quantitative correlation between pulsed laser single event testing, ion testing, and modeling/theory
- Provide representative radiation effects results with early devices that may not be representative of final device structure
- Identify and characterize atom level defects in situ or with minimal sample preparation

Prospective investigators are encouraged to collaborate with NASA, DoD, DOE and other federally sponsored and overseas facilities in order to facilitate transition of the research to be performed to practice.

PerE-YIP-Topic 10: Techniques, Methods, and Structures for Characterizing Radiation Effects in Emerging Nanoscale Memory and Logic Materials and Devices (Thrust Area 3)

Average Award Amounts for PerE-YIP-Topic 10 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 10.

PerE-Topic 11: Chemistry of Chemical Agents, Simulants and Precursors (Thrust Area 4)

Average Award Amounts for PerE-Topic 11:

- Single Scope Awards will average approximately $100,000 to $150,000 per year.
- Multidisciplinary Awards will average approximately $200,000 to $350,000 per year.

Award Structure for PerE-Topic 11:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Counter-WMD operations in non-permissive or access-denied environments often rely on conventional weapons with energetic material payloads to defeat WMD targets. Current conventional weapons contain explosives and future custom-designed counter-WMD weapons will include reactive materials that continue to burn over longer periods of time than a conventional explosive. It is important to understand the effect of burning, variable heating rates, high temperature and temperature duration, on chemical agents that could be contained in a WMD target, and asymmetric heating rates arising in multi-room structures (thermal delay/shielding). What intermediate reactive species and final products are formed as chemical agents/simulants/precursors are subjected to variable high temperatures and heating rates? What are the thermal degradation conditions and reaction rates? It is important to consider if any thermal decomposition products or intermediate products are harmful or toxic. Further, since future weapons may contain reactive metals that burn to form metal oxides, or sulfates that form sulfides, or halogenated oxides that form halogens, any enhanced effect from metal oxides, sulfides or halogens are also of interest.

In addition, counter-WMD operations could potentially leak agents/simulants/precursors on to the floor or subsurface areas, which could be various porous (such as concrete, soil, etc.) or cracked/broken surfaces. Depending on the floor surface, pH of the surface, chemical composition of the surface, polyvalent cation concentrations, etc., a certain amount of agents/simulants/precursors may be neutralized in the surface or dispersed by water after it had been absorbed in to the surface.

Both effects, destruction during the counter-WMD operation and post-operation neutralization by the environment, need to be characterized and understood to evaluate the full effect of counter-WMD operations on targets containing chemical agents, simulants and precursors. Therefore, this topic seeks basic research on high-temperature decomposition reaction mechanisms and kinetics chemical agents, simulants and precursors, to include studies in the presence of metal oxides, sulfides or halogens; and considering various types of floor surfaces such as concrete, soil, etc.

Impact: The success of this research would provide essential characterization and kinetic parameters that will put adversarial WMD targets at risk, particularly those with chemical agent. This research is also critical for predicting a weapon's effectiveness and lethality against chemical-agent containing WMD targets.

Objectives: This research topic seeks chemistry of chemical agents, simulants and precursors. White papers proposing experiments or modeling will be considered.

Research areas may include but are not limited to the following:

- Reactions, reaction mechanisms and kinetics of chemical agents and/or simulants and/or precursors when heated at varying heating rates from 10,000 degrees per second to 100 degrees per second, to high temperatures from 300K to 2,000K
- Reactions, reaction mechanisms and kinetics of chemical agents/simulants/precursors heated in the presence of metal oxides, sulfides or halogens when heated at varying heating rates from 10,000 degrees per second to 100 degrees per second, to high temperatures from 300K to 2,000K
- Considering various types of floor surfaces such as concrete or soil, on reactions, kinetics, and mechanisms of chemical agents/simulants/precursors

---

PerE-YIP-Topic 11: Chemistry of Chemical Agents, Simulants and Precursors (Thrust Area 4)

Average Award Amounts for PerE-YIP-Topic 11 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 11.

PerE-Topic 12: Alternative Signatures and Characterization Methods for Monitoring Potential CBRN Sites (Thrust Area 5)

Average Award Amounts for PerE-Topic 12:

- Single Scope Awards will average approximately $100,000 to $150,000 per year.
- Multidisciplinary Awards will average approximately $200,000 to $350,000 per year.

Award Structure for PerE-Topic 12:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section 3.1.1 for details on the possible structure of awards under this CALL.

- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Operations at sites used for storing, handling, or testing WMD may comply with recognized treaties or agreements and monitoring systems exist that can help support verification of compliance. WMD development and proliferation has also occurred outside of treaties or agreements and may include advances by nations or subnational groups. This introduces uncertainties that further complicate efforts to reduce the WMD threat. Both cooperative and non-cooperative cases benefit from identification and exploitation of additional, novel signatures to provide alternative means of indicating development of WMD. In addition to nuclear proliferation, non-nuclear WMD developments need to be addressed.

Physical and life science methods can contribute to innovation in identifying and exploiting novel signatures. New materials and techniques in nanoscience, mass spectrometry, spectroscopy, quantum sensing, imaging, isotope analysis, and radiometry are examples of physical science methods that continue to push the envelope of sensitivity, selectivity, and reduction of false positives.

In order to verify treaty compliance but protect state secrets, rapid and reliable conclusions about the provenance of an item presented to an inspectorate must be produced. These methods must be scientifically sophisticated enough to conclusively identify the composition and time-dependent radiation exposure history of a component from a dismantled nuclear weapon system. As a complement to conventional nuclear detection techniques, unique physicochemical signatures may be a valuable way for the onsite inspection (OSI) team to determine if the object presented matches its declared use and history. Other goals include those techniques that can be used with area or remote collection of samples to understand processes at a facility of interest and identify the likely presence of WMD materials.

Life science techniques may seek to find pathways and accumulation mechanisms for chemicals and isotopes to enter into flora, fauna, and biota in general. A challenge is to make such methods very sensitive, and to seek techniques that cover accumulated concentrations less than parts per million and desirable to much less than parts per billion; i.e., ultra-trace.

Impact: Successful innovations from this basic research will improve understanding of signatures that identify and describe WMD development and proliferation. This will impact the ability to assure treaty and agreement compliance across chemical, biological, radiological, and nuclear WMD, as well as provide capabilities for identifying proliferation activities associated with CBRN proliferation. This will also provide ability to reduce uncertainties surrounding site activities in non-cooperative situations such as may arise in conflict requiring military action to counter WMD.

Objective: Investigate theoretical, experimental, and/or modeling approaches to novel signatures for characterization. Studies addressing radioactive contamination at sites should address intensities between 0.01 and 100 millirads/hour to cover cases ranging from approximately natural background to hot spots holding very radioactive sources. Much smaller dose rates indicating trace presence of isotopes is also sought. Studies examining chemical signatures should focus on trace or ultra-trace methods, and quantify sensitivities (e.g., nanomolar or much smaller concentrations achieved?) to advance state-of-the-art for the signature studied.

Research areas may include but are not limited to the following:

- Explore methods for rapid identification and characterization of readily exploitable isotopic-based differences that support characterization of site processes, identification of components and their origins. Advances in determining global background variation, mass spectrometry, nanoscience

mechanisms, spectroscopy and other means may be used to perform ultratrace analysis and identification.

- Investigate chemically reactive signatures for chemical, nuclear, or biological WMD production activities. The focus is not on WMD agents but on indirect indicators such as may identify missile testing, WMD production techniques, or other supporting activities in WMD system development.
- Determination of unique physicochemical signatures through advanced analysis techniques such as:
    - Mass spectrometry such as SIMS or GC-MS to look for changes in the elemental or molecular composition of the material
    - Microscopy techniques such as AFM or SEM to identify microstructural or morphological changes
    - Optical or surface spectroscopy such as Raman spectroscopy or ellipsometry to identify subtle chemical or physical property changes
    - Bulk measurement techniques such as nanoindentation or conductivity tests to quantify changes in hardness or charge mobility
    - Imaging techniques such as hydroacoustic imaging or x-ray to probe subsurface structural shifts or defects
- Novel methods to investigate both time-integrated and time-dependent radiation exposure history of a component to assist with verification of items found at a facility.
- Methods to distinguish between physicochemical signatures of operational radiation exposure and artificial aging of a component from a variety of radiation sources, both stockpile-relevant and relevant for understanding origins.
- Methods that enable site profiling and verification of presence of processes or materials, by investigation of natural biological source specimens local or remote to a site that provide biomarkers/bioindicators of WMD-related materials or activities. This may be achieved by means of indicators related to uptake of WMD-related: chemicals; isotopes (including non-radioactive ones that may be signatures); or radioactive and nuclear materials. The research focus may include transport in air/water/earth (including relation of transport processes to bioaccumulation / biomagnification of WMD interest), accumulation pathways (i.e., advance the understanding of how such processes relate to bioavailability and concentration factors to advance knowledge of how the concentration in an organism relates to environmental concentrations of chemical X), biological (or other) half-lives, and means to readily extract trace or ultra-trace indicators (either physical extraction or information read-out methods, such as means for sensing or interrogation of biological markers of exposure) from exposed biological samples.

PerE-YIP-Topic 12: Alternative Signatures and Characterization Methods for Monitoring Potential CBRN Sites (Thrust Area 5)

Average Award Amounts for PerE-YIP-Topic 12 will be approximately $100,000 per year.

For topic description and award structure see PerE-Topic 12.