DEFENSE THREAT REDUCTION AGENCY

BROAD AGENCY ANNOUNCEMENT

HDTRA1-11-16-BRCWMD-Service Call for

DoD Degree-Granting Academic Institutions

Amendment 3 (December 2013)

Research and Development Enterprise

Basic and Applied Sciences Directorate

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

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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 D, DTRA seeks unclassified, basic research ideas that are responsive to the goals and objectives of the topics outlined in Section 10. The topics labeled "PerD" are only valid for Period D of this Service Call. Only white papers responsive to the topics posted for Period D and submitted by the Period D 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.

3.1.1. 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

3.2. 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.

3.3. 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.

3.4. 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.

3.5. 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 year 2011, 2012, or 2013 Basic Research funds but **may** apply to future awards.

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

3.7. 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 D 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. The final submission must be 'locked' on the DTRA proposal submission website; until a submission has been 'locked' (saved as final), the submission is not eligible for review. Look for this 'lock' icon  on the DTRA proposal submission website. Applicants are responsible for ensuring compliant and final locked 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 8.0 or greater. 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 D 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 8.0 or greater. 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.

[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 year 2011, 2012, or 2013 Basic Research funds but may apply to future awards.

- 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.
- 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]

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.

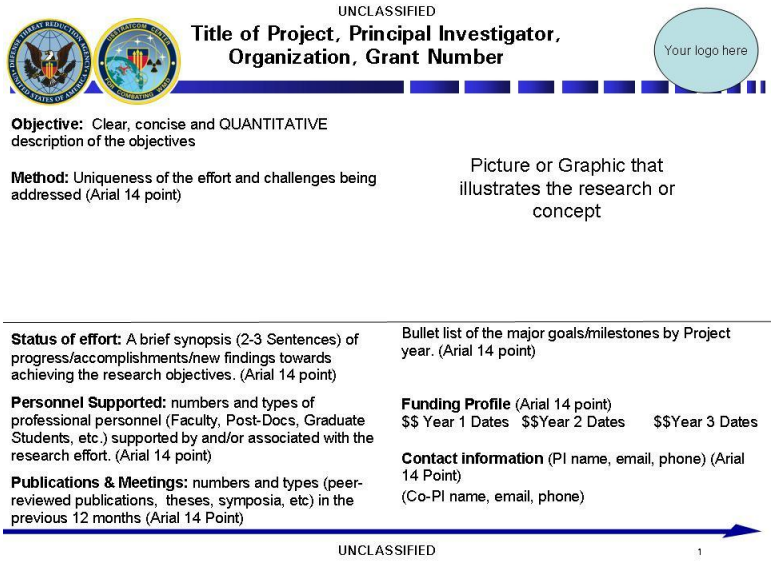

Figure 1: Pictorial representation of the quad chart.

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

[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 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 year 2011, 2012, or 2013 Basic Research funds but may apply to future awards.

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.

- ***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 September of each year. Awards effective after 31 May will not require a progress report until 1 September of the following year. A Technical Reporting Guide may be found online at the www.dtrasubmission.net/portal.

  - □ Annual Quad Chart(s)

  - □ Annual Research Summary(ies): The Research Summary is a short (less than one page)

description of the research objectives and current status.

□ Annual Metrics Survey

□ 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 using DD Form 882 Reporting 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.

5.5.1. 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).

5.5.2. 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, and Period C are CLOSED	
Period D	
2 December 2013	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period D topics and white paper receipt deadline
Midnight EST, 13 January 2014	Phase I white paper receipt deadline
Midnight EST, Not prior to 1 April 2014, and not later than 2 May 2014 *	Phase II invitation-only proposal receipt deadline
October—December 2014	Period D MIPRs scheduled to be awarded
Period E	
TBD	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period E topics and white paper receipt deadline
TBD	Phase I white paper receipt deadline
TBD	Phase II invitation-only proposal receipt deadline
TBD	Period E MIPRs scheduled to be awarded
Period F	
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 D Topics

DTRA Basic Research Needs

PerD-Topic 1: Refractory Debris Dissolution Techniques for Nuclear Forensic Field Procedures (Thrust Area 1)

Average Award Amounts for PerD-Topic 1:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-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: This topic explores ways to dissolve post-detonation debris from a nuclear event using environmentally friendly, potentially field deployable, techniques on a reasonable time scale (<15 hour total dissolution time for a 5-10 gram sample), and/or a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical measurements. The Department of Defense provides the capability to collect and analyze post-detonation debris. DTRA is responsible for research and development that will enable this post-detonation forensic analysis.

The current methodology includes a radiochemical assay that requires complete dissolution of difficult-to-dissolve refractory samples to obtain statistically accurate results. Current dissolution strategies utilize hazardous chemicals and hard acids such as hydrofluoric acid (HF) which requires a brick-and-mortar lab for personnel and environmental safety. The elimination of such hazardous materials could potentially allow for samples to be dissolved in the field. Ideally, these novel methodologies would also provide a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical measurements, enabling increased interpretation of nuclear forensic analysis results. Disciplines which may advance the science for post-detonation nuclear forensics debris dissolution include but are not limited to radiochemistry, chemistry, chemical engineering, and instrument development.

Impact: The development of advanced post detonation forensics addresses DTRA's counter WMD need to enable prevention of future detonations, 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 ways to dissolve post-detonation debris from a nuclear event using environmentally friendly, potentially field deployable, techniques on a reasonable time scale (<15 hour total dissolution time for a 5-10 gram sample), and/or a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical. Specific interests include the investigation of non-hazardous chemical dissolution techniques, techniques mating fieldable instrumental dissolution assistance with chemical techniques, and an understanding of the fundamental phenomenology of such dissolution methodologies on the quality of forensic analytical measurements. Proposals that engage government laboratory institutions are also

encouraged. Research proposing direct ablation of surfaces into an analytical instrument (ex. LIBS) are not requested at this time.

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

- Organic methods to completely dissolve high-pressure, high-temperature, refractory debris with environmentally friendly chemicals (e.g. chemicals not requiring containment such as fume hoods, glove boxes, or inert environments)
- Inorganic methods to completely dissolve high-pressure, high-temperature, refractory debris with non-hazardous chemicals (e.g. chemicals not requiring containment such as fume hoods, glove boxes, or inert environments)
- Physically assisted methodologies for dissolving refractory debris such as microwave, sonic, or photon techniques

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PerD-YIP-Topic 1: Refractory Debris Dissolution Techniques for Nuclear Forensic Field Procedures (Thrust Area 1)

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

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

PerD-Topic 2: Photodetectors and Solid-State Neutron Sensors for Radiation Detection (Thrust Area 1)

Average Award Amounts for PerD-Topic 2:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-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: Current radiation detection technologies suffer from setbacks generated by making tradeoffs for many desired features. Such tradeoffs are particularly evident in neutron detection and in the light collection stage of scintillation detectors. Tradeoffs include the following: high detector efficiency demands large area detectors with large power supply needs, good pulse shape discrimination from high radiation backgrounds may incur longer detection times, lightweight and low-cost detector designs generally yield high uncertainties from their poorly-resolved results. Furthermore, older technologies, such as photomultiplier tubes (PMTs) for light collection, remain the gold standard even though they are non-robust, have large associated monetary and power expenses, experience long response times, and may have relatively poor quantum efficiency ($\leq 25\%$).

Understanding the phenomenologies governing novel materials may expose new insights available for radiation-sensing materials and alternative sensing methodologies. For example, nanomaterials may have many exploitable advantages for neutron sensing applications: large surface area to volume ratio, variations in fundamental properties relative to its bulk material, and its potential for self-assembly.

As an example of areas that may be leveraged, the active field of solar cell technology development has the potential to enhance photodetection capabilities by increasing detection efficiency and accommodating flexible and scalable detector designs.

Impact: This topic is important to the counter-WMD mission of DTRA by transforming radiation detection technologies via the unique properties of novel materials which may yield increased sensitivity and specificity. Furthermore, it may enable the development of compact neutron sensors and photodetectors as replacements for older technologies (such as ^{3}He for neutron detection, and photomultiplier tubes for scintillator based detection of neutrons or gammas).

Objective: This topic seeks to surpass the present limitations of detection technologies by exploring novel methodologies and phenomenologies which may improve how neutrons or gamma rays are sensed and recognized from radiological and nuclear materials of interest. Please note that this topic is neither seeking to advance existing detectors nor to geometrically scale down current detection systems/methodologies. Additionally, materials exploring solid-state indirect conversion heterostructures for neutron sensing are not of interest at this time.

In general, neutron-sensing materials must aspire to include the following characteristics: fast response times, excellent neutron-gamma discrimination, non-toxicity, low noise, and an ability to perform neutron spectroscopy in high flux fields. In addition, photodetectors should have high quantum efficiencies in the wavelength region that is typical of current scintillators (near blue to deep ultraviolet).

Research areas exploring nanoscale or microscale materials and phenomenology may include but are not limited to the following areas:

- Investigation of new ecomimetic materials for photodetection
- Exploration of solid-state, direct conversion neutron sensors
- Photodetection techniques employing organic or polymer-based materials
- Current methodologies being investigated for solar cells, such as plasmonic nanostructures or Mott insulators

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PerD-YIP-Topic 2: Photodetectors and Solid-State Neutron Sensors for Radiation Detection (Thrust Area 1)

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

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

PerD-Topic 3: Sensing of Radiation Shielding Materials and Exploiting Interactions with Radiation from Radiological and Nuclear Sources (Thrust Area 1)

Average Award Amounts for PerD-Topic 3:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-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 transportation of concealed special nuclear materials (SNM) most likely would be accompanied by sufficient quantities of radiographic shielding. Such shielding would unavoidably be heavy, composed of specific materials, and may be shaped within geometric constraints to be effective. Specific signatures will often accompany these shielding constraints. This topic is intended to identify and investigate novel signatures that would be unique to shielding materials which may then be used to indicate its presence.

Such signatures may be used to directly sense shielding materials and/or leverage interactions of radiological and nuclear (RN) material with common shielding materials. Many prior studies on similar materials have explored material response (e.g. mechanical) under neutron exposure for conditions relevant to fission and fusion reactor materials. Some of these studies explored bulk effects such as radiation embrittlement, swelling, and radiation creep on extended media at moderate to high temperatures.

The intent of this topic is not to investigate radiation interactions from RN materials with surrounding air or the specific RN material itself. Additionally, proposals outside the scope of basic research (i.e. device build) will not be considered. We are primarily focused on novel methods for direct identification of shielding materials. Specifically, we desire to better characterize radiation interactions from RN materials with potential shielding materials and identify how these resulting interactions might be exploited to reveal a unique signature that can be detected from a distance. Active probing methods that utilize particle radiation and hard photon (> warm x-rays) techniques are not of interest at this time.

Impact: This topic is intended to advance the science related to RN material detection by utilizing any surrounding shielding materials as an indicator of its presence. Currently available technologies present a new opportunity to identify signatures of shielding materials. The anticipated impact of this topic is to elucidate further understanding of novel signatures.

Objective: This research topic seeks basic research to significantly improve our understanding of identifying shielding materials. Collaboration across multiple disciplines is strongly encouraged in order to successfully confront some of the scientific challenges associated with this scale of work (e.g. atomic physics, materials science, radiation physics, remote sensing).

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

- Investigate accumulation of interfacial defects at high Z and low Z material boundaries
- Approaches for characterization of atoms or molecules to assist in the remote sensing of shielding materials
- Novel characterization of unique signatures of shielding materials (e.g. thermal effects on moderator materials)
- Novel sensing based on quantum properties or atomic interference to detect particles, electro-magnetic radiation, gravity, or motion (e.g. gravity gradiometry, mass tomography)
- Interactions and properties of quasiparticles and quantum condensates that can lead to sensing mechanisms
- Capitalize on high precision metrological techniques in microwave to UV frequencies to identify novel signatures (e.g. EUV acoustic nanometrology)

PerD-YIP-Topic 3: Sensing of Radiation Shielding Materials and Exploiting Interactions with Radiation from Radiological and Nuclear Sources (Thrust Area 1)

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

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

PerD-Topic 4: Development of Extremely Rapid Control Strategies for Mitigation of Cascading Failures on Multi-layer/Multi-dependent Dynamic Networks (Thrust Area 2)

Average Award Amounts for PerD-Topic 4:

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

Award Structure for PerD-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: DTRA continues to reappraise the threat, its consequences, the best near term practices, and longer-term research needed for the preservation of essential military capabilities following an attack employing weapons of mass destruction (WMD). A low-cost observation and control methodology exploiting existing equipment has been an identified need since the Electromagnetic Pulse Task Force Report of 1984. Recent advances in network graph theory and the ability to rapidly observe the state of multiple interdependent military and national infrastructure networks, opens the possibility to now address this need and rapidly respond in a manner that will control/stabilize the complex system of networks against single or multiple cascades. Dependent (load), interdependent (load and control) networks, for both military (US and coalition) and national networks play a vital and complex role in this situation. WMD stressors to networks include widely distributed

failures of electronics from nuclear electromagnetic pulse or the long-term denial of network elements or segments due to WMD contamination from nuclear, biological, and chemical (NBC) material as well as direct physical damage.

Research involving single layer non-dynamic, low- or non-observable network strategies will not be considered. This effort is intended to answer questions such as:

- How do we effectively exploit existing control infrastructure to minimize/stop a cascade?
- What new procedures/controls are required to implement a sub-second control scenario?
- How to perform a sub-second network calculation after an event, combine that with pre-event planning calculations, and use that analysis to halt a cascade in progress?
- How to optimally island the damaged network in time to halt a cascade?
- How to perform all of these tasks with existing infrastructure (existing fiber optic lines and sensors judiciously placed in our networks) at very low cost?
- How to simulate this environment to answer these questions?

Impact: This research has the potential to minimize network outages, significantly reduce the area affected by a cascade, and advance the underlying methodology and theoretical understanding of methods necessary to improve multi-layer/multi-dependent network robustness, management and recovery, and resilience to cascading failures. This research will identify methods to use observable information from networks that are geographically spaced far apart in conjunction with novel pre-planned network analysis techniques for rapid determination of optimal network control to minimize the impact of WMD stressors on complex multi-layer networks. Such planning and control combined with new novel point protection of networks, has the potential to provide cost-effective solutions for EMP, reducing acquisition costs, and increasing WMD survivability and operability.

Objective: The main thrust of this topic is to extend prior network theory research to develop strategies to rapidly control the onset of pre-cascade behavior before the networks decay into full blown cascading failure. The emphasis is on sub-second response, coupled pre-planning and active rapid control strategies, and large realistic synthetic environments for prediction and control of the cascading failures that result from WMD attacks.

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

- Exploitation of currently available sensor information to observe the large geographical scale multi-layer/multi-dependent network state under a WMD attack so that observable data can be used as input for rapid real time network analysis.
- Sub-second network computations to enable decisions concerning real-time minimization of network instability.
- Novel advancements in extremely fast adaptive/computer relaying and other wide area measurement methods to rapidly reconfigure loads as appropriate to minimize the possibility of cascade in the system.
- Novel graph theoretical methods to incorporate distributed real time assessment of the network to be controlled.
- Theoretical understanding of novel point protection and other types of stabilization devices on overall network resilience/robustness. Analysis or development of individual point protection devices themselves is not included in the research areas, only how the fundamental network analysis changes in terms of reliability when networks of such devices are inserted into the networks under question.
- Optimal Rapid and Intelligent islanding/load shedding to limit the cascade affected area.

High value is placed on innovative approaches that have a high potential to yield low cost rapid solutions, can be easily tested physically, and can be inserted into real world large scale synthetic environments for analysis and simulation.

PerD-YIP-Topic 4: Development of Extremely Rapid Control Strategies for Mitigation of Cascading Failures on Multi-layer/Multi-dependent Dynamic Networks (Thrust Area 2)

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

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

PerD-Topic 5: Improved Semantic Analysis Theory to Identify WMD-Related Activities (Thrust Area 2)

Average Award Amounts for PerD-Topic 5:

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

Award Structure for PerD-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 DTRAs ability to extract evidence of preparation of WMD attacks. 60% of events are missed or misclassified, however post hoc analysis indicates that evidence of these WMD events was usually manifest in reports and other communications that were 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 number of necessary data. The WMD related evidence takes the form of extracted 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. Verb subcategorization, meaning components, selectional preferences, and semantic roles are poorly developed, and in some cases poorly understood. For example, ambiguous word senses and semantic roles are difficult to label. Furthermore, existing knowledge is distributed in diverse lexicographical resources, each having its own gaps. These limitations translate to the current limited ability to detect WMD related activity.

DTRA's unique operational demands push the envelope in this area. There is a strong need for extremely high detection (recall) of events in a computational demanding environment that has a high flow of information. The information is expressed in poor grammar, using diverse and irregular language which increases the demands on

the representations used. A primary driver to properly analyze events is to convert text to meaning, which depends on the semantic tools available (such as Wordnet, Verbnet, Framenet, etc.). To fulfill DTRA's operational requirements, work needs to be done to enhance lexicographic resources, build better ontologies, and develop methods that can automatically find semantic representations for words in their textural context.

Impact: This research will advance the theoretical understanding and methods necessary to improve an existing natural language processing. Specifically this research will directly improve lexicographic tools such as Verbnet, which is at the heart of DTRA's most important text analysis processes. It will also 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 level of 40%. 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: The objective of this effort is to advance the fundamental understanding and discover improved methods to accurately analyze events. Proposed research may extend existing approaches, but preference will be given to developing innovative methods that mirror linguistic structures and lexicographic resources in new ways. The main thrust of this topic is to discover innovative and novel new automatic lexical acquisition approaches to improve semantic analysis on both lexical and predicate-argument structure levels. Areas of interest are:

1) 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.

2) 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.

3) Interpretation. Develop automatic processes to translate sentences to a form that provides semantic characterization. The process should take into account contextual cues.

These areas are not independent but build on each other.

Research areas may include but are not limited to the following areas (proposed research focused on discourse analysis and methods will not be considered):

- Develop novel new lexicographic resources to include both semantic and quantitative information suitable to enhance or supplement existing resources. Semantic information could include meaning components, subcategorization, selectional restrictions, and which alternations a term will participates in. Quantitative information would principally be probabilistic such as frequency of occurrence. Of principle interest is material that can continue to support development and use for new purposes such as an annotation bank.
- Contextual and distributional analysis to automatically extract semantic representation from corpora. Proposals should specify both the method to infer representation and also the representational basis (e.g. vector space, network, hierarchy). In addition to explaining the approach, proposals should provide the reason as to why the approach was chosen over other potential approaches. The emphasis of this topic is on the diversity and innovativeness of how semantic information is extracted with the goal to significantly reduce both false positive and false negative results. For example, paradigmatic as

well as syntagmatic features might be considered. More importantly how the representation reflects meaningful semantic structures in contrast to mere statistical correlations that have no linguistic basis.

- Novel development of representational learning (e.g. deep learning) to represent semantic features such as meaning components and selectional preferences. Also innovative developments of methods to encode and fuse contextual or syntactic information with semantic information are of interest. Development would 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. Of particular interest is: verb sub-categorization, semantic role labeling, meaning components, selectional preferences, or other forms of semantic representation of sentences.
- New methods to rapidly and accurately relate semantic findings to language processing such as word sense disambiguation, advanced generalization of semantic role labeling, and parsing informed by a semantic representation. This area should build on the foundation of the other three areas, and only enter in during later years.

PerD-YIP-Topic 5: Improved Semantic Analysis Theory to Identify WMD-Related Activities (Thrust Area 2)

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

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

PerD-Topic 6: Area of Responsibility Centric Cultural Modeling for WMD Threat Detection (Thrust Area 2)

Average Award Amounts for PerD-Topic 6:

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

Award Structure for PerD-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: DTRA, in its role as a combat support agency, is consistently in contact with the Combatant Commanders to maintain awareness of their operational needs. Recently DTRA has received notification of Combatant Commander requirements for modeling support of radical ideation for course of action analysis. Though some current models exist, these models are largely generic, and are insufficiently validated on Area of Responsibility (AOR)-based populations of interest to the Combatant Commanders.

Social network and behavioral modeling research is critical to understanding and predicting the behavior of adversaries under a variety of situations. In particular, research in the social and behavioral sciences provides

insights into ways the threat of WMD attack may be reduced by addressing factors that lead individuals, groups, and states to entertain such attacks and provides tools and methodologies for inferring likely hostile intent or illicit activity through analysis of network interactions.

While analysts and subject matter experts involved in direct personal assessment of WMD threat can directly analyze subjects of interest using their heuristics derived from personal experience, the basic research aimed at quantifying and developing reusable tools routinely makes broad claims about human psychology and behavior based solely on samples drawn from a limited sample of test subjects (Arnett '08). Researchers assume that either there is little variation across human populations, or that these "standard subjects" are representative of all other populations. However, broad analysis has shown that members of different societies have substantially unique characteristics that cannot be derived from general analysis. These findings extend across manifold fundamental aspects of psychology, motivation, and behavior.

This is of great concern, as WMD threats are increasingly from non-state actors; with over one hundred different groups in the past two decades alone from a diverse range of backgrounds. Individual analyst analysis of all of these groups presents a strain on available resources, calling for the need for mathematical and computational models to assist. The findings of distinct regional and cultural differences at the most basic levels (cf. Hermann '08, Heinrich '10, Burke '10, Du '12) call into question the extensibility and basic appropriateness of existing generic models and inferences to the diverse populations across the varied AORs.

WMD related activity is difficult to detect because evidence tends to be low observable and ambiguous. As such, combinations of evidence including actor motivation and ideation are critical to the detection of WMD related activity. Social networks both relate evidence and demonstrate patterns that can expose activity long before the activity would be evident by other means.

To enhance and enable this early detection, and to support the Combatant Commander needs, basic models of human social influence and decision need to be validated on the variety of cultures across the AORs from which groups and individuals shown or suspected of using or pursuing WMD have originated, and where necessary, expanded to include the distinct cultural and regional characteristics that affect said use and pursuit.

Impact: The primary impact of this research will be the development of new capabilities for the Combatant Commanders, enabling them to accurately model radical ideation with their AORs.

This research will advance theoretical understanding and methods necessary to accurately model those cultures from which the majority of adversaries possessing or seeking WMD arise. This will enhance tools to identify those organizations and individuals who have intent to acquire, proliferate, and possibly use WMD, by accurately tailoring them to take into account the unique features that arise from within their cultures of origin.

These enhanced tools can be used as an aid to direct combat, intelligence, or diplomatic efforts to prevent said acquisition, proliferation, or use, which could save both resources as well as lives, by preventing WMD attacks.

Additionally, as network science is a broad and multi-disciplinary field, the methods developed under this effort will likely enhance other DTRA capabilities in Network Science.

Objective: There are two main objectives of this research program: 1) validate (or invalidate) current generic models for social networks or social influence with data derived from populations across the varied AOR of the Combatant Commanders, and 2) where these models are explicitly shown to be invalid, expand mathematical, statistical, and analytical techniques to understand and represent the specific cultural factors and behaviors of those populations.

Research proposals should cover one or more of the following areas:

- Culturally and Regionally Dependent Social Network topography and evolution whether of the network (social ties/link prediction) or of information and influence using the network as a medium, including simultaneous treatment of interactions between multiple groups or actors with distinct cultural or regional characteristics through multiplex networks, multigraphs or hypergraphs.
- Culturally and Regionally Specific Socio-cognitive models of radicalism or other extremist behavior that relate to the use or pursuit of weapons of mass destruction.
- Culturally and Regionally Specific Integration of operational and technical capacity with knowledge of motivation and intent without losing meaning.
- Culturally and Regionally Aware Computational algorithms and methods that allow for culturally dependent variable incorporation and validation, such as extensions of techniques for tree decomposition, graph spectral systems, block representations, and embedded geometries, for increased complexity and increased efficiency. Methods that help to analyze special networks such as weighted, directed, bipartite networks, or hypergraphs. Methods to compute network representations more efficiently or to use representations to visualize complex, large networks.

While it may be necessary to generate data sets in order to accomplish the above tasks, the generation of a data set itself is not sufficient for this research work and should not represent a primary goal. Additionally, our regions of interest do not include NORTHCOM AOR or the Western European component of EUCOMAOR, and research focusing on these areas will not be considered.

PerD-YIP-Topic 6: Area of Responsibility Centric Cultural Modeling for WMD Threat Detection (Thrust Area 2)

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

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

PerD-Topic 7: Interrogation of Mechanisms for Cellular Resistance to Radiation Damage using Melanized Fungi as Model Systems (Thrust Area 3)

Average Award Amounts for PerD-Topic 7:

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

Award Structure for PerD-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: Exposure to ionizing radiation like that associated with military operations in CBRN environments can cause deleterious biological effects and result in psychological impacts that degrade mission performance. The ever-present risk of a radiological or nuclear incident, whether intentional in the form of a malevolent act or unintentional as in the case of the recent Fukushima accident, highlights the need for development of better radiation-protective measures for the warfighter in order to reduce morbidity and mortality associated with ionizing radiation exposure:

> *"The proliferation of nuclear material and technology has made the acquisition and adversarial use of nuclear and radiological weapons more probable. Additionally, military personnel may be deployed to areas that could be radiologically contaminated because of the presence of radioactive materials and nuclear facilities."*
>
> *~ Treatment of Nuclear and Radiological Casualties. 2001. Armed Services Field Guide.*

Despite six decades of work, the search for the ideal protective agent has languished. Currently, the majority of countermeasures for ionizing radiation are designed to be administered post-exposure, when biological damage may have already occurred. Such treatments can produce undesirable side effects or require specialized treatment regimens thus are not suitable for use in operational settings. Development of prophylactic treatments that are: (i) safe, (ii) effective, and (iii) cost-effective for exposures unique to the warfighter are critical for the protection of personnel and for sustaining operations in radiation-contaminated environments. Achievement of counter-WMD missions requires fulfillment of both aims.

In recent years, research on some of the world's most radioresistant organisms has yielded important clues regarding mechanisms of damage due to radiation exposure and could lead to the development of next generation radioprotectants with unprecedented efficacy. For example, *Deinococcus radiodurans* (a.k.a., "Conan the Bacterium") is an extremely resilient strain of bacteria that can endure radiation levels 2,000 times higher than the lethal human dose. Early work on the bacterium focused on investigating DNA repair mechanisms, as the conventional paradigm suggested that DNA was the principle target of damage and arbiter of observed radiation toxicity. However, the studies revealed that there was nothing unusual about radiation-induced levels of DNA damage or mechanisms of repair in *D. radiodurans* as compared to more radiosensitive strains.

Newer data counter previously-held beliefs and suggest that protection of crucial DNA repair proteins is a key contributor to radioresistance. Research on other taxa (e.g., bdelloid rotifers) known to be radioresistant provides evidence to substantiate the claim. Moreover, studies on both prokaryotic and eukaryotic radiophiles (i.e., "radiation loving" organisms) indicate that cellular protection is likely reliant upon not just one but numerous mechanisms. The sum total of results implies that development of radiation countermeasures may be more appropriately directed toward the protection of multiple cellular targets as opposed to only DNA. Leveraging multiple mechanistic strategies to counter damage is a common tactic in the biological world, thus it is reasonable to suppose that useful countermeasures will require a combination of approaches in order to be effective.

The present topic focuses specifically on mechanisms of protection in melanized fungi. The photoprotective effects of melanins are well-documented and appear to be associated with enhanced ability to scavenge reactive oxygen species as well as to act as biological quenching agents capable of electron de-excitation. Melanized fungi were found recently in highly radioactive zones near the Chernobyl Nuclear Power Plant, leading scientists to postulate that melanins may also protect against higher energy (e.g., gamma) radiation. Further evidence for the potential role of melanin in radioprotection is the documented radioresistance of human melanoma, a malignancy of the melanocytes which produce melanin. However, the specific mechanism by which melanin may exert its protective effects or whether it is actually the primary contributor to radioresistance

has yet to be elucidated. Melanized fungi represent suitable model systems to interrogate the role of melanin as well as other intracellular components or pathways in radioprotection.

The proposed line of research is a natural outgrowth of two previous topics which sought to characterize radioresistance in bacterial and mammalian cell lines. Although resilience against high levels of exposure has been documented as a cross-domain phenomenon, it is not known whether mechanisms of protection are analogous or are wholly divergent depending upon the species. Understanding the suite of strategies for radioresistance will allow down-selection of mechanisms for further study in mammalian systems and could inform the development of combined approaches as referenced above.

Impact: Work conducted under the auspice of the present topic will allow identification of radioresistance pathways in lower organisms that could lead to the development of countermeasures compatible with human physiology. The proposed research is responsive to the National Military Strategy to Combat Weapons of Mass Destruction (2006) with regard to its dictum for minimizing WMD effects in order to sustain military operations in a "WMD environment" and to provide support for domestic authorities in the event of a WMD incident. Developing a greater understanding of the mechanisms contributing to cellular protection against IR exposure will provide insight for future research efforts designed to develop novel prophylaxes.

Objective: The proposed research seeks to identify and characterize mechanisms of radioresistance in melanized fungi. The most competitive responses will interrogate multiple mechanisms rather than focusing on a single process (e.g., ROS-scavenging by melanin) in order to develop holistic knowledge of cellular response to ionizing radiation. Whole genome sequencing of melanized fungi is not of specific interest for the present effort.

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

- Identify means by which the cells sense ionizing radiation and transform the signal into a recognizable input for responsive chemical species.
- Investigate the identity and nature of small intracellular chemical species (including organo-metallic complexes, co-factors, nucleotides, peptides, among others) known or believed to be radioprotective and development of a deeper understanding of the mechanism by which such species confer protection.
- Identify the necessary location of action for the chemical species at the subcellular level.
- Characterize the mechanisms and pathways activated following radiation exposure to gain a more global understanding of the components activated or up-regulated directly or via signaling cascades.
- Determine whether radioresistance mechanisms in fungi may be extrapolated to mammalian cell lines and whole animal systems.

PerD-YIP-Topic 7: Interrogation of Mechanisms for Cellular Resistance to Radiation Damage using Melanized Fungi as Model Systems (Thrust Area 3)

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

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

PerD-Topic 8: Basic Science of Radiation Effects in Micro/Nanoelectromechanical Systems MEMS/NEMS (Thrust Area 3)

Average Award Amounts for PerD-Topic 8:

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

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

Award Structure for PerD-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: Mircoelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS) have seen rapid adoption in commercial products (e.g. cell phones and automobiles) primarily as sensors. Since MEMS offer considerable size and weight advantages over conventional devices, their incorporation into advanced commercial and military systems is expected to increase. Some MEMS devices have been incorporated into satellites or other space vehicles as primary or secondary sensors without any reported radiation effects problems. However, there has not been a systematic investigation of the effects of radiation on these systems.

There have also been significant developments in micro/nanoscale mechanical switches and logic gates in terms of size, speed, reliability, and power requirements. While these mechanical logic gates are unlikely to be able to compete with CMOS based logic in terms of speed and density, they are promising for low power applications and applications in extreme environments. The mechanical design is likely to be extremely resistant to radiation induced single event effects. The effect of total dose radiation effects is more uncertain and has not yet been investigated systematically.

Impact: Radiation insensitive MEMS/NEMS and mechanical logic devices will reduce the size, weight, and power requirements for military systems operating in extreme environments, especially extreme radiation environments.

Objective: Investigate the effects of radiation (gamma, x-ray, ion, neutron, and high energy electron) on MEMS/NEMS and mechanical logic devices. Of particular interest are advanced devices employing thin films, small feature sizes, novel designs, or other advanced technologies. The proposed research should focus on the fundamental physics of radiation effects as it applies to MEMS/NEMS or mechanical logic devices. Research that is primarily device development or fabrication is not of interest, nor is the test and evaluation of commercial devices. The proposed research should separate any radiation effects in the support electronics from radiation effects in the devices themselves.

Significant literature exists on the radiation effects in silicon microelectronics and proposed research should build on this existing knowledge base. Submissions that focus on specific applications (not the basic enabling science), applied configuration research, or systems engineering are discouraged. 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.

References: Shea, Herbert R; Radiation Sensitivity of Microelectromechanical System Devices, *J. Micro/Nanolith. MEMS MOEMS*, 8(3), 031303, **2009**.

PerD-YIP-Topic 8: Basic Science of Radiation Effects in Micro/Nanoelectromechanical Systems MEMS/NEMS (Thrust Area 3)

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

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

PerD-Topic 9: Crustal-Earth Materials and Manufactured Materials under Dynamic Extremes (Thrust Area 4)

Average Award Amounts for PerD-Topic 9:

- Single Scope Awards will average approximately $100,000 to $150,000 per year.
- Multidisciplinary Awards will average approximately $150,000 to $300,000 per year.

Award Structure for PerD-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: Offensive Counter-WMD operations currently rely on air-dropped ordnance that must penetrate or otherwise gain entry into WMD locations, which are frequently protected in underground or hardened storage facilities. Once the WMD target is reached, the weapon payload is detonated yielding a shock wave whose energy must couple with the WMD target to destroy it. Munitions in current inventory impact targets at velocities of ~300 m/s. Fragments driven by high explosives typically have initial velocities of 1,000-2,000 m/s. As a result, Counter-WMD events occur at high rates (10^2-10^6 s^{-1}) where physical changes can take place on nanosecond times scales. Penetration, gaining entry to the WMD target, and weapon-target interactions (WTI), necessarily involve a wide variety of highly-heterogeneous materials such as concrete, grout, breccia, sandstone, granite, schist, gneiss, or mixtures of these materials, etc., under high dynamic loading conditions.

WMD-defeating systems are designed by using engineering hydrocodes that simulate weapon effects and WTI. The hydrocodes can produce accurate simulations only if high-fidelity constitutive material models are incorporated. Predicting the penetration trajectory of a weapon in concrete and various crustal-earth or manufactured materials require damage analysis of the crushing and cracking of materials. The final WTI requires accurate energy dissipation and stress propagation within these materials. Accurate energy dissipation should incorporate local stress in mixed media, involving order-of-magnitude differences in local hardness or toughness.

Recent advances in studying material behavior under high dynamic loads, especially using synchrotron sources such as the Dynamic Compression Sector beam lines at the Advanced Photon Source of Argonne National Laboratory or proton radiography at the Los Alamos Neutron Science Center, have enabled near-real-time visualization of damage.

Basic research on dynamic effects on crustal-earth materials and manufactured materials will be transitioned through improvements to computational methods, potentially improving micro-scale methods, focused on meso-scale methods, and ultimately improving macro-scale continuum mechanics models (such as EPIC, FLEX, or LS-DYNA) or other (e.g., peridynamic) methods that can be used directly to study real-world weapons effects.

Impact: Accurate weapon simulations will allow intelligent design of improved capabilities to defeat WMD systems protected by hard and deeply buried targets (HDBT), and upgraded computational methods will allow more accurate engineering codes being integrated into weapon-effect decision-support tools, immensely improving HDBT attack and operational planning capabilities.

Objectives: This research topic seeks experimental and computational basic research to significantly improve our understanding of the effects of high-dynamic compression and tension on highly-heterogeneous crustal-earth and manufactured materials.

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

- Experimental dynamic studies, perhaps with near-real-time visualization of damage under high dynamic load, especially for detailed study of the penetration/cavity expansion physical process.
- Computational approaches for material damage modeling and prediction, at the micro-scale (pulverization of geo-materials around penetrator nose), the meso-scale (grain-boundary scale or pebble-scale in mixtures), and bridging to the continuum scale.
- Stochastic considerations to characterize weapon effects and WTI.
- Experimental or computational approaches to improve simulation of extremely high strain rate mechanics in pre-shocked/pre-stressed geo-materials, for enhanced understanding of multi-shock scenarios, such as penetration followed by detonation or penetration into already damaged materials.

PerD-YIP-Topic 9: Crustal-Earth Materials and Manufactured Materials under Dynamic Extremes (Thrust Area 4)

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

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

PerD-Topic 10: Energetic Materials for CWMD (Thrust Area 4)

Average Award Amounts for PerD-Topic 10:

- 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 PerD-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: Counter-WMD operations in non-permissive environments currently rely largely on weapons with blast and fragmentation effects from standard energetic formulations to defeat WMD targets. Standard high-explosive formulations are insufficiently energy dense for penetration to, and destruction of, hard/ deeply buried targets. Further, when the targets contain chemical and/or biological agents, the use of such weapons can create unacceptable consequences by releasing hazardous chemical agent, or infectious biological agents into the environment with the explosively generated plume.

Therefore, this topic seeks energetic materials research which addresses one or both of the following needs:

- High-density energetic materials with fast energy release that exhibit significantly improved energy density over current energetics like CL-20, and that can survive weapon penetration, to maximize weapon energy on hard-or- deeply-buried WMD targets.
- Reactive materials that burn with high thermal output producing large amounts of WMD-defeating chemical products (for example, halogen-containing species) for WMD targets containing chemical-agent or biological-agents. Preferred solutions would destroy bulk agents stored in container(s), deactivate aerosolized agent within the immediate target area, and render useless any agent released with the plume. These materials should demonstrate capability for agent destruction orders-of-magnitude better than previously researched payloads, and/or provide more-than-stoichiometric neutralization (catalytic effects).

Once new materials are prepared and densities measured, they should be tested for sensitivity to air, water, and other environment factors, and for sensitivity to ignition or initiation. If the materials appear usable, and can be prepared in sufficient quantities, applicants should plan to collaborate with DoD labs for testing and evaluation of materials for WMD defeat application.

Impact: The success of this research would provide technological capabilities that will put adversarial WMD at risk, whether they are hard/deeply-buried targets or soft targets. Novel high-energy-density materials will enhance the ability of the DoD to defeat these targets with smaller/lighter/more versatile weapon systems, while agent-defeat materials will neutralize chemical and biological agent within the target and eliminate collateral damage that could result from a post-strike infectious/toxic plume.

Objectives: This research topic seeks new energetic materials with high energy density and fast energy release to significantly improve conventional weapons lethality; or reactive materials that produce persistent (milliseconds to seconds) high temperatures (1000ºC or above) and employ chemical kill mechanisms to significantly improve chemical-agent and biological-agent defeat capabilities.

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

- Materials that combine the exothermic nature of inter-metallic reactions with gas-producing oxidizing constituents that can break up the oxide shell formed
- Conglomerations of metal and energetic materials using supra-molecular chemical techniques, including co-crystallization, frame working, self-assembly, etc., resulting in an entire formulation in one material
- Metal-Inorganic-organic materials that deflagrate at high temperature and produce chemicals that decompose chemical agents or destroy bio agents

- Novel shock- or detonation-focusing techniques (not shaped charges) to achieve greatly enhanced shock damage to WMD storage, production or distribution facilities
- Other innovative, non-traditional materials and approaches for achieving high-energy-density and/or agent-defeat purposes
- Demonstration of the effect of these materials, including testing and evaluation of high-energy density materials or agent-defeat materials

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PerD-YIP-Topic 10: Energetic Materials for CWMD (Thrust Area 4)

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

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

PerD-Topic 11: Smart Materials with Unconventional Indicators for Facility Access Denial and Security of WMD Materials (Thrust Area 5)

Average Award Amounts for PerD-Topic 11:

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

Award Structure for PerD-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: The purpose of this topic is to identify, investigate, and research innovative scientific solutions that can physically deny entry/exit or operational use of facilities that support the production, storage, and/or employment of Weapons of Mass Destruction (WMD) materials (i.e., Chemical, Biological, Radiological, Nuclear). These types of solutions are necessary to secure hazardous materials and equipment used to employ them before operations teams can arrive on site. Such access denial scenarios may be warranted to reduce illegal proliferation, control sensitive sites, and/or protect civilian populations. The desired period of denial effects may range from > 1 day to weeks which can be influenced by operational environments, mission scenarios, security personnel limitations, etc.

The focus of this effort will be on those sites in which friendly ground forces have limited or no direct access to either the entrances or mission space. This is different from the concept of access control which entails the controlled passage of personnel and equipment into and within a building or structure. Current physical security uses multiple methods to control or deny access to sites, installations, equipment, and materials. This can involve such means as barriers, locks, seals to provide evidence, and access control or alarm. Access control technologies often involve biometrics, such as iris scanners or fingerprint readers, card readers for access control, or closed circuit TVs and alarm systems with reach back connectivity to security forces. Basic research

can provide significantly improved methods that simultaneously address detection, control/denial, and containment of WMD materials and facilities.

Emerging science areas provide opportunity to address these needs. Polymer science, for example, can be enabled by nanoscale smart materials with material structures tailored to a particular function. For example, reconfigurable materials that act in response to stimuli can provide means to contain WMD facility ingress/egress points. Smart material may exhibit a structural change that allows it to follow the movement of the WMD, and progressively seal the areas where a material of interest is detected. Novel sensing mechanisms can be created to drive such a response. In addition, such unconventional indicators (unlike traditional detector system) can be readily deployed over an area or at a perimeter to control/deny access to add further uses for such scientific developments.

Impact: This topic is important to the counter-WMD mission of DTRA by addressing the operational need of rapidly securing WMD materials in time-sensitive denied areas. Such basic science could support access denial technology that secures the WMD from a standoff distance until proper security could arrive. Such a capability will give the warfighter a far greater capability to hold at risk WMD without fear of releasing WMD materials.

Objective: We seek unconventional indicators in combination with new smart materials to advance methods to detect, characterize, and control/deny WMD and WMD-materials. The combination should detect and characterize the presence of WMD or related activities, then respond to said presence in such a way that prevents it from spreading and controls access in WMD environments.

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

- Exploration of novel materials (e.g. biomimetic) to seal, encapsulate, or contain WMD vapors or other materials of interest; e.g., which will provide controls to section off vents, doors, or portal entrances to WMD
- Investigation of additional morphing materials (e.g., reconfigurable materials- shape memory, polymer chemistry, colloidal changes, functional nanostuctures, other mechanisms in rheology, programmable matter, nanoenergetics) that provide potential for forming expandable, thin membranes or other forms to aid containment including degradation of vital WMD components/equipment or interference with WMD transportation modalities
- Additional understanding of the properties of materials and cues from embedded sensors that enable material flow in response to where WMD presence is tracked to support containment
- Unconventional indicators of chemical/biological analytes to provide warning of intrusions or presence/movement of WMD, CW/BW precursors, or related equipment of interest
- Additional unconventional indicators (i.e., novel ways to measure or sense observables) of CBRNE presence or movement including sensing of environmental disturbances indicating movement or WMD activities

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PerD-YIP-Topic 11: Smart Materials with Unconventional Indicators for Facility Access Denial and Security of WMD Materials (Thrust Area 5)

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

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