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I. OVERVIEW OF THE FUNDING OPPORTUNITY

A. REQUIRED OVERVIEW CONTENT

1. **Federal Agency Name:** U.S. Army Research Laboratory, 2800 Powder Mill Road, Adelphi, MD 20783-1197

2. **Issuing Acquisition Office:** U.S. Army Contracting Command – Aberdeen Proving Ground (Soldier, Chemical, Research & Test), Research Triangle Park Contracting Division, 4300 S. Miami Blvd., Durham, NC 27703

3. **Funding Opportunity Title:** Collaborative Research Alliance (CRA) for Materials in Extreme Dynamic Environments (MEDE)

4. **Announcement Type:** Initial

5. **Funding Opportunity Number:** W911NF-11-R-0001

6. **Catalog of Federal Domestic Assistance (CFDA) Number(s):** 12.630 - "Basic, Applied, and Advanced Research in Science and Engineering"

7. **Dates:** The following is a summary of the events and dates associated with the MEDE CRA Program Announcement (PA):

EVENT	ESTIMATED DATE/TIMEFRAME
Draft PA released	October 2010
Opportunity Conference	19 November 2010
Open House	16 December 2010
Final PA released	21 January 2011
Proposals due	07 March 2011
Evaluation and Negotiations	June-August 2011
Final Proposals due	August 2011
Award	February 2012

B. EXECUTIVE SUMMARY

The U.S. Army Research Laboratory is seeking to develop the capability to design, optimize, and fabricate lightweight protection material systems exhibiting revolutionary performance. The approach is to realize a "Materials by Design" capability by establishing a new Collaborative Research Alliance (CRA) focused on *Materials in Extreme Dynamic Environments* (MEDE). The focus of the CRA will be to advance the fundamental understanding of materials in relevant high strain rate and high stress regimes. The CRA is intended to create a collaborative environment that enables an Alliance of participants from academia, government and potentially industry and/or non-profit organizations to advance the state of the art and assist with the transition of research to enhance the performance of materials of interest to the U.S. Army. The ARL believes that the establishment of this CRA, as part of an ARL "Enterprise for Multiscale Research of Materials" and in conjunction with a robust internal mission program, provides the optimum path to success. It is envisioned that the results of the MEDE CRA research will be efficiently and rapidly transitioned to ARL in-house research and development programs.

The foundational problem to be addressed by the MEDE CRA is the lack of understanding of the physical phenomena at multiple scales that govern high-stress and high strain-rate material performance resulting from the paucity of validated linkages between experimental and computational research tools at critical length and time scales. Recent significant advances in experimental and computational technology at disparate scales have provided the framework to couple phenomena at diverse length and time scales to address this challenge with an exceptional likelihood of success.

To address this problem, the MEDE CRA seeks proposals focusing on one polymer, one metal, one ceramic, and one composite material system. A successful program will demonstrate a comprehensive "materials-by-design" capability for materials in high strain rate and high stress environments and for each of the four material classes listed above address the following core elements:

- Advanced Experimental Techniques: Develop experimental methodologies to interrogate and characterize the in-situ materials response to extreme dynamic environments at critical length and time scales
- Modeling and Simulation: Develop computational approaches to predict the materials response to extreme dynamic environments at critical length and time scales
- Bridging the Scales: Develop physical and mathematical constructs necessary to bridge critical length and time scales
- Material Characteristics and Properties at Multiple Scales: Utilize existing and novel experimental methodologies to validate computational approaches in order to bridge the characteristic length and time scales, and to identify the comprehensive set of material characteristics, microstructural features and dynamic properties that govern high stress and high strain-rate deformation and failure phenomena
- Synthesis and Processing: Incorporate research discoveries to enable the synthesis of novel materials and the processing of final products with critical material characteristics and resulting properties

A successful fundamental research program under the MEDE CRA will achieve the following scientific goals, with tangible benefits to the soldier at each stage: (NOTE: These goals are described in greater detail in the FUNDING OPPORTUNITY DESCRIPTION below.)

2-Year Goals:

Science: Advance the experimental and computational state-of-the-art for characterizing the in-situ materials response to extreme dynamic environments at critical length and time scales in metallic, polymeric, ceramic and composite material systems.

Benefit to the Soldier: Improved protection systems through incorporation of enhanced discrete deformation and failure algorithms in current continuum simulations and design codes.

5-Year Goals:

Science: Integration of novel experimental methodologies and multiscale computational approaches to enable unprecedented microstructural control and predictive capabilities.

Benefit to the Soldier: The CRA will transition to the Army and the industrial base the key materials characteristics and properties to achieve a 15%-30% weight reduction for selected protection systems.

10-Year Goals:

Science: Demonstrate a comprehensive "materials-by-design" capability to include both designing materials and predicting key properties for materials in extreme dynamic environments.

Benefit to the Soldier: The CRA (including ARL) and industrial partners will utilize the "materials-by-design" capability to design and produce protection materials with 1/3 the weight of the current systems.

Award Instrument: This PA will result in the award of a cooperative agreement (CA) as defined at 31 U.S.C. 6305 for the execution of the MEDE CRA. The CA will be awarded to a Consortium of organizations that may include academic, industrial and non-profit organizations. To assure the creation of a well focused research program, the number of partners should balance the need for expertise in all four material classes and the five core elements with the need to maintain a focused, cohesive, well integrated research program. The Consortium must be led by an academic institution that will be charged with spearheading the focused basic research program. This organization will be designated as the Lead Research Organization (LRO). It is anticipated that an optimally sized consortium would include no more than six members (including the LRO), but this should not be considered a hard limit. Proposals that include more than six members must provide a rationale for the additional members. Additionally, it is required that "covered educational institutions" (to include Historically Black Colleges and Universities and Minority-Serving Institutions or HBCU/MSIs – see also **PART II.C.1** below) shall receive 5-10% of the annual CA funding. The Consortium will function as a collective of equal partners deciding upon all Consortium matters equally. Since fundamental research in any aspect of material science draws upon a broad palette of science and engineering, it is expected that the Consortium will be enhanced by a constantly changing group of additional researchers and research organizations chosen jointly by the Consortium and the Government to foster new ideas, innovation and thus complement research already undertaken by the Consortium and Government. These researchers and research topics, while part of the Annual Program Plan, will be subawardees to one of the Consortium Members and not part of the Consortium proper. To insure these new ideas and innovations are a core element of the CA, ten percent (10%) of the annual research effort is expected to be devoted to novel and innovative research conducted by these subawardees. The Alliance will also be able to seek opportunities for basic and applied research from other government agencies that enhance and or parallel the core basic research program of the CRA.

Articles of Collaboration: The Articles of Collaboration (AOC) define the operational structure within the Consortium. An attachment to the PA provides a sample AOC for offerors to consider in preparing proposals; however, offerors are free to modify this document as necessary and appropriate to coincide with their proposal. The AOC included in the proposal will be evaluated under the Program Management and Execution Evaluation Factor. Proposals must include a copy of their proposed AOC, signed by a duly authorized representative for each Consortium member.

Period of Performance: Awards made as a result of this PA will provide for a period of performance of five years, with an optional five-year extension period.

Place of Performance: There is no limitation on the place of performance for any organization participating under the CA.

Funding: This PA is issued subject to the availability of funds. ARL has submitted the requisite documents to request funding for the period covered by the CA; however, offerors are reminded that this request is subject to Presidential, Congressional and Departmental approval. The PA provides the estimated funding levels for the core Basic Research (6.1) for the MEDE CRA. **The funding levels provided in the PA are for proposal preparation purposes only. The actual funding level of the CA will be updated annually as part of the appropriation process.** Further, this PA identifies additional levels of funding to potentially enhance the research program with additional basic and applied research funds. It is expected that during performance there will be opportunities to secure this additional funding from ARL or other Government agencies to be added to the CA to enhance the core basic research program. This "Enhanced Research Program" funding is not currently available or in the financial plans for ARL.

Profit/Fee: Profit/fee is not permitted under the CA.

Cost Sharing: Cost sharing is not required (with the exception of Federally-Funded Research and Development Centers (FFRDCs) and National Laboratories) to be responsive to the PA. However, cost sharing is encouraged. During the evaluation of proposals, cost sharing will be evaluated as it relates to the evaluation factors listed in the PA, based on the degree to which the proposed cost sharing enhances the proposal to result in added benefits to the MEDE CRA Program. In order for the proposed cost sharing to receive appropriate credit during the evaluation process, the proposal should evidence a firm commitment to provide such cost share and also evidence **a process for integrating the cost share into the collaborative research program.**

Proposal Submission: **PART II.D** of the PA provides information on proposal preparation and submission. Offerors should note that there are page limitations and other requirements associated with the submission process. Proposals in connection with this PA are due by the date and time specified in **PART II.D**.

Evaluation and Award: Evaluation and Award in connection with this PA will be performed in accordance with **PART II.E.**

Questions & Comments: All questions or comments concerning this PA will be posted through the MEDE CRA website at www.arl.army.mil/CRAMEDE. Questions and comments should be concise and to the point. In addition, the relevant part and paragraph of the PA should be referenced. Responses to questions received will be posted to the MEDE CRA website for the benefit of all interested parties. Should an offeror have questions they believe are of a proprietary nature, the offeror must clearly state so in the question when posed. Answers to questions of a proprietary nature will be provided via email directly to the poser of the question.

Opportunity Conference: An Opportunity Conference concerning the MEDE CRA was held on 19 November 2010. The purpose of the Opportunity Conference was to provide potential offerors with information concerning the MEDE CRA and to provide an opportunity for potential offerors to discuss the MEDE CRA with Government personnel. All presentations, questions, and answers discussed at the Opportunity Conference have been posted on the MEDE CRA website. While offerors were encouraged to attend the Opportunity Conference, offerors may submit proposals under this PA without attending the Opportunity Conference. (NOTE: This Opportunity Conference covered both the MEDE CRA and another CRA being issued by ARL associated with Multiscale Multidisciplinary Modeling of Electronic Materials (MSME). See www.arl.army.mil/CRAMSME for additional information on the MSME CRA.)

Open House: ARL's Open House for the MEDE CRA was held on 16 December 2010. The purpose of the Open House was to provide potential offerors with information on ARL's Weapons & Materials Research Directorate (WMRD) internal mission program, capabilities and facilities for planning their proposed collaborative efforts with ARL employees in response to the MEDE CRA PA. While offerors were encouraged to attend the Open House, offerors may submit proposals under this PA without attending the Open House. Presentations from the Open House have also been published on the MEDE CRA website.

II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY

A. FUNDING OPPORTUNITY DESCRIPTION

1. ARL Vision

The objective of the MEDE CRA is to develop (cooperatively and collaboratively with ARL) the capability to design, optimize, and fabricate novel material systems exhibiting revolutionary performance in extreme dynamic environments. To achieve the objective the long term goal of the Army is a robust "materials-by–design" capability for optimum high strain rate material response and electronic material and device performance. Significant advances in experimental and computational approaches at disparate scales have long provided motivation to address this challenge; recent and emerging approaches to coupling phenomena at diverse length and time scales provide a new opportunity to address this challenge with an exceptional likelihood of success.

The foundational problem to be addressed by the MEDE CRA is the lack of understanding of physical phenomena governing high-rate material performance resulting from the paucity of validated linkages between experimental and computational research tools at critical length and time scales. The CRA in Materials in Extreme Dynamic Environments (MEDE) will develop the capability to design, optimize and fabricate novel materials and material systems for high stress and high strain-rate environments. The MEDE CRA will examine the following material classes: metals, ceramics, polymers and composites.

The Army seeks a sustained research program, comprised jointly of extramural and intramural basic research efforts, which through collaborative research will methodically and systematically push towards this vision. To this end, the Army Research Laboratory will establish the Enterprise for Multiscale Research of Materials with three components: 1) a CRA for Materials in Extreme Dynamic Environments (MEDE), 2) CRA for MultiScale multidisciplinary Modeling of Electronic materials (MSME) and 3) an in-house Initiative for Multiscale Modeling of Materials (I3M).

As part of both CRAs, ARL Scientists will have substantial involvement in performance, with a cadre of ARL scientists engaged in deep and meaningful collaborative research with the other CRA team members. The MEDE CRA will develop the capability to design, create, synthesize, process and manufacture high strain rate tolerant materials and material systems. The MEDE CRA may consider a range of material classes such as metals, ceramics, polymers and composites. The MSME CRA will develop the capability, with modeling emphasis, to create electronic device applications to include sensors and electronics for enhanced battlespace effects and efficient power and energy devices. The MSME CRA will focus on advancing the fundamental science, understanding, and state-of-the-art (SoA) for Multiscale Multidisciplinary Models in each of the following Electronic Materials Research Areas: 1) Electrochemical Energy Devices, 2) Hybrid Photonic, Spintronic Devices, and 3) Heterogeneous Metamorphic Electronics.

As part of ARL's vision for an Enterprise for Multiscale Research of Materials, the MSME and MEDE Alliances will work collaboratively with the I3M to identify areas for interdependent basic research projects that have definitive links to the current Army mission and long-term vision. Collaborations or transition links among the CRA's and I3M will also be pursued and defined through continuous collaboration, technical exchanges, site visits, staff rotations, and mutual participation in technical reviews during the period of performance. This will strengthen Army/ARL mission-relevance in the CRA research and enable the transition of developments from the Enterprise to further strengthen ARL's efforts in multiscale multidisciplinary computational science, polymer & soft matter science, and optoelectronic/electronic/power & energy science. Within these contexts,

and through collaborations via the CRA, the outcomes will take the form of theoretical, modeling or experimental methods that improve mission flexibility and capabilities for ARL to pursue its core mission programs and business areas with the visionary arc towards materials by design.

2. ARL WMRD Internal Mission Program

The ARL WMRD Internal Mission is an important element to consider when defining the collaborative research under this CRA. Understanding the internal programs being executed to carry out the ARL WMRD mission helps provide a background for the relevance of the research to be funded under this CRA. Additionally, it provides information needed for potential offerors to identify and propose substantial collaborative research with in-house personnel. Thus, a description of the ARL WMRD Internal Mission programs follows. Additional detail, including information about equipment and capabilities is described in the below Collaboration discussion. Offerors may also consult the ARL Web Site at: http://www.arl.army.mil/www/default.cfm .

The MEDE CRA is one of the extramural arms of the ARL Enterprise for Multiscale Research of Materials and will be an integral partner with the WMRD Internal Mission. The ARL Enterprise is also described in the COLLABORATION section discussion below. The WMRD Mission is to enhance the lethality, survivability, and sustainability of the individual soldier, the Army's advanced weapons systems and ground combat systems through a vigorous basic and applied research program. The research program enables ARL researchers to conceive and transition novel concepts, capabilities and technologies in the areas of advanced weapon systems, soldier systems, ground combat systems and new materials to Army Research, Development, and Engineering Centers (RDEC's), Army Program Executive Offices (PEOs) and Program Managers (PMs), Army Life Cycle Management Centers (LCMCs), and industry. WMRD also uses its core expertise in the areas of lethality, protection and material science to bring state of the art solutions to technical problems associated with developmental and fielded systems as well as to support current operations.

Additionally, the Computational and Information Sciences Directorate (CISD) of ARL serves as the principal Army organization for basic and applied research in information sciences, network sciences, battlefield environment, and advanced computing and computational sciences to ensure current and future U.S. military superiority. CISD's collaboration participation in the CRA is integral to achieving the vision of a "materials by design" capability.

Materials and manufacturing science is the foundation for all technology insertion and engineered systems that provide the soldier with the required lethality, survivability and sustainability needed to dominate the modern battlefield. The WMRD internal mission program in Materials and Manufacturing Science (M&MS) is responsible for basic and applied research in metals, ceramics, polymers, composites and hybrids such as metal matrix composites and ceramic matrix composites. The M&MS fundamental and applied research in these core areas integrates state of the art experimental capabilities, high performance computational modeling and simulation, characterization and response of materials/ material systems, novel material synthesis and processing capabilities to design, develop and transition advanced materials.

In the area of lethality, M&MS provides material solutions for advances in interior, exterior, transitional and terminal ballistic science and technology. This enables new propellants for munitions and rockets, multifunctional scalable warheads, fuzing, projectile design, direct and indirect fire precision munition systems. Precision munition systems alone require advances in materials in electronic substrates, seeker windows, actuator systems, guidance, navigation and control systems, aerodynamic flow control and projectile structures for both launch and flight.

New materials and enhanced material performance are critical to advancing the state of the art in protection and survivability of soldier and ground combat systems. Novel materials, complex materials systems of metals, ceramics, polymers, glasses, composites and hybrids are required for ballistic and blast protection. Combinations of new materials are needed for multi-material interfaces in vehicle or soldier survivability technologies, passive and active multi-mechanism protection systems and crew survivability. All these protection systems must survive, operate and perform in extreme environments from hypervelocity impact to road induced vibrations.

Clearly, advanced materials and material systems in extreme dynamic environments are required across and throughout the entire spectrum of the WMRD research continuum. Fundamental research that advances the state of the art and enables the design of materials with the optimum properties and response is critical to the future of the Army and is a significant element of the WMRD program. The purpose of this PA is to solicit proposals to create a "materials by design" capability to design, optimize and fabricate materials and material systems for high strain rate/high stress environments. The CRA strategy is founded on a "materials by design" concept with five core elements: Advanced Experimental Techniques, Modeling and Simulation, Bridging the Scales, Materials Characteristics and Properties at Multiple Scales, and Synthesis and Processing.

3. Current State of the Art - MEDE

The last extensive review of the response of materials at high loading rates was in 1980. The National Materials Advisory Board (NMAB) undertook a study (NMAB-356) concerned with materials response to ultra-high loading rates. The study focused primarily on metals, including their equations of state, plastic yield characteristics, empirical failure models, brittle crack propagation, ductile void growth and adiabatic shear banding. There was no focus on light metals (Al, Mg, metal matrix composites), ceramics (e.g., the nature and role of plasticity), fibers, polymer matrix composites, laminated materials assemblies, or other hybrid material systems. Also absent in this study was any focus on mechanisms at the nano- and micro-structural scales and materials processing considerations. Since that time, no analogous study has been undertaken that contemplates the impact of advances in state-of-the-art high-performance computational modeling and simulation tools, considers the response of composites, ceramics, and hybrid materials, and includes benefits derived from newly-acquired understanding of material response dependence on features at very small scales.

More recently, the NMAB just completed a study on Integrated Computational Materials Engineering (ICME). In addition, the Department of Energy (DOE) Basic Energy Sciences Office convened high level committees on Directing Matter and Energy: Five Challenges for Science and the Imagination and another on Basic Research Needs for Materials Under Extreme Environments. Currently the NMAB and the Board for Army Science and Technology (BAST) have convened a Committee to Review Opportunities in Protection Materials Science and Technology for Future Army Applications to make a comprehensive study of the state of the art in materials science for protection. Note: When and if available, NMAB reports are in the public domain and may be obtained from the NMAB at http://sites.nationalacademies.org/DEPS/NMAB/index.htm.

After reviewing the state of the art in materials research at high strain rates and identifying the focus and goals of currently established research programs, ARL convened a workshop in Towson, Maryland from September 22-23, 2008 specifically on the subject of *Multi-Scale Materials Behavior in Ultra-High Loading Rate Environments*. The workshop investigated the current state of the art in multi-scale materials research at high loading rate environments. The workshop was attended by a total of 97 participants. Participants included industry, academia, and government. From government agencies, participants attended from the Defense Advanced Research Projects Agency, the National

Institute of Standards and Technology, the U.S. Air Force, and the U.S. Navy. From within the U.S. Army, participants attended from the Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology, the Natick Soldier Research Development and Engineering Center, the Technical Cooperation Program, and ARL. Additional representatives attended from Sandia, Los Alamos and Lawrence Livermore National Laboratories and from academic institutions. The workshop focused on materials and mechanics for dynamic energy management at the macro-, meso-, micro- and nano-scale. Discussions involved materials that have unique responses to dynamic loading at extreme rates and the corresponding deformation and failure mechanisms; new materials with enhanced strength, toughness, stiffness, etc.; materials with unique responses, such as auxetic materials (materials with negative Poisson's ratios); composite materials with complex matrices that harden under high strain rates; dynamically reconfigurable materials; self-healing materials; multidisciplinary material concepts; and high loading rate fracture mechanics. The first part of the workshop was spent on concepts and ideas to address the challenges across the spectrum of materials/mechanisms. Then the participants prioritized ideas and concepts, making recommendations for future research to expand the current knowledge base that could lead to promising material technologies for use in high stress and high loading rate applications. The participants identified the gaps and requirements for state-of-the-art modeling, theory, real time quasi-static and dynamic characterization of mechanisms, new experimental methods, and micro-scale and nano-scale structural characterization, processing, and manufacturing that would be necessary to realize their recommendations.

At the end of the workshop, several important themes emerged that suggested approaches to future research that is needed in this area. Presentations and discussions at the workshop concluded that significant technical gaps exist that limit "materials-by-design" approaches. Resolving these gaps would revolutionize and enable novel material response under high strain rate / high stress loadings. These gaps are listed below along with the principal outcomes and conclusions of the workshop.

Major Gaps In The Current State Of The Art

- A limited ability to relate materials chemistry, structure, and defects to materials response and failure under extreme conditions
- An inadequate ability to predict the roles of materials structure, processing, and properties on performance in relevant extreme environments and designs
- The lack of experimental capabilities to quantify multiscale response and failure of materials under extreme conditions

Principle Workshop Conclusions

- The ability to perform quantitative concurrent spatial and temporal modeling and characterization of materials across multiple scales would revolutionize material design
- The Army should challenge the community to develop fully predictive multiscale "materials-by-design" approaches for high stress and high loading rate applications
- Successful "materials-by-design" approaches will require quantitative methods (i.e., figures of merit) to link material performance in systems to material properties, microstructure, and processing
- A systems approach to fundamental research that links, coordinates, and leverages the many excellent research projects towards materials-by-design concepts and capabilities will make all efforts more effective

4. CRA Programmatic Strategy

The CRA is intended to foster collaborative basic research (Budget Activity 1 – see definition below) involving government, industry, and academia. ARL's strategy is to continue exploiting research and expertise where it exists through the issuance of a single award through this Program Announcement (PA) to a consortium of academic,industrial partners, and /or non-profit entities. This consortium will work in collaboration with ARL scientists and engineers to help fulfill the need of advances in areas of materials that will support future critical military objectives. ARL and the consortium selected for award will establish one CRA to address research topics critical to materials in extreme dynamic environments; however the outcome and results of the research is expected to be ubiquitous and broadly support all aspects of science and engineering across a spectrum of materials classes. Additionally, other Government agencies will have the option to participate in the CRA and to contribute in an enhanced program their technical expertise and personnel. A significant goal of this effort will be to create a critical mass of collaborating academic, private sector and government scientists and engineers focused on solving the research challenges outlined within the scope of the CRA. This intellectual synergy is also expected to include sharing equipment, personnel and facilities to promote efficiency and collaboration.

Based on the gaps identified and detailed in section 3, the research and collaboration strategy developed by the offeror for the CRA should consider the application of a systematic approach to fundamental research focused on material response in high strain rate and high stress environments within the context of a true "materials-by-design" optimization strategy.

It is the intent of this PA to solicit the most creative, innovative, and flexible approaches to the ultimate goal of generating and exploiting research to solve pressing research gaps and issues impacting both the military and commercial sectors. This PA seeks proposals from self-formed consortia, each led by an academic institution, which will result in the award of a single cooperative agreement. In response to the PA, offerors will be required to:

- Formulate a basic research program which clearly demonstrates innovative, detailed and substantive scientific plans to address each of the five core elements, and the two, five and ten year goals as discussed in section 5
- Define the strategy for implementing a "Materials-by-Design" approach (as shown below in Figure 1) which synergistically integrates the five core elements, and outline the metrics by which success is expected to be measured for the four material classes
- Present the experience and qualifications of the scientific staff and the quality and relevance of research facilities
- Identify the approach to building collaborations within the consortium and with both ARL and external entities, which are essential to the success of the CRA to demonstrate relevance to ARL's long-term mission and programs, and more broadly to the national technology base
- Identify the overall management (business plan) and programmatic and administrative team with the expertise to achieve the stated research goals and to oversee and manage finances, reporting, data, meetings, reviews and intellectual property

This programmatic strategy provides the structure for the desired comprehensive and cohesive outcome of the basic research performed under the CRA. However, the CRA will also allow participation from other government agencies (see discussion of Enhanced Program below) which may result in additional Budget Activity 1 (basic research) funding as well as Budget Activity 2 (applied research) funding. Therefore, the research proposed and performed must comply with the definition for

Budget Activity 1 or Budget Activity 2 funding (as appropriate) as outlined in the DoD Financial Management Regulation (FMR), Volume 2B, Chapter 5 (July 2008) as follows:

Budget Activity 1: Basic Research. Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards 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 progress. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. Program elements in this category involve pre-Milestone A efforts.

Budget Activity 2: Applied Research. Applied research is 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. It may be oriented, ultimately, toward the design, development, and improvement of prototypes and new processes to meet general mission area requirements. Applied research may translate promising basic research into solutions for broadly defined military needs, short of system development. This type of effort may vary from systematic mission-directed research beyond that in Budget Activity 1 to sophisticated breadboard hardware, study, programming and planning efforts that establish the initial feasibility and practicality of proposed solutions to technological challenges. It includes studies, investigations, and non-system specific technology efforts. The dominant characteristic is that applied research is directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters. Applied Research precedes system specific technology investigations or development. Program control of the Applied Research program element is normally exercised by general level of effort. Program elements in this category involve pre-Milestone B efforts, also known as Concept and Technology Development phase tasks, such as concept exploration efforts and paper studies of alternative concepts for meeting a mission need.

5. CRA Research Strategy

The U.S. Army Research Laboratory is seeking to develop the capability to design, optimize, and fabricate lightweight protection material systems exhibiting revolutionary performance. The approach is to realize a "Materials by Design" capability by establishing a new Collaborative Research Alliance (CRA) focused on *Materials in Extreme Dynamic Environments* (MEDE). "Materials in extreme dynamic environments" is defined as materials subjected to high strain rate and high stress environments. The relevant high strain rate and high stress regimes include dynamic pressures up to 50 GPa and strain rates from 10^3 to 10^9 sec^{-1}.

The CRA Research Strategy and its core elements are graphically outlined in Figure 1. The synergistic integration of all five core elements within the "materials-by-design" concept is critical to the success of the program and will be one of the important indicators of achievement.

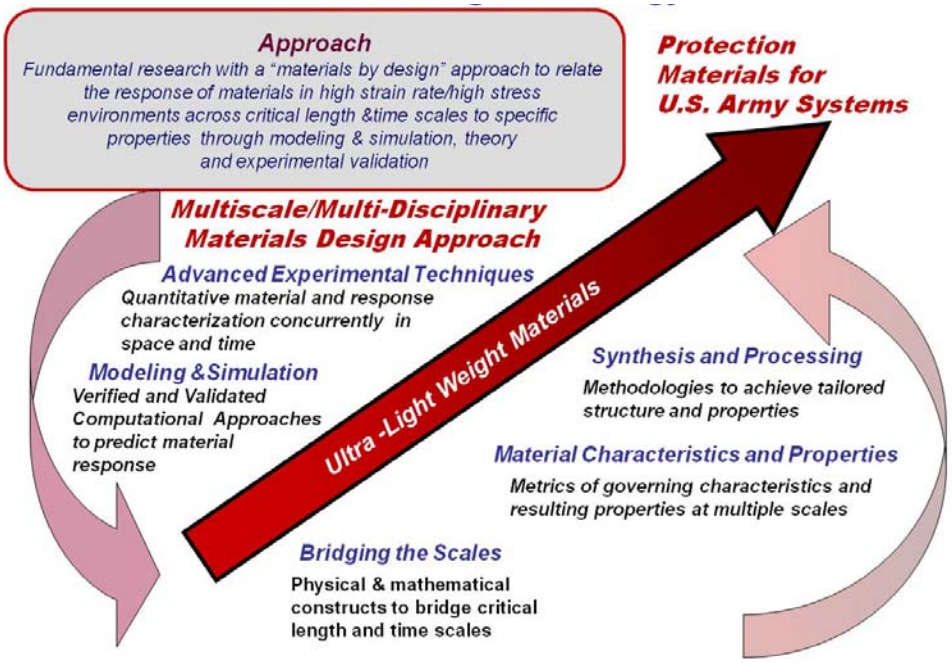

Figure 1: CRA Research Strategy for "Materials-by-Design"

This design capability is required for materials to include one of each: metals, ceramics, polymers and composites. The proposed program will develop the strategy for a focused effort to execute the "materials-by-design" concept as shown in Figure 1. As outlined in the executive summary, the program must contain five core elements:

- Advanced Experimental Techniques: Develop experimental methodologies to interrogate and characterize the in-situ materials response to extreme dynamic environments at critical length and time scales
- Modeling and Simulation: Develop computational approaches to predict the materials response to extreme dynamic environments at critical length and time scales
- Bridging the Scales: Develop physical and mathematical constructs necessary to bridge critical length and time scales
- Material Characteristics and Properties at Multiple Scales: Utilize existing and novel experimental methodologies to validate computational approaches in order to bridge the characteristic length and time scales, and to identify the comprehensive set of material characteristics, microstructural features and dynamic properties that govern high rate deformation and failure phenomena
- Synthesis and Processing: Incorporate research discoveries to enable the synthesis of novel materials and the processing of final products with critical material characteristics and resulting properties.

It is critical that the five core elements described above of a "Materials-by-Design" strategy are included and that the contribution of each is of fundamental and equal importance to the final goal of a material design capability for materials with revolutionary performance in extreme dynamic environments. This capability should be developed for one polymer, one metal, one ceramic, and one composite material system. It is also stressed that within each core element a cohesive research strategy to advance the state of the art is evident with the commensurate validation and verification

plan. The research gaps to be addressed by the offeror in each of the five specific core elements are discussed in sections "a" through "e" below.

a. Advanced Experimental Techniques: Develop experimental methodologies to interrogate and characterize the in-situ materials response to extreme dynamic environments at critical length and time scales.

The grand challenge is to develop the "*the ability to perform quantitative concurrent spatial and temporal measurements and characterization of materials at multiple scales.*" The realization of this in concert with concurrent advances in modeling and simulation would revolutionize "Materials-by–Design" capabilities for designing and fabricating materials with optimized performance in dynamic environments. The offeror may consider some or all of the suggestions below and propose any and all advanced experimental technique research and development deemed necessary to successfully achieve the 2, 5 and 10 year program goals and address the grand challenge.

- The development of advanced experimental technique/probes/sensors to:
    - capture complex high rate material response concurrently in space and time
    - measure properties of a material at multiple locations over a range of spatial and temporal scales
    - increase the penetration depth of probing excitations to make relevant 3-dimensional measurements of the physical processes operating during high strain rate experiments
- Develop experimental methods and protocols to probe wholly new material systems/microstructures guided by physical insights learned from parallel modeling / experiments
- Measurement of material elastic, and inelastic deformation, bulk plasticity, progressive / catastrophic failure, and phase response at microstructural length scales and below
- New experimental techniques to probe materials microstructure and response under extreme conditions (rates, pressure, etc) including *in situ* observations of relevant mechanisms such as
    - Bond stretching, transformation, and breakage, phase transformation, dislocation nucleation, twinning, strain hardening, void and crack formation and growth, adiabatic shear localization, fracture and vibration spectra
- Experimentally quantify deterministic and stochastic parameters for physical models at critical length scales; includes relevant microstructure and interface features and properties
- The multidisciplinary (chemistry, electrodynamics, magnetics, and mechanics) experimental analysis of a material in an extreme dynamic environment

b. Modeling and Simulation: Develop computational approaches to predict the materials response to extreme dynamic environments at critical length and time scales

The U.S. Army has the long-term strategy to advance the state of the art in computational materials modeling of material response during dynamic events. The strategy is to develop the science and computational capability to exploit critical information obtained at relevant length scales. The result of the research should include a robust suite of recommended and validated models and codes at the length and time scales appropriate for predicting material response in extreme dynamic environments. The offeror may consider some or all of the

suggestions below and propose any and all modeling and simulation research deemed necessary to successfully achieve the program goals.

- Novel computational approaches and algorithms
- Modeling and simulation codes and algorithms at critical length scales
- Multiphysics, i.e. combined mechanics (solid and/or fluid) with electro-magnetic effects
- Calculating the same properties using multiple codes in regions of overlapping scale
- Development of physics-based models and algorithms for embedding into meso-scale and continuum codes
- Models and algorithms for incorporating discrete failure /damage and interfaces into codes
- New model formulations and approaches for continuum models that are robust with respect to advection

c. Bridging the Scales: Develop physical and mathematical constructs necessary to bridge critical length and time scales

The U.S. Army believes that a successful comprehensive program to advance the physics of materials in extreme environments requires a parallel and concurrent effort in analysis, theoretical mathematics and algorithms. This aspect of the program should aim to (1) enhance the ability to do modeling and simulation, (2) extract, evaluate and correlate experimental results, (3) theoretically link material micro, meso and macrostructure structure-property relationships across scales and disciplines, (4) provide the foundation for new numerical modeling algorithms, and (5) provide physical insight into equations of state and constitutive equations. The offeror may consider some or all of the suggestions below and propose any and all theoretical and mathematical research deemed necessary to successfully achieve the program goals.

- Novel mathematical theories/algorithms that link the fundamental governing equations across scales with the long term goal to have a unified set of governing equations which are asymptotically valid between and across scales
- Novel mathematical theories/techniques linking the fundamental governing equations, equations of state and constitutive equations across scales and disciplines that can be used to optimize information transfer due to disparate length and time scales
- Novel methods to manipulate and correlate deterministic and stochastic data from models, simulations and experiments for use in code validation
- New and novel mathematical techniques that would be the basis for optimum numerical algorithms in a multiscale environment
- New theory and mathematics that would bring a higher level of fundamental physics to equations of state and constitutive models (provide predictive capability)
- New mathematical techniques for manipulation and analysis of experimental data for validation and verification needed to understand the capabilities of modeling and simulation in a multiscale environment

d. Material Characteristics and Properties at Multiple Scales: Utilize existing and novel experimental methodologies to validate computational approaches in order to bridge the characteristic length and time scales, and to identify the comprehensive set of material characteristics, microstructural features, and dynamic properties that govern high rate deformation and failure phenomena.

It is important to be able to describe in detail, both deterministically and stochastically, the characteristics of a material so it can be processed and/or synthesized. This aspect of material science is well founded for materials subjected to static or slowly varying loads. However, for materials in extreme dynamic environments there are serious gaps in the ability to predict non-linear material response during dynamic events. The offeror is to consider developing advanced deterministic and stochastic descriptions of governing material characteristics and resulting properties. This will define the desired properties, microstructure and characteristics of materials with revolutionary response under extreme dynamic environments. The offeror may consider some or all of the suggested areas of study below.

- Material characteristics, defects, mechanisms, failure modes statically and in time and space
    - Non-linear material characteristics in time and space
    - Definition of the macro, micro structure, crystal and atomic structure
- Deterministic and stochastic metrics describing
    - Bond stretching, transformation, and breakage; phase transformation; dislocation nucleation, twinning, adiabatic shear localization, and strain hardening; void and crack formation and growth, fracture and vibration spectra
- Consider metrics for multidisciplinary description of materials
    - Spatial and temporal changes in chemical composition, phase reactivity
    - Spatial and temporal changes in electrodynamics and magnetic response
- Ensure the metrics can be extracted from modeling, experiments and theory as described in sections "a," "b" and "c" above

e. Synthesis and Processing: Incorporate research discoveries to enable the synthesis of novel materials and the processing of final products with critical material characteristics and resulting properties

At the heart of this CRA is a approach described in "Materials Science and Engineering for the 1990's", National Academy Press, Washington, DC, 1989, as follows: "… that the properties and phenomena associated with a material are intimately related to its composition and structure at all levels (scales), including what atoms are present and how the atoms are arranged in the material, and that this structure is the result of synthesis and processing. It is these elements – properties, structure and composition, synthesis and processing, and performance and their strong interrelationship among them – that define the field of materials science and engineering". It is understood that during the start up of the CRA, the research will rely on available materials, but it is very important that as the other parts of the program evolve, the ability to design and fabricate, with technical rationale, new materials be developed. This will include the synthesis of designed starting materials (e.g. powders, fibers, interface chemistry or structure, monomers, etc.) with controlled composition and atomic structure and further processing of these starting materials into bulk materials with controllable nano-, micro- and meso-structures. The offeror should strategically address these aspects by considering any and all approaches and techniques, which may include:

- Model synthesis and processing
    - Use of high performance computing modeling and simulation to optimize processing
    - Modeling and simulation strategies such as genetic algorithms, artificial intelligence algorithms to drive optimization techniques
    - Strategies for relating the processing to new metrics developed under the CRA

- New synthesis and processing techniques
- In-situ processing techniques that can be non-destructively monitored concurrently in time and space
- New methods to synthesize starting materials with controlled composition and atomic structure and possible functionalization with minimum defects and unwanted phases.
- Process starting materials into bulk materials with controlled nano-, micro- and meso-structure
    - Minimize unwanted phases and defects
    - Control interfaces between similar and dissimilar materials
    - Novel nano-, micro- and macrostructures for energy dispersion, redirection and transformation.

f. Overall Core CRA Research Program Goals The Army requires the capability to design, optimize, and fabricate lightweight protection material systems exhibiting revolutionary performance. A "Materials by Design" capability will be established through a Collaborative Research Alliance (CRA) focused on *Materials in Extreme Dynamic Environments* (MEDE) to advance the fundamental understanding of materials in relevant high strain rate and high stress regimes. A successful program should address the following related periodic goals, with tangible benefits to the soldier at each stage:

2-Year Goals: Advance the experimental and computational state-of-the-art for characterizing the in-situ materials response to extreme dynamic environments at critical length and time scales in metallic, polymeric, ceramic and composite material systems. Two-year outcomes that demonstrate progress toward the goals should include:

- Demonstration of real-time microstructural interrogation during high-rate experiments
- Preliminary identification of key microstructural phenomena related to high-rate deformation, fracture, and failure at critical length and time scales
- Accurately predict one or more bulk dynamic properties based upon models built up from smaller size scales in each of the four selected systems.

Benefit to the Soldier: Improved protection systems through incorporation of enhanced discrete deformation and failure algorithms in current continuum simulations and design codes.

5-Year Goals: Integration of novel experimental methodologies and multiscale computational approaches to enable unprecedented microstructural control and predictive capabilities. Five-year outcomes that demonstrate progress toward the goals should include:

- Validation of the comprehensive set of material characteristics and properties at length scales that govern high rate deformation, fracture and failure phenomena in metallic, polymeric, ceramic and composite material systems through both computational and experimental techniques.
- Demonstration of a 30% improvement in multiple concurrent key properties in newly designed and processed materials from each of the four selected systems.

Benefit to the Soldier: The CRA will transition to ARL and the industrial base the key materials characteristics and properties to achieve a 15%-30% weight reduction for selected protection systems.

10-Year Goals: Demonstrate a comprehensive "materials-by-design" capability to include both designing materials and predicting key properties for materials in extreme dynamic environments. Ten-year outcomes that demonstrate progress toward the goals should include:

- Demonstrate computational capability at critical length scales (bridged and optimized as required) for one polymer, one metal, one ceramic, and one composite material system for the relevant spectrum of stresses and strain rates.
- Deliver the fabrication technology for optimized polymeric, metallic, ceramic and composite systems.

Benefit to the Soldier: The CRA, ARL and industrial partners will utilize the "materials-by-design" capability to design and produce protection materials with 1/3 the weight of the current systems.

6. Funding

Table 1 below presents the estimated funding levels for the research to be conducted under the CA over the projected period of performance, including option years. The projected funding includes all costs associated with the CA, i.e. the research costs, costs to manage the program, costs to collaborate and to enable the transitioning of the research. The table makes two key assumptions: (1) award of the CA will be in the second quarter of FY12 and the program will ramp up with start-up activities during the third and fourth quarters of FY12 resulting in less than full funding during the initial fiscal year of operation (i.e., the funding identified for FY12 in Table 1 is the amount of funding anticipated for the start-up year and as such it is less than the annual funding for subsequent years) and (2) planning numbers for Basic Research for the CRA that are currently part of the FY12 President's budget indicate increased funding in the Program Objective Memorandum (POM) out years. The Table also contains possible Enhanced Research Program funding. This is currently unfunded. As the CRA proceeds it is anticipated that other Government agencies will be able to provide funding for some enhancements to the CRA.

Offerors should not assume equal levels of funding for each of the five core elements and four material classes, but should prioritize funding based upon the goals of the research portfolio presented in the proposal. As a reminder, the funding levels provided in this PA are for proposal preparation purposes. The actual funding levels for CRA will be updated annually after the US appropriation processes. Also, it is required that "covered educational institutions" (to include Historically Black Colleges and Universities and Minority-Serving Institutions or HBCU/MSIs – see also **PART II.C.1** below) shall receive 5-10% of the annual CA funding.

Given the significant length of the proposed period of performance (including option years), it is not possible to foresee all changes in requirements for the program or the direction of research over the total life of the CRA. Therefore it is possible that the mix of expertise available to the Alliance will be required to evolve over the course of its lifetime. As part of this PA, provision is being made for the Consortium to continually renew itself by scouring the research community for new and relevant ideas and concepts consistent with the focus of the MEDE CRA, including the incorporation of new research partners. To achieve the continued infusion of innovation and new concepts into the Alliance, it is expected that beginning in FY13 with the first Annual Program Plan, 10% of the proposed funding is expected to be devoted towards new and innovative research conducted by a continually changing group of subawardees. These tasks will be elements of the program and are expected to complement the ongoing research. Offerors, as part of the proposal, are invited to propose mechanisms for identifying and evaluating new research topics under this element of the

Alliance. Additionally tasks falling under this element of the program shall be identified in a separate portion of the Annual Program Plan document.

These novel research projects are expected to be funded under the CRA CA with entities not necessarily Members of the Consortium, i.e., these entities will be considered subawardees. That means for year FY13 and beyond, offerors proposals should include the use of proposed subawardees for 10% of the funding for the CRA. It is recognized that as this 10% funding is for novel research projects, the identities and scope associated with such research projects may not be known beyond FY13. Thus, the cost proposal should show specifically proposed projects through FY13 and provide some general plans for FY14 and beyond based on previous experience and the offeror's proposed approach to the scope and research issues associated with the CRA.

Enhanced Program: This unfunded program will provide a mechanism within the CRA for growth and enhancement. ARL, the Army and other government agencies may choose to support the program with basic and/or applied research dollars in areas of specific interest to their basic and applied mission programs. This enhanced program will leverage, parallel and/or transition the research, technology and capabilities that are part of the core of the ARL funded CRA. **In response to this PA, offerors are requested to provide a detailed proposal to address the Core CRA Research Program at the core level of funding. However, offerors are also asked to include a brief general discussion of possible additional research that could be pursued should funding be received to enhance the CRA effort. (See the Cost Proposal section below for further guidance.)**

Award will be made to the Consortium that offers the best value to the Government. Thus, the participation of the Consortium Members is considered extremely important during the period of performance; however, Members must recognize and understand that there are no guarantees associated with the levels of funding for each Member during the period of performance. All Members may be expected to compromise and sacrifice anticipated funding to their organization as necessary and appropriate to meet the goals and objectives of the CRA as established through the collaborative planning process during the period of performance.

Core CRA Research Program ($)													
	Fiscal Year												
Funding Category	FY12	FY13	FY14	FY15	FY16	**Total 1st(5yr)**	FY17	FY18	FY19	FY20	FY21	**Total 2nd(5yr)**	**Total (10yr)**
Basic Research ($M)	3.2	6.5	7.6	7.8	8	**33.1**	8	8	8	8	8	**40**	**73.1**
Core Total ($M)	3.2	6.5	7.6	7.8	8	**33.1**	8	8	8	8	8	**40**	**73.1**
Example of an Enhanced Research Program ($)													
Basic Research ($M)	0.2	0.6	1.15	1.15	1.15	**4.25**	1.2	1.2	1.2	1.2	1.2	**6**	**10.25**
Applied Research ($M)	0	0.2	0.75	0.75	0.8	**2.5**	0.8	0.8	0.8	0.8	0.8	**4**	**6.5**
Enhanced Total ($M)	0.2	0.8	1.9	1.9	1.95	**6.75**	2	2	2	2	2	**10**	**16.75**
Program Total ($M)	3.4	7.3	9.5	9.7	9.95	**39.85**	10	10	10	10	10	**50**	**89.85**

Note: Total Funded 10 Year Core CRA Program $73.1M
Total Funded 10 Year Core and Unfunded Enhanced Program $89.85M

Table 1. Anticipated CRA Funding
(Funded Core CRA Research Program and Unfunded Enhanced Research Program)

7. Collaboration

a. Background

The CRA continues the ARL concept of the creation of an Alliance to facilitate a close relationship between ARL and its partners so that collaborative research with the government across the academic and industrial community enhances innovation and has a high return on investment. It is ARL's strong belief that collaboration between the members of the Consortium and the Government is integral to the execution and success of the CRA. Creation of an environment that is conducive to collaboration is therefore a critical element in establishing the CRA and will be evaluated as such. This section describes collaborative opportunities and potential avenues to collaborate under the CRA. The implementation of the collaboration with ARL will be through the proposed Initial Program Plan (IPP) and the subsequent Annual Program plan (APP). Offerors are invited to suggest additional new and innovative avenues for fostering collaboration among Alliance partners as part of their proposal.

b. Collaboration Opportunities

(1) ARL Mission Programs

ARL/WMRD/CISD Mission Program
ARL will specifically fund an in-house mission program to foster direct highly collaborative partnerships between the MSME team and government researchers. This in-house effort will cover the five critical core technical elements of the MEDE CRA as well as the materials by design strategy. ARL will develop that mission program for optimal synergies with the CRA strategy, the CRA Initial Program Plan (IPP) and the subsequent Annual Program Plans

(APPs), thus insuring a direct and continuing collaboration across the Alliance. The LRO will be required to submit a comprehensive collaboration plan in response to this PA. The APP will be the basis for the Alliance to optimize the collaboration, information, research and technology transfer between the CRA and ARL subject matter experts. The open house, ARL web site and briefings posted on the MEDE website provide information to the offerors on the current ARL mission program and available facilities relevant to the MEDE CRA. This information will provide the background for the offeror to develop the required collaboration plan.

ARL In-House Initiative for Multiscale Modeling of Materials (I3M)
This CRA is part of the ARL Enterprise for Multiscale Research of Materials. The Enterprise will include an in-house ARL Initiative for Multiscale Modeling of Materials (I3M) that will be established prior to the CRA awards. The long term goal of the I3M is to develop new physics-based scientific multidisciplinary multiscale modeling methodologies and software that can interrogate design space in which material imperfections, surface and interfaces (ISI's) are prominent enablers or detractors for performance. The I3M will be a partner in collaboration with the CRAs. It is envisioned that this Enterprise effort will provide the Army and DoD fundamentally new cross-cutting capabilities (high level physics-based computational tools) that will help overcome obstacles for materials development relevant to energetics, sensors, electronics, power, modeling and simulation applications. This I3M will also provide access to advanced high performance computing capability, computing environments, validated codes and software, visualization suites, and data management techniques that can be leveraged by the CRAs.

As mentioned above, ARL will specifically tailor research in its mission programs at WMRD and CISD (and through the ARL Enterprise for Multiscale Research of Materials) to collaborate within the CRA construct. ARL will structure approximately $3.5M per year of ARL mission programs to compliment and augment the MEDE CRA activities. While these resources will form a vital part of the collaboration within the CRA, it is important to note that they will still be managed within ARL and prioritized to meet ARL WMRD/CISD missions. It is also critical that these CRA focused programs take advantage of WRMD/CISD personnel, capabilities, and facilities. In addition to these resources, the CRA should be able to collaborate with other programs in the ARL mission portfolio, and utilize the DoD Supercomputing Resource Center (DSRC). Figure 2 shows the internal programs that will be directly structured to work within the CRA, along with programs that should provide significant opportunities for collaboration. Details of the current ARL WMRD program were provided at the Open House at ARL WMRD on 16 December, 2010. These briefings are also provided on the website
http://www.arl.army.mil/www/default.cfm?page=535

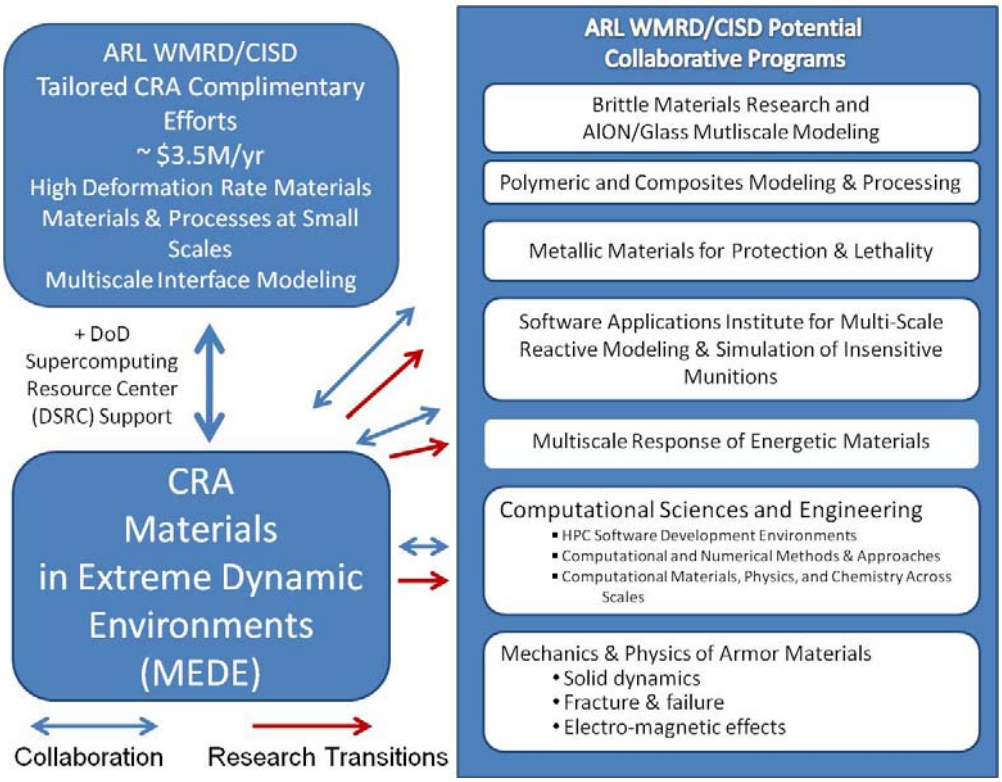

Figure 2. Collaboration between ARL WMRD/CISD mission programs and the MEDE Collaborative Research Alliance.

The following information provides WMRD's and CSID's experimental and analytical and computations capabilities and facilities, and is intended to provide the offerors the necessary information for creating a collaborative research plan for each of the five core elements: Advanced Experimental Techniques, Modeling and Simulation, Bridging the Scales, Material Characteristics and Properties at Multiple Scales, and Synthesis and Processing.

Rodman Materials Laboratory - ARL has over 132 individual laboratories devoted to materials synthesis, processing and characterization

Materials Characterization and Properties

- Focused Ion Beam Facility
  - 3D microstructural analysis
  - Micron scale specimen fabrication and mechanical testing
- Quasi-Static Mechanical Characterization
  - Servo-hydraulic moderate to large scale tension, compression and torsion
  - Combined Tension/Torsion
- High Strain-Rate Facilities
  - Split-Hopkinson (Kolsky) bars compression, tension, torsion micro-bars for strain rates above 10^4/s dynamic fracture toughness w/digital image correlation & high-speed photography
  - Laser Shock Facility

    - Gas guns
      Single stage and two stage w/ compression/shear & 4 beam VISAR
- Small and large scale blast facilities w/digital image correlation & high-speed photography
- Nanoindentation and Hertzian Indentation for Brittle and Soft Materials
- Extensive Microscopy Labs:
    - Atomic Force Microscopy & Profilometry
    - Analytical Transmission Electron Microscopy
    - Scanning Electron Microscopy
    - Laser Confocal and Floresence Microscopy
    - Optical Microscopy
    - X-ray Photoelectron Spectroscopy
    - Auger Electron Spectroscopy
- X-ray diffraction analysis
- X-ray Computer Tomography (CT)
- Thermal and dielectric analysis laboratory
- Phased-Array Acoustic NDE
- 1 MeV Ion beam analysis (Rutherford Backscattering, Nuclear Reaction Analysis)

Materials Synthesis and Processing

- Composites Processing
    - Thermal Equipment Autoclaves
    - High-tension Filament Winders
    - Resin Transfer Molding & VARTM
    - Composite Pultrusion
    - Laminating Presses
- Polymer Processing Laboratories
    - Adhesive formulation, application, and processing facilities
    - Extensive chemical synthesis laboratory
    - Melt-spinning
- Ceramic Processing
    - Hot Isostatic Pressing (HIP)/Hot Press Processing
    - Ball milling
    - Tape casting
    - SPS (Spark Plasma Sintering)
    - Large area sputtering
    - MOCVD processing of thin films
- Metals Processing
    - Cryomilling
    - Equi-Channel Angular Pressing
    - Cold-spray coating and synthesis
    - Hot Isostatic Pressing(HIP)
    - SPS (Spark Plasma Sintering)
    - Large area sputtering

Computational Resources (CISD)

- Defense Supercomputing Resource Center (DSRC)
    - As of FY10, 350 TeraFlops

        - 2 SGI ALTIX ICEs
        - Cray XT5 Cluster
        - 2 Linux NetworXs
    - Extensive Library of Applications
        - Computational Chemistry and Materials Science
        - Computational Structural Mechanics
        - Programming and System Tools
            - Scientific Visualization

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(2) Staff Rotation

An important element of CRA collaboration is the advancement, education and rotation of technical staff through short- and long-term temporary assignments. The scope of this collaboration may range from regular, periodic short term visits to sabbaticals lasting as long as a year. Staff rotations will be undertaken to foster and facilitate collaborative research where face-to-face interaction is advantageous, to enable a researcher to utilize unique facilities, to enable Alliance personnel to obtain specialized training or experience and to facilitate the exchange of research results. In addition, this exchange, or cross fertilization, of personnel will provide Consortium personnel with insight into Army unique requirements and will provide Government personnel with insight into SOA research and commercial practices and/or the opportunity to pursue fundamental research with noted researchers. The success of these interactive and collaborative exchanges will be assessed by the quality of the collaboration as demonstrated by joint efforts such as basic research transitions to applied research programs, archival journal papers, patents, and refereed presentations. In the proposal offerors should outline the range of opportunities foreseen for collaboration and the mechanisms that will be put into place to foster staff rotations and other collaborative activities.

All salary and travel costs associated with the rotation of Government personnel will be borne by the Government. All salary and travel costs associated with staff rotations of Consortium members will be funded under the CA or may be provided by the Consortium member as cost-share. There should be a balance of staff rotations across all the partners in the Consortium and across all the research areas. It is anticipated that some portion of the Consortium's scientific labor-years will be in staff rotations.

(3) Lectures, Workshops, and Research Reviews

The Alliance (i.e., the Consortium and ARL) will be encouraged to hold, from time to time throughout the period of performance of the MEDE CRA, scientific lectures, short courses and workshops on mutually agreed upon topics. These lectures and workshops will serve as both educational and research outreach opportunities and should involve participants outside the Alliance when appropriate. Additionally, the Alliance is expected to hold regular, periodic research reviews that will permit the free exchange of ideas and research results, especially those impacting any cross-cutting research themes, among the entire ARL Enterprise for Multiscale Research of Materials. The costs associated with the Consortium's efforts for these lectures, short courses, workshops and reviews will be funded under the CA.

(4) Education

As a means to foster the professional growth, technical strength and to provide a venue for training personnel in the scientific disciplines underlying the Alliance, the Consortium will identify educational opportunities for Government scientists and engineers. These opportunities may include fellowship programs that lead to masters and doctoral degrees, and short courses (e.g., summer and intensive special topic courses in critical technology areas) that lead to the award of appropriate academic credit. The Consortium will further consider means to foster collaboration with the ARL technical staff through programs such as internships at ARL for graduate and undergraduate students, faculty sabbaticals and summer research. The costs associated with the Consortium's efforts to identify, prepare for and execute such educational opportunities will be funded under the CA. The cost associated with salaries, travel, etc. for Government personnel will be the responsibility of the Government, and will not be funded under the CA.

(5) Industry

To foster industrial participation offerors are required to provide a plan for engagement of Industry. As an example, such a plan may include the establishment of a separate, self-funded Industry/University consortium that will parallel the government funded CRA. Such an Industry consortium, for example, may offer: funding of industry driven R&D projects, interaction with key players in industry, peers and customers, access to intellectual property, access to pre-publication research papers, access to world class facilities and researchers, access to students and transfer of research results to serve industry projects and products. Other industrial participation mechanisms may also be proposed. Examples of Industry/University Collaborative Research Centers that may be used to model a proposed plan for engagement of industry may be found at:

http://flexdisplay.asu.edu/partners/industry
http://www.ccmd.psu.edu/
http://ccmc.rutgers.edu/

(6) Other Collaboration Opportunities

High Performance Computing DoD Supercomputing Resource Center (HPC-DSRC) (http://www.arl.hpc.mil/) The CRA partners can request access to the DSRC under the CRA umbrella to utilize the computational, and visualization resources. ARL is a partner with the DoD High Performance Computing Modernization Program Office (HPCMPO) and operates one of its four DoD Supercomputing Resource Centers (DSRCs). The ARL DSRC also delivers the latest in computational tools, visualization and innovative technology. The DSRC modeling and simulation environment enables research, helps subject matter experts engineer, develop, test, and field weapon systems faster and more efficiently. ARL DSRC Team members are helping scientists develop more effective techniques for simulating combat environments, detecting munitions, and creating new armaments-to save lives on future battlefields. The Center offers a full spectrum of computational capabilities for the Department of Defense (DoD) Science and Technology and Test and Evaluation communities, including:

* Powerful parallel processors
* Reliable high-speed networks
* A wide range of software
* Comprehensive storage

* Scientific visualization
* Novel storage platforms
* Close ties with academic partners
* Advanced training
* Outstanding end-user care

HPC (High Performance Computing) Software and Application Institute (HSAI) for Multi-Scale Reactive Modeling and Simulation of Insensitive Munitions (MSRMS-IM).

The HSAI for MSRMS-IM has the mission, vision, and goals to develop a science-based capability to simulate munition response to insults through adequately capturing the effects that micro, meso and macrostructural heterogeneities, inherent in composite Energetic Materials (EM), impose on macroscopic events. This effort will transform the current Modeling and Simulation (M&S) process that DoD utilizes to design IM compliant weapons. This will provide a change in paradigm by eliminating current system-specific M&S tools that have high levels of empiricism and inaccuracies. The HSAI will introduce an agile and robust set of M&S tools applicable for a wide range of IM design and development and are amenable for future growth and expansion. Further, this multi-scale approach provides true predictive capability of system-level munitions response based on fundamental physics and chemistry linked to engineering/continuum models, resulting in 1) faster design and implementation of IM technology solutions 2) reduced risk with IM technology integration and 3) a reduction of the development and acquisition cycle to introduce IM compliant mission-capable munitions into service. This multiscale design and analysis tool suite will allow for extrapolation beyond current IM threats and will be transitioned and disseminated to DoD, industry and university researchers, developers and the acquisition community. The output of the HSAI will be validated and vetted computational codes, equations of state and constitutive models for multiscale modeling of IM compliant energetic materials.

Other Government Agencies (OGAs)

The government will work with the LRO to leverage and/or integrate other interested OGA's (and funding where appropriate) into the CRA umbrella. This may become part of the Core Research Program, or maybe enabled directly through the enhanced CRA program. These efforts and thrusts may be lead by the LRO, consortium partners or coordinated jointly. The offeror is free to propose leverage of and/or utilization of unique facilities and or capabilities available within OGA's. Other service elements such as the U.S. Air Force, the U.S. Navy and the U.S. Army Research and Development Centers (RDECs) such as the U.S. Army Tank-Automotive Research Development and Engineering Center (TARDEC), the U.S.Army Armaments Research Development and Engineering Center, (ARDEC), the U.S. Army Aviation and Missile Research and Development Center (AMRDEC), the Natick Soldier Research Development and Engineering Center (NSRDEC) and the U.S. Army Engineer Research Development Center (ERDEC) have requirements for Materials in Extreme Environments and will be able to leverage the CRA work and/or provide funding in areas of interest. The U.S. Army RDEC's will be a part of the CRA Research Management Board.

8. Management

a. Background

It is critical that the Consortium be structured and managed to create and foster an open, collaborative research environment in which each member of the Consortium is an equal partner, to facilitate the transition of basic research. This section describes a framework for

the organization of CRA. The framework is sparse and flexible to minimize overhead, yet insure research relevance and proper oversight. Offerors can suggest additional management tools and mechanisms as part of the proposal, but in doing so they must also justify and demonstrate the benefit and cost effectiveness of these additional management activities.

b. Overall Management Concept

ARL and the winning Consortium will establish a CRA. Additionally, other Government agencies may be invited to join this Alliance and to contribute, as appropriate, their technical expertise, personnel, access to research facilities and funding. The Alliance will strive for a focused, yet flexible research environment. To accomplish this the Government proposes that the consortium consist of a small number of academic and industrial organizations, optimally sized with no more than six members, possessing significant expertise in one or more of the research areas covered by the CRA, led by a single organization, the LRO, with the ability to integrate the broad palette of research required to realize the goals of the CRA. Each of these entities shall be a full Member of the consortium and possess equal voting rights in accord with the Articles of Collaboration.

In addition to research conducted by members of the consortium, the annual research program may be enhanced by research undertaken by other organizations selected jointly by the Alliance as part of its annual planning process. Offerors are asked to suggest a detailed process for the selection and incorporation of these additional topics into the annual research program. These additional researchers and research organizations will be subawardees to one of the consortium members. Subawardee funding will be provided to the Consortium Member with which the Subawardee has or will have a legal relationship.

c. Technical Guidance and Oversight

The following framework is required for the management and oversight of the Alliance. It consists of parallel managers from the Government and the Consortium who will provide day-to-day coordination, as well as a small managing board representing the interests of each of the Consortium members and a consultative group of interested parties from the Government. Offerors may propose additional plans or mechanisms for management; however, offerors are cautioned to ensure that any such plans or mechanisms are: (1) not duplicative of the requirements, and (2) not overly burdensome to the Alliance. A description of each component of the Alliance Management follows:

- **Collaborative Alliance Manager (CAM)**. The research executed under the CRA will be considered an extension and integral part of the US Army Research Laboratory (ARL) research program. As such, the program established under this PA will be planned, defended, executed, and reviewed as part of ARL's mission program. Overall scientific management and fiscal responsibility for the CRA will reside with a senior ARL scientific manager, who will be designated the CAM for the CRA under the cooperative agreement. The ARL Grants Officer/Contracting Officer will receive recommendations from the CAM/COR and will be the ultimate legal authority empowered to make formal adjustments to the CA.

- **Program Manager (PM).** The CRA Program Manager (PM)is the Consortium's scientific representative charged with the Consortium's overall responsibility for management and guidance of the cooperative agreement. The PM will be designated by the LRO and be a member of that organization. The CRA is expected to be the primary

responsibility of the individual assigned as PM and a commitment of time commensurate with this responsibility is also expected. The PM is required to be an eminent scholar in the field of material science and have the stature, experience and leadership skills to successfully execute the CRA program. The PM will need to reduce any teaching schedule commitments commensurate with the duties required to manage the CRA. It is also recognized that the PM may require significant staff support to manage and execute the cooperative agreement, and this should be included in the CRA proposal submission.

- A **Research Management Board (RMB)** will be established to identify and develop collaborative opportunities, advise and assist the CAM in setting research goals, and facilitate transition to ARL basic and applied research programs. The RMB will be chaired by the CAM and will include representatives from Army, other service organizations and other government agencies with interest, expertise in the technologies related to the CRA. The RMB will be invited to the APP Meeting and Technical Review, and be informed about the Annual Program Plan approval process.

- **Consortium Management Committee (CMC).** The CRA will have a Consortium Management Committee (CMC) that consists of one representative from each member of the Consortium. The CAM participates as ex officio member in all discussions except those that deal with purely internal Consortium matters. The CMC will be chaired by the PM. Each Member will have one vote on the CMC to support programmatic and management-related activities and decisions. In the event of a tie, the LRO will cast the deciding vote. The CMC will be responsible for the management and integration of the Consortium's efforts under the CRA including programmatic, technical, reporting, financial, and administrative matters. The CMC makes recommendations that concern the membership of the Consortium, the definition of the tasks and goals of the participants, and the distribution of funding to the participants. Quarterly meetings will be conducted by the CMC.

d. Articles of Collaboration

The Articles of Collaboration define the operational structure within the Consortium. A sample for offerors to consider in formulating their proposals is provided on the CRA website. Offerors are required to submit their proposed Articles of Collaboration with the proposal. Such articles must be signed by a duly authorized representative for each Member of the Consortium.

e. Initial Program Plan (IPP) and Annual Program Plan (APP).

Within 90 days after award, the Consortium (through the CMC) and the Government will jointly prepare an Initial Program Plan (IPP) to cover the first 9 months of performance. The IPP will be based substantially on the final proposals received from the Consortium. The IPP will be accompanied by a five-year roadmap that describes the overall plan to be accomplished by the Consortium within the Alliance structure. This roadmap should provide the vision for grand challenges and crosscutting themes to be addressed during the first five years of the Alliance. The roadmap should provide a detailed description of a well-coordinated preliminary APP for execution of the basic research, balancing theoretical and experimental elements of the program in each of the five core elements. It should provide a clear plan for data collection, technology integration, and technology assessment activities to facilitate planning by all Alliance partners. It should provide approximate timelines for research activities to facilitate potential future basic research transitions.

Eight months after award, the Consortium (through the CMC) and the Government will jointly prepare a proposed Annual Program Plan (APP) for the next fiscal year. Through discussion among the consortium members, an APP will result that enables integration and execution of crosscutting themes that strive to achieve CRA objectives. The CAM will approve the APP and formally submit the approved APP to the Grants Officer for incorporation into the collaborative agreement. This process will continue through the life of the collaborative agreement.

Each APP will cover a one-year timeframe, but may be altered, with the approval of the CAM and the Grants Officer, if research work requirements change. The APP will provide a detailed plan of research activities (including research goals, key personnel, educational opportunities, staff rotation, facilities, demonstrations and budget) that commits the Consortium to use their best efforts to meet specific research objectives. The APP will also describe the collaborative efforts with the Government. The APP will include, as a separate volume, a detailed description of the projects proposed to be undertaken by subawardees, including new subawardees that may be included at the discretion of the Government, and funded by up to a 10% withhold on the Consortium annual budget. In addition to the items normally outlined for each Consortium task in the APP, this appendix will demonstrate the novel nature of the research, the manner in which it complements the research being undertaken by the consortium, and how it is being integrated into the overall research program..

During the course of performance, if it appears that research goals will not be met, the CMC will provide a proposed adjustment to the APP for approval by the CAM. In addition, the CAM may from time to time request that additional research be added to the APP within the scope of the collaborative agreement. The Consortium, as an entity, will not solicit or accept funding from outside sources other than the US ARL without the approval of the CAM and the Grants Officer.

During the course of performance, the Grants Officer, in coordination with the CAM, will have approval authority for certain specific changes to the IPP/APP including but not limited to:

- Changes in the scope or the objective of the program, IPP/APP, or research milestones;
- Change in the key personnel specified in the IPP/APP;
- The absence for more than three months, or a 25% reduction in time devoted to the project, by the PM;
- The need for additional Federal funding; and
- Any subaward, transfer, or contracting out of substantive program performance under an award, unless described in the IPP/APP.

The CAM, in coordination with the CMC and ARL management, will be responsible for integrating the IPP/APP into the overall respective research and technology programs.

During the course of performance, the Grants Officer, in coordination with the CAM, will have approval authority for certain specific changes to the CA including, but not limited to:

- Changes to the Articles of Collaboration if such changes substantially alter the relationship of the parties as originally agreed upon;

- Solicitation or acceptance of funding under the agreement from sources other than ARL; and

- Changes in Consortium membership.

f. APP Meeting and Technical Review

Each year, the Alliance must organize a CRA APP Meeting and Technical Review to display and present the results of its previous year's research and describe plans for the next year. The APP Meeting and Technical Review will foster interactions and collaborations among researchers. Planning for the APP Meeting and Technical Review will be executed through the PM and the CAM. Additionally, it is anticipated that the Alliance will participate in other ARL/Army program reviews.

g. Evaluation For Five-Year Extension

The CRA will be awarded for a five-year period beginning in FY12. There will be an option to extend the CRA for an additional five years. At the end of the fourth year, a program review will be conducted as directed by ARL. The program will be measured against the 2, 5, and 10 year goals as outlined in section II.A.5.f. of this PA. The progress towards the 5 year goal will be evaluated, and an assessment will be made of the ultimate ability of the Consortium to achieve the 10 year goal. This review will consider cumulative performance metrics, the Consortium's vision for the additional five-year period of performance (to be submitted by the Consortium at the end of the fourth year), funding availability and the current fundamental research needs and goals of the US Army. Performance metrics are expected to include items that provide an indication of the CRA's accomplishments, such as research transitions from the CRA, the number of refereed journal articles, invited presentations, relevance of the work to ARL, collaboration, staff rotation, education, management**,** etc. The decision as to whether to exercise the option is expected to be based on the results of the review and evaluation described above.

h. Distribution of Funding

The LRO will distribute the funding to all members of the Consortium. Subawardee funding will be provided to the Consortium Member with which the Subawardee has or will have a legal relationship.

B. AWARD INFORMATION:

One CA will be awarded as a result of this PA. Offeror selected for award will be notified by the Grants Officer or his/her designee telephonically or via email. Once notified the selected offeror will be required to sign the CA. The award is not official until each Member of the successful Consortium on the selected offeror's proposal has signed the CA and the Grants Officer has signed the CA. Substantial government involvement is expected as described under the COLLABORATION section above.

C. ELIGIBILITY INFORMATION:

1. Eligible Applicants

During performance it is envisioned that there will be Consortium Members as well as Subawardees performing under the CA. The LRO has specific leadership and management responsibilities and roles as outlined below. Consortium Members are expected to have significant involvement and input on a long-term basis as outlined below. It is anticipated that an optimally sized consortium would include no more than six members (including the LRO), but this should not be considered a hard limit. Proposals that include more than six members must provide a rationale for the additional members. While Subawardees are expected to fulfill short-term needs as outlined below, they are particularly expected to execute new and innovative research covered by the 10% of overall funding that the Government reserves the right to withhold for this purpose. In addition, covered educational institutions must receive 5-10% of the CRA annual funding. Thus, offerors are expected to consider carefully the construct of their proposed Consortium and effectively engage the appropriate Membership and Subawardee performance to achieve the goals of the CRA.

To be qualified to be a Consortium Member, potential applicants must:

- Have the management capability and adequate financial and technical resources, given those that would be made available through the cooperative agreement, to execute the program of activities envisioned under the cooperative agreement.
- Have a satisfactory record of executing such programs or activities (if a prior recipient of an award).
- Have a satisfactory record of integrity and business ethics.
- Be otherwise qualified and eligible to receive a cooperative agreement under applicable laws and regulation.

  In deciding whether a recipient is otherwise qualified, the Grants Officer shall ensure that the potential recipient: is not identified in the Government-wide Excluded Parties List System (EPLS) as being debarred, suspended, or otherwise ineligible to receive the award; has provided all certifications and assurances required by Federal statute, Executive order, or codified regulation, unless they are to be addressed in award terms and conditions at the time of award; and meets any eligibility criteria that may be specified in the statute authorizing the specific program under which the award is being made.

The following is a discussion of Consortium Members and other Participants in the CRA:

- **Lead Member called the Lead Research Organization (LRO)**:

  The LRO is required to be an academic institution. The academic institution is expected to be an advanced degree-granting educational institution under the Higher Education Act of 1965 as amended. This institution is also expected to have doctoral level courses of study in scientific and research areas related to this CRA that can result in the granting of a doctoral degree. The LRO has primary responsibility for articulating and executing the vision for the basic research and maintaining cross-Consortium collaboration and integration. This Member is expected to articulate a vision for the CRA, promote collaboration among Consortium Members, and members of the Alliance, and coordinate crosscutting themes with Alliance Members. This Member is required to administer, integrate, and manage the Consortium, participate in the research, and promote the transition of research and technologies resulting from the research

program within the CRA. This includes distribution of Government funding to Consortium Members in accordance with the approved IPP/APP under the agreement. The LRO is also responsible for timely billing (invoicing) of executed research for itself and the other Consortium Members to ensure proper disbursement of government funds.

- **Consortium Members:**

  Each Consortium Member may be an industrial, non-profit or academic institution but must possess substantial experience and expertise in the research areas contained within the scope of the CRA. Under special considerations outlined below Federally Funded Research and Development Centers (FFRDCs) and National Laboratories may participate in the Consortium as a Member. Academic members are expected to be advanced degree-granting educational institutions under the Higher Education Act of 1965 as amended. Those institutions are also expected to have doctoral level courses of study in scientific and research areas related to this CRA that can result in the granting of a doctoral degree. Industrial members are expected to have the ability to conduct appropriate research activities utilizing in-house engineers, scientists and facilities. All Members are expected to demonstrate opportunities for substantive collaboration with ARL, including appropriate opportunities for staff rotations and research collaboration.

- **Covered Educational Institutions**:

  The FY10 Department of Defense (DoD) Authorization Act, Public Law 111-84, provides authority for the Secretary of each military department to carry out a program to provide assistance to "covered educational institutions" to assist DoD in defense-related research, development, testing, and evaluation activities. The term “covered educational institution” is defined to mean an **(1)** an institution of higher education eligible for assistance under title III or IV of the Higher Education Act of 1965 (20 U.S.C. 1051 et seq.); or **(2)** an accredited postsecondary minority institution. As defined under title III or IV of the Higher Education Act, “covered educational institution” includes Historically Black Colleges and Universities/Minority-Serving Institutions (HBCU/MSIs).[1]

  Accordingly, it is required that covered educational institutions receive 5-10% of the annual funding under the CA. This may be accomplished through one of the following: (a) a covered educational institution submitting the proposal as the LRO; (b) a covered educational institution being included as a Member or Subawardee in a proposal; or (c) the proposal including a plan for how the LRO will work collaboratively with the Government to identify a covered educational institution for participation in the program.

- **Subawardees:**

  Consortium Members will be augmented with Subawardees to conduct specific research projects as necessary and appropriate to meet the goals of the CRA, especially for the conduct of new and innovative research for which they are particularly qualified. Subawardees are organizations that (1) are not expected to provide strategic input concerning the goals and direction of the CRA and (2) may possibly have only a short term relationship with the Consortium.

- **Federally-Funded Research and Development Centers (FFRDCs) and National Laboratories:**

[1] See the definition of a “eligible institution” at 20 U.S.C. 1067q which includes historically Black colleges and universities and other minority-serving institutions.

FFRDCs and National Laboratories may participate as Consortium Members or Subawardees but may not be the LRO, and their participation must be within the scope of their charter or sponsorship agreements. Further, FFRDCs and National Laboratories must cost-share an amount at least equal to the funding to be provided to them under the CRA.

2. Cost Sharing Or Matching

Except for FFRDC or National Laboratory Members of a consortium, cost sharing is encouraged, but not required, to be responsive to the PA. During the evaluation of proposals, cost sharing will be evaluated as it relates to the evaluation factors listed in the PA, based on the degree to which the proposed cost sharing enhances the proposal to result in added benefits to the CRA Program. In order for the proposed cost sharing to receive appropriate credit during the evaluation process, the proposal should evidence **a firm commitment** to provide such cost share and also evidence **a process for integrating the cost share into the collaborative research program**.

3. Dun and Bradstreet Universal Numbering System (DUNS) Number and Central Contractor Registration (CCR)

I. *Central Contractor Registration and Universal Identifier Requirements.*

A. *Requirement for recipients.* Unless you are excepted from this requirement under 2 CFR 25.110, you as the recipient must maintain the currency of your information in the Central Contractor Registration (CCR) until you submit the final financial report required under this award or receive the final payment, whichever is later.

B. *Requirement for subrecipients.* If you are authorized to make subawards under this award, you:

1. Must notify potential subrecipients that no entity (*see* definition in paragraph C of this award term) may receive a subaward from you unless the entity has provided its Data Universal Numbering System (DUNS) number to you and is registered in the CCR.
2. May not make a subaward to an entity unless the entity has provided its DUNS number to you and is registered in the Central Contractor Registration.

C. *Definitions.* For purposes of this award term:

1. *Central Contractor Registration (CCR)* means the Federal repository into which an entity must provide information required for the conduct of business as a recipient. Additional information about registration procedures may be found at the CCR Internet site (currently at *http://www.ccr.gov*).
2. *Data Universal Numbering System (DUNS) number* means the nine-digit number established and assigned by Dun and Bradstreet, Inc. (D&B) to uniquely identify business entities. A DUNS number may be obtained from D&B by telephone (currently 866–705–5711) or the Internet (currently at *http://fedgov.dnb.com/webform*).
3. *Entity*, as it is used in this award term, means all of the following, as defined at 2 CFR part 25, subpart C:
   a. A Governmental organization, which is a State, local government, or Indian tribe;
   b. A foreign public entity;
   c. A domestic or foreign nonprofit organization;
   d. A domestic or foreign for-profit organization; and
   e. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

4. *Subaward:*

a. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.
b. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, *see* Sec. __.210 of the attachment to OMB Circular A–133, ‘‘Audits of States, Local Governments, and Non-Profit Organizations’’).
c. A subaward may be provided through any legal agreement, including an agreement that you consider a contract.

5. *Subrecipient* means an entity that:
a. Receives a subaward from you under this award; and
b. Is accountable to you for the use of the Federal funds provided by the subaward.

D. APPLICATION AND SUBMISSION INFORMATION

1. Address to Request Application Package -

Proposals shall be submitted electronically through the www.grants.gov portal. Proposals sent by fax or email will not be considered.

Registration Requirements for www.grants.gov: There are several one-time actions that an offeror must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See www.grants.gov/GetRegistered to begin this process. Use the Grants.gov Organization Registration Checklist at www.grants.gov/Applicants/get-registered.isp to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 21 days to complete these requirements. It is suggested that the process be started as soon as possible.

Questions: Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov.

2. Content and Form of Application Information

Application forms and instructions will be available at Grants.gov. To access these materials, go to http://www.grants.gov, select "Apply for Grants", and then select "Download a Application Package." Enter the funding opportunity number, W911NF-11-R-0001.

NOTE: Compatible versions of Adobe Reader are currently 8.1.1 and 8.1.2. You will be asked to specify your Operating System (examples: Windows, Mac) and Version (examples: XP, Vista, 10.4.9) be sure to specify Adobe Reader Version 8.1.2 to get the compatible version to apply for grants on Grants.gov. Click here to download version 8.1.2 from Adobe Website: http://www.adobe.com/products/acrobat/readstep2_allversions.htm.

Offerors must complete the mandatory forms and any optional forms (e.g., SF-LLL Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. The required fields should be completed in accordance with the “pop-up” instructions on the forms. To activate the instructions, turn on the “Help Mode” (icon with the pointer and question

mark at the top of the form). Files that are attached to the forms must be in Adobe Portable Document Form (PDF) unless otherwise specified in this announcement.

The following formatting rules apply for the file attachments:

- Paper size when printed – 8.5 x 11 inch paper
- Margins – 1 inch
- Spacing – single
- Font – No smaller than Times New Roman, 10 point

Form: SF 424 (R&R) (Mandatory) – Complete this form first to populate data in other forms. Authorized Organization Representative (AOR) usernames and passwords serve as "electronic signatures" when your organization submits applications through Grants.gov. By using the SF 424 (R&R), offerors are providing the certification required by 32 CFR Part 28 regarding lobbying.

Form: Research & Related Other Project Information - Complete questions 1 through 6 and attach files.

Project Summary/Abstract (Field 7 on the form) - The Project Summary should be a brief abstract `that summarizes the content of the Basic research of the proposal. The project summary must not exceed 5 pages. Pages in excess of the page limit may be removed for the evaluation of the proposal.

- Project Narrative (Field 8 on the form) - Chapters and Numbers of pages – Field 8 is to contain the chapters set forth below and may not exceed the stipulated page counts for those chapters. Pages in excess of the page limits may be removed for the evaluation of the proposal.

- Chapter 1 - **Research Program**. The pages included in Chapter 1 shall be numbered. Offerors are advised that Chapter 1 **shall not exceed 75 pages**, utilizing one side of the page.

- Chapter 2 – **Collaboration Plan**. The pages included in Chapter 2 shall be numbered. Offerors are advised that Chapter 2 of the proposal **shall not exceed 30 pages**, utilizing one side of the page.

- Chapter 3 - **Program Management** . The pages included in Chapter 3 shall be numbered. Offerors are advised that Chapter 3 of the proposal **shall not exceed 20 pages**, utilizing one side of the page.

- Chapter 4 – **Biographical Sketches** - Biographical sketches shall be limited to two (2) pages per individual, with no limitation on the number of individuals.

Bibliography and References Cited (Field 9 on the form) - Attach a listing of applicable publications cited in above sections.

Facilities and Other Resources (Field 10 on the form) - The offeror is to include a listing of facilities and other resources available to support the proposal. Any Government resources necessary for performance are to be clearly identified. Attach this information at Field 10.

Equipment (Field 11 on the form) - The offeror is to include a listing of equipment available to support the proposal. Any Government equipment necessary for performance is to be clearly identified. Attach this information at Field 11.

Other Attachments (Field 12 on the form) are as follows:

1. Attached the completed Proposal Cover Sheet. (See PART D.6 below.)

2. Attached the completed certifications. (See PART F.2 below.)

3. Attach any exceptions or conditions to the Model Collaborative Agreement (See CRA website for this document.)

4. Attach the signed Articles of Collaboration for all Members. (See CRA website for a sample document.)

5. Attach the Cost Proposal. **The Cost Proposal must include 2 separate budgets for the first five years of performance: one for the Core Research Program and one for the Enhanced Research Program. The Cost Proposal for the Core Research Program MUST address all requirements for the Core Research Program. It is acknowledged that the Cost Proposal for the Enhanced Research Program is expected to be in lesser detail as the specifics of such activities will not be known until performance. The cost proposal for the Enhanced Research Program is to be based on the general discussion of research that might be pursued with Enhanced Program funding. (The Consortium will be requested to provide a complete cost proposal for the optional five-year period of performance as part of the evaluation to be completed prior to making the decision concerning this optional period.)** The cost portion of the proposal shall contain cost estimates sufficiently detailed for meaningful evaluation. For budget purposes, assume a performance start date of 1 February 2012**.** The proposed amounts shall not exceed the funding ceilings identified for the Core Research Program of this PA. For all proposals, the elements of the budget should include:

   - Direct Labor - Individual labor category or person, with associated labor hours and unburdened direct labor rates.

   - Indirect Costs - Fringe benefits, overhead, G&A, etc. (must show base amount and rate). Justify.

   - Travel - Number of trips, destination, duration, etc. Justify and include basis for costs.

   - Subaward - A cost proposal, as detailed as the offeror's cost proposal, will be required to be submitted by each proposed subrecipient.

   - (NOTE: Cost proposals must evidence the required level of subaward costs for each year. A detailed cost proposal is not required for subawardees after FY13; however, offerors are to provide some basis for the subawardee costs proposed after FY13.)

   - Consultant - Provide consultant agreement or other document that verifies the proposed loaded daily/hourly rate. Include a description of the nature of and the need for any consultant's participation. Provide budget justification.

   - Materials - Specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application, shall be provided. Include a brief description of the offeror's procurement method to be used (competition, engineering estimate, market survey, etc.). Justify.

   - Other Directs Costs - Particularly any proposed items of equipment or facilities.

Equipment and facilities generally must be furnished by the recipient (justifications must be provided when Government funding for such items is sought). Include a brief description of the offeror's procurement method to be used (competition, engineering estimate, market survey, etc.). Justify.

All entities, i.e. Consortium Members and Subawardees, included in the cost proposal are to provide detailed information on all cost elements included in their proposed budgets as part of the proposal submission process. However, it is recognized that some entities may choose to submit their proprietary rate information directly to the Government in lieu of providing such information to the LRO for inclusion in the cost proposal submitted through grants.gov. In such a case, a separate submission can be made directly to the Government. Such a submission MUST include the PA Number, i.e. W911NF-11-R-0001, and the name of the LRO associated with the proposal on the mailing envelope submitted to the following address:

U.S. Army RDECOM Contracting Center
RTP Contracting Division
ATTN: W911NF-11-R-0001/MORSE
4300 S. Miami Blvd.
Durham, NC 27703

NOTE: All such separate submissions must arrive NLT than the due date and time for the proposal submission through grants.gov to be considered. Further, for all such submissions summary cost information must be provided to the LRO for the grants.gov submission that is sufficient in detail for the Government to use in the evaluation of the cost proposal for cost realism, and can be clearly mapped to the proprietary rate information submitted directly to the Government.

SF-LLL - Disclosure of Lobbying Activities

If applicable, attach a complete SF- LLL at Field 11 of the R&R Other Project Information form. Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the grant/collaborative agreement, you must complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying."

3. Submission Dates and Times

Proposals are due by 3:00pm (local time in North Carolina, USA) on 07 MAR 2011.

After a proposal is submitted through Grants.gov, the Authorized Organization Representative (AOR) will receive a series of three emails. It is extremely important that the AOR watch for and save each of the e-mails. Offerors will know that the proposal has been properly received when the AOR receives e-mail Number 3. The three emails are:

Number 1 – The AOR will receive a confirmation page upon completing the submission to Grants.gov. This confirmation page is a record of the time and date stamp for the submission.
Number 2 – The AOR will receive an email indicating that the proposal has been validated by Grants.gov within a few hours of submission. (This means that all of the required fields have been completed.)

Number 3 – The third notice is an acknowledgment of receipt in email from Grants.gov. The email is sent to the AOR for the institution. The email notes that the proposal has been received and provides the assigned tracking number. THE PROPOSAL IS NOT CONSIDERED PROPERLY RECEIVED UNTIL THE AOR RECEIVES EMAIL #3.

4. Intergovernmental Review - Not applicable

5. Funding Restrictions - See PART II.A above.

6. Other Submission Requirements

The following Proposal Cover Sheet is required to be submitted by each offeror:

PROPOSAL COVER SHEET

1. Information concerning the LRO (points of contact (POC)):

Research POC: _____
Phone No.: _____
Fax No.: _____
Email Address _____

Business POC _____
Phone No.: _____
Fax No.: _____
Email Address: _____

2. List the names and relationships of all organizations included in the proposal:

LRO _____
Consortium Member(s) _____
Subawardee(s) _____
Covered Educational Institution(s) _____

3. Provide a point of contact for each organization included in the Cost Proposal. These individuals may be contacted for questions concerning the Cost Proposal:

Organization: _____
POC: _____
Phone No.: _____
Email Address _____

4. Signature of one person for the proposed LRO, and one person from each proposed Consortium Members, authorized to submit a proposal and bind that organization: (These signatures may be provided on separate sheets.)

Organization Name: _____

Signature: _____

Type Name/Title: _____

Date (Proposal): _____

E. APPLICATION REVIEW INFORMATION

1. Proposal Evaluation Criteria

The following represents the evaluation criteria for this PA:

Factor 1: Scientific and Technical Merit of Each of the Five Core Elements: The scientific and technical merit will be evaluated with regard to each of the five core elements of the MEDE CRA. The five subfactors are a) Advanced Experimental Techniques, b) Modeling and Simulation, c) Bridging the Scales, d) Material Characteristics and Properties at Multiple Scales, and e) Synthesis and Processing. Each of these five sub-factors has equal weight. Each sub-factor will be assessed with regard to its overall scientific merit, creativity, innovation, and likelihood of substantially advancing the current state-of-the-art in materials science for each of the four material classes. The proposed scientific approach must be feasible and complete. Task descriptions and associated scientific elements provided must be complete and in a logical sequence with all proposed outcomes clearly defined such that a final outcome can be expected that addresses the five core elements of the MEDE CRA and that achieves the two, five, and ten year goals of the MEDE CRA as given in section II.A.5.f. of this PA. The proposals must clearly identify major scientific opportunities to be pursued and the associated risks, and clearly define feasible mitigation strategies to address those risks. The proposals must clearly explain in substantial detail the specific scientific plans that will be employed to meet or exceed each program goal, and provide ample justification as to why the approaches are likely to substantially advance the underlying science.

Factor 2. Overall Materials by Design Strategy: implementation and integration of the Materials by Design concept across disciplines and participants in the five core elements which will be evaluated by considering:

- The strategy for executing the materials by design concept to design materials and predict properties among the participating consortium members
- The integration of the five core elements into the overarching concept of materials by design (Are all the core elements constructively working to the strategic goal?)
- The strategy for incorporating all of the required materials systems: metals, ceramics, polymers, composites
- The validation techniques and metrics proposed to verify the strategy is working

Factor 3: Experience and Qualifications of Scientific Staff and Quality of Research Facilities: The qualifications, publications, capabilities, availability, and experience of the offeror's research personnel, their relevant past accomplishments in multiscale/multidisciplinary research, and their ability to achieve the proposed research objectives will be evaluated. The type, nature, quality, relevance, availability, access and SOA of the research facilities and equipment will be evaluated. This factor will assess:

- The research team stature, qualifications and track record of SOA research:
    - scientific/engineering stature of research personnel as indicated by publications, awards, professional society status and activities, etc.
    - Relevance of experience/stature relative to the five core areas
    - Relevance of experience across all materials classes to be considered

- Degree to which research staff's time-commitment to the CRA is meaningful and substantial

- The breath, depth and degree of SOA of the proposed experimental facilities
- The breath, depth and degree of SOA of the proposed modeling and simulations assets

Factor 4: Collaboration Plans with ARL: Evaluation of this factor will focus on the proposed collaboration plans for the CRA in accordance with the collaboration requirements set forth in the PA. The proposed collaboration plans should be feasible and are expected to create a cost-effective collaborative program with ARL researchers and with the other Consortium members that promotes collaboration on a regular, physical and continuing basis (i.e., in an open lab environment) in the spirit of the CRA. Creative strategies for sharing of resources (labor and equipment), organization of personnel exchange programs, identification of personnel with shared interests and/or complementary skills and strategies for facilitating transition of research results and new technologies to the Army will be assessed.

Factor 5: Relevance to the ARL missions and programs: Evaluation of this factor will concentrate on the long term relevance of the proposed research to the ARL/WMRD mission. The effectiveness of the proposed research to address scientific challenges and research barriers currently facing Army materials and manufacturing research will be evaluated. The proposed scientific approach is expected to make significant contributions to in-house ARL research activities and simultaneously exhibit high relevance to the national technology base.

Factor 6: Program Management and Execution. Evaluation of this factor will assess the adequacy of the overall management (business) plan, internal team structures and composition with respect to achieving the research goals of the program. The offeror's plan for program execution will be assessed to include the offeror's ability to develop and follow a program plan in accordance with Army obligation and disbursement goals. Items that will be evaluated under this factor include:

- The quality of the overall management plan, oversight strategy and the proposed metrics for success
- The qualification, leadership skills and experience of the PM and CMC
- The plan for the time commitment of the CRA leadership should be substantial and consistent with the scope of the program to ensure successful execution of the program
- Degree to which the CRA leadership are preeminent and accomplished scientists/engineers in their own right and have the requisite management experience required
- The proposed management plan to foster industry participation after the first year of the program
- The proposed strategy for involvement of a "covered educational institution"
- If management of similar efforts is cited as evidence of management and execution capabilities, the information should include identification of the Government sponsors, a description of the scope of the program, and an assessment of performance.
- The plans for the Enhanced Research Program

Factor 7: Cost. While this area will not be weighted, evaluation of this area will consider cost realism, cost reasonableness, and affordability within funding constraints. The Government may make adjustments to the cost of the total proposed effort as deemed necessary to reflect what the effort should cost. These adjustments shall consider the task undertaken and approach proposed. These adjustments may include upward or downward

adjustments to proposed labor hours, labor rates, quantity of materials, price of materials, overhead rates and G&A, etc.

Relative Importance of the Evaluation Factors: The combined weight of Factor (1) and Factor (2) is somewhat more than the combined weight of the remaining factors (Factors (3) through (6)). Each of the subfactors (a-e) in Factor (1) are of approximately equal weight, and Factor (2) is more important than any of the individual subfactors of Factor (1). The combined weight of all subfactors of Factor (1) is greater than the weight of Factor (2). For Factors (3-6), Factors (4) and (6) are approximately equal and somewhat more important than Factors (3) and (5) which are also approximately equal. Factor (7) is not weighted.

2. Review and Selection Process

All information necessary for the review and evaluation of a proposal must be contained within the proposal. No other material will be provided to those evaluating proposals. An initial review of the proposals will be conducted to ensure compliance with the requirements of this PA. Failure to comply with the requirements of the PA may result in a proposal receiving no further consideration for award.

Proposals that are in compliance with the requirements of the PA will be evaluated in accordance with the evaluation factors described above using an adjectival and color rating system. A Source Selection Evaluation Board (SSEB) will evaluate the proposals. The SSEB consisting of qualified groups of scientists, managers, and cost specialists, will evaluate each proposal and provide the results of that evaluation to the Source Selection Authority (SSA). The SSA will make decisions concerning the competitive range and award selection.

If a competitive range is established and negotiation discussions are held, ARL anticipates such discussions will be held at a site identified by each offeror. This site is expected but not required to be the location of the LRO. Any such meeting will be coordinated with the offeror at the appropriate time.

Award will be based on an integrated assessment of each offeror's ability to satisfy the PA requirements. The Government reserves the right to award without discussions. If discussions are held, offerors in the competitive range will be invited to submit Final Proposal Revisions, that will be evaluated using the same evaluation procedures as were used in the initial proposals. The Government will make award to the offeror, conforming to the PA, that offers the best value to the Government, cost and other factors considered. Further, award may be made to other than the offeror who offers the lowest cost proposal. ARL reserves the right not to make an award should no acceptable offer be submitted.

3. Recipient Qualification - See **PART II.C.1** above.

4. Anticipated Announcement and Award Dates - See **PART I** above.

F. AWARD ADMINISTRATION INFORMATION

1. Award Notices

Should your proposal be selected for award, you will be contacted telephonically or via email by the Grants Officer or his/her representative. At that time the offeror will be asked to

execute the CA. Award is not officially made until it each the CA is signed by each Member of the Consortium (included in the selected offeror's proposal) and the Grants Officer.

2. Administrative and National Policy Requirements

Offerors must comply with National Policy Requirements Matrix Appendix "C" found at http://www.nsf.gov/bfa/dias/policy/rtc/appc.pdf.

3. Reporting

Reporting requirements for the CA are contained in the Model CA which will be posted to the CRA website.

G. AGENCY CONTACTS

Questions or comments concerning this PA will be posted through the CRA website at www.arl.army.mil/CRAMEDE. Questions and comments should be concise and to the point. In addition, the relevant part and paragraph of the PA should be referenced. Responses to questions received will be posted to the CRA website for the benefit of all interested parties. Should an offeror have questions they believe are of a proprietary nature, the offeror must clearly state so in the question when posed. Answers to questions of a proprietary nature will be provided via email directly to the poser of the question. A location on the website will be provided for potential offerors to post their availability for teaming with others.