Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*					R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	207.983	219.180	221.901	-	221.901	224.167	229.009	234.391	238.657	Continuing	Continuing
305: *ATR Research*	-	2.385	2.204	2.281	-	2.281	2.386	2.397	2.621	2.668	Continuing	Continuing
31B: *Infrared Optics Rsch*	-	2.763	2.836	2.861	-	2.861	2.893	2.926	2.895	2.947	Continuing	Continuing
52C: *Mapping & Remote Sens*	-	2.878	2.233	2.259	-	2.259	2.288	2.312	2.344	2.386	Continuing	Continuing
53A: *Battlefield Env & Sig*	-	3.412	3.534	3.572	-	3.572	3.621	3.583	3.642	3.708	Continuing	Continuing
74A: *Human Engineering*	-	7.886	8.265	8.413	-	8.413	8.642	8.816	8.880	9.040	Continuing	Continuing
74F: *Pers Perf & Training*	-	5.560	7.094	5.719	-	5.719	5.838	5.958	6.083	6.219	Continuing	Continuing
F20: *Adv Propulsion Rsch*	-	3.940	4.211	4.256	-	4.256	4.307	4.283	4.357	4.435	Continuing	Continuing
F22: *Rsch In Veh Mobility*	-	0.577	0.606	0.612	-	0.612	0.621	0.630	0.642	0.654	Continuing	Continuing
H42: *Materials & Mechanics*	-	8.262	8.644	8.907	-	8.907	8.998	9.053	9.208	9.374	Continuing	Continuing
H43: *Research In Ballistics*	-	8.867	9.103	9.383	-	9.383	9.546	9.607	9.769	9.945	Continuing	Continuing
H44: *Adv Sensors Research*	-	9.778	10.219	10.347	-	10.347	10.658	10.943	11.127	11.327	Continuing	Continuing
H45: *Air Mobility*	-	2.393	2.515	2.552	-	2.552	2.588	2.625	2.671	2.719	Continuing	Continuing
H47: *Applied Physics Rsch*	-	4.977	5.222	5.270	-	5.270	5.535	5.980	6.001	6.109	Continuing	Continuing
H48: *Battlespace Info & Comm Rsc*	-	15.399	21.519	21.557	-	21.557	22.177	22.446	22.752	23.180	Continuing	Continuing
H52: *Equip For The Soldier*	-	1.096	1.135	1.146	-	1.146	1.157	1.172	1.189	1.210	Continuing	Continuing
H57: *Single Investigator Basic Research*	-	76.109	78.050	80.385	-	80.385	80.047	82.675	84.357	85.875	Continuing	Continuing
H66: *Adv Structures Rsch*	-	1.929	1.999	2.018	-	2.018	2.046	2.069	2.022	2.058	Continuing	Continuing
H67: *Environmental Research*	-	0.987	1.020	1.031	-	1.031	1.054	1.065	1.084	1.104	Continuing	Continuing
S13: *Sci BS/Med Rsh Inf Dis*	-	10.693	12.099	10.702	-	10.702	10.656	11.119	11.249	11.657	Continuing	Continuing
S14: *Sci BS/Cbt Cas Care Rs*	-	9.424	10.197	9.172	-	9.172	9.302	9.161	9.721	9.607	Continuing	Continuing
S15: *Sci BS/Army Op Med Rsh*	-	6.246	5.683	7.370	-	7.370	7.320	6.977	7.056	7.307	Continuing	Continuing
T22: *Soil & Rock Mech*	-	4.824	4.034	4.579	-	4.579	4.780	4.978	5.056	5.147	Continuing	Continuing
T23: *Basic Res Mil Const*	-	1.863	1.659	1.773	-	1.773	1.715	1.732	1.964	1.999	Continuing	Continuing

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army											DATE: April 2013		
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*					R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*								
T24: *Signature Physics And Terrain State Basic Research*	-	1.605	1.495	1.601	-	1.601	1.539	1.547	1.656	1.686	Continuing	Continuing
T25: *Environmental Science Basic Research*	-	8.027	6.888	7.175	-	7.175	7.170	7.293	8.254	8.403	Continuing	Continuing
T63: *Robotics Autonomy, Manipulation, & Portability Rsh*	-	1.797	1.956	1.991	-	1.991	2.025	2.059	2.094	2.132	Continuing	Continuing
T64: *Sci BS/System Biology And Network Science*	-	2.128	2.824	2.959	-	2.959	2.930	2.972	3.022	3.038	Continuing	Continuing
VR9: *Surface Science Research*	-	2.178	1.936	2.010	-	2.010	2.328	2.631	2.675	2.723	Continuing	Continuing

[#] FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

[##] The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This program element (PE) builds fundamental scientific knowledge contributing to the sustainment of US Army scientific and technological superiority in land warfighting capability and to solving military problems related to long-term national security needs, investigates new concepts and technologies for the Army's future force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. This PE fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision capability) and areas where there is no commercial investment due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigator research on areas of high interest to the Army (e.g., high-density compact power and novel sensor phenomenologies). The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to transition knowledge and technology into appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.

Work in this PE is performed by: the US Army Research Laboratory (ARL), Adelphi, MD; the RDECOM, Aberdeen, MD; the Medical Research and Materiel Command (MRMC), Ft. Detrick, MD; the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army					DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*			R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*		
B. Program Change Summary ($ in Millions)	**FY 2012**	**FY 2013**	**FY 2014 Base**	**FY 2014 OCO**	**FY 2014 Total**
Previous President's Budget	213.604	219.180	226.586	-	226.586
Current President's Budget	207.983	219.180	221.901	-	221.901
Total Adjustments	-5.621	0.000	-4.685	-	-4.685
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.000	-			
• SBIR/STTR Transfer	-4.621	-			
• Adjustments to Budget Years	-	-	-4.685	-	-4.685

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 305: *ATR Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
305: *ATR Research*	-	2.385	2.204	2.281	-	2.281	2.386	2.397	2.621	2.668	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project fosters research for automatic target recognition (ATR) concepts to enhance the effectiveness of Army systems while simultaneously reducing the workload on the Soldier. This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios including tagging, tracking, and locating (TTL) of non-traditional targets. This research enables Army systems that can act independently of the human operator to detect and track targets including clandestine tracking of non-cooperative targets. Such capabilities are needed for smart munitions, unattended ground sensors, and as replacements for existing systems. Critical technology issues include low depression angle, relatively short range, and highly competing background clutter. The resulting research will provide a fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at determining the complexity and variability of target and clutter signatures and ultimately utilizing that knowledge to conceptualize and design advanced ATR paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. Research in this project builds knowledge for several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared (FLIR), and advanced multi-function laser radar (LADAR).

Work in this project complements and is fully coordinated with the Armaments Research, Development, and Engineering Center (ARDEC); the Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the Edgewood Chemical Biological Center (ECBC).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: ATR Algorithms	1.391	1.300	1.339
Description: Investigate new algorithms to improve aided/unaided target detection and identification.			
FY 2012 Accomplishments: Researched automatic machine perception algorithms that provide enhanced situational awareness; investigated fast algorithms for feature extraction and scene understanding from hyperspectral and multimodal data.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 305: *ATR Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Investigate methods for object and event detection and classification using multimodal and hyperspectral imaging sensors to support Data-to-Decision capabilities. Conduct research for optimal sensor fusion and novel feature selection techniques to enhance Automatic Target Recognition (ATR) and biometric capabilities. ***FY 2014 Plans:*** Will investigate methods for human detection, cross-modality face recognition, and robust spectral signature analysis to enhance Data-to-Decision capabilities. Will develop ATR algorithms insensitive to signature variations and environmental changes.			
Title: Tagging, Tracking and Locating (TTL) ***Description:*** Conduct basic research to support advances in state-of-the-art clandestine TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are in accordance with the Hostile Forces TTL Capabilities Development Document and the TTL Science and Technology Roadmap. This effort will directly support ARL's efforts in applied research and the Communications-Electronics Research, Development, and Engineering Center's advanced research in clandestine TTL. ***FY 2012 Accomplishments:*** Researched efforts in the areas of imaging and tagging for TTL enhancements and applications. Specific research included novel concepts of e-field detection, ultraviolet taggant detection, and lensless imaging. ***FY 2013 Plans:*** Investigate and design advanced algorithms, components, sensors, and techniques applicable to TTL. Assess the use of inherent target signatures including hyperspectral signatures to provide enhanced TTL standoff capabilities. Further investigate the application of nanotechnology and microelectromechanical systems(MEMS) to TTL technologies. Examine the development of advanced taggant technologies across the electromagnetic spectrum including ultraviolet, infrared, and radio frequency for enhanced range performance and covertness. Advance flexible electronics and non-cooperative biometric identification for TTL applications. ***FY 2014 Plans:*** Will develop multimodal methods to monitor, extract and disseminate information related to target's changing characteristics and the means to influence target behavior to create measurable signatures of interest. Will develop (from the hyperspectral data assessment made in FY13) more effective methods for autonomous, non-motion based, motor-vehicle tracking by fusing proven detection/classification techniques for different applications (e.g. hyperspectral target detection, speech recognition) to provide enhanced TTL standoff capabilities.	0.994	0.904	0.942
Accomplishments/Planned Programs Subtotals	2.385	2.204	2.281

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 305: *ATR Research*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 31B: *Infrared Optics Rsch*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
31B: *Infrared Optics Rsch*	-	2.763	2.836	2.861	-	2.861	2.893	2.926	2.895	2.947	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems; radio frequency (RF) photonics for radar, communications, and electronic warfare applications; and laser technology for missile threat countermeasure protection. Its research aims to generate new technologies for unprecedented battlefield situational awareness and to continue the dominance of Army units during night operations. To achieve these objectives, IR focal plane arrays (FPAs) and lasers with significantly improved performance, lower cost, and increased operating temperatures are required. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. Research is focused on material growth, detector and laser design, and processing for large area multicolor IR FPAs and Midwave IR lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semi-conductor materials to enhance the performance of lasers and IR FPAs. In the area of RF Photonics, near-IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. This research also is intended to lay the foundation for the development of integrated optoelectronic circuits using active and passive devices and components such as lasers, waveguides, and detectors in conjunction with fiber optic interconnects for the generation, distribution, processing, and control of microwaves and study the fundamental physics of signal processing and noise generation as well as the conversion between the time and frequency domains and the optical and electrical domains in these opto-electronic (OE) circuits/systems. The technical goals are to manage and control defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation over time and thermal management, particularly as it applies to interband cascade lasers. This work is coordinated with the Communications-Electronics Research, Development, and Engineering Center (CERDEC).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: IR Focal Plane Arrays, RF Photonics, and Infrared Countermeasures	2.763	2.836	2.861

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 31B: *Infrared Optics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Conduct research into IR Focal Plane Arrays, RF Photonics, and IR countermeasures to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance missile threat IR countermeasure (IRCM) protection. ***FY 2012 Accomplishments:*** Conducted laser research for IR countermeasures including detailed studies on the thermal characteristics of Midwave Infrared (MWIR) lasers for IRCM; investigated environmental effects of RF-photonic devices and reduced their vibration and temperature sensitivity for improved reliability; continue the development of nano-fabrication techniques to achieve chip-scale RF photonic devices; and investigated methodologies for quantum well infrared detector arrays to be fabricated up to 2K x 2K focal plane arrays. ***FY 2013 Plans:*** Advance investigations of environmental effects on RF photonic devices and reduce their vibration and temperature sensitivity for improved reliability; Experimentally validate the RF-Photonic time domain signal auto-correlation processor for signals intelligence applications; develop nano-photonic devices and nano-fabrication techniques for chip-scale opto-electronic integrated circuit devices with reduced size, weight and power, Investigate plasmonic materials, metamaterials, photonic crystals and resonating materials on the quantum efficiency of Quantum Well Infrared Photodetectors (QWIPS); extend the operating wavelength of III-V semiconductor devices, explore materials properties for the Type II Strained Layer Superlattice and investigate novel growth approaches and novel growth structures that will result in cheaper IR focal plane arrays. Investigate possible methods of improving power output of quantum cascade lasers with potential transition to infrared countermeasures applications. ***FY 2014 Plans:*** Will research advanced Radio Frequency (RF)-Photonic/optical techniques to study noise generation and mitigation in RF-over fiber links to achieve ultra high resolution, wideband signal transmission. Will investigate long-wave infrared (LWIR) two-color IR detectors using combinations of bulk materials and artificially layered structures, taking advantage of low cost materials and novel insights in materials properties. Will establish a 3-dimensional, finite element electromagnetic model to calculate Quantum Efficiency (QE) for any infrared detector structures. Will design novel semiconductor metastructure photonic devices to provide the basic building blocks for future chip scale processing. Will investigate frontier optical effects to design high QE detectors. Will improve power output of quantum cascade lasers.			
Accomplishments/Planned Programs Subtotals	2.763	2.836	2.861

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 31B: *Infrared Optics Rsch*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 52C: *Mapping & Remote Sens*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
52C: *Mapping & Remote Sens*	-	2.878	2.233	2.259	-	2.259	2.288	2.312	2.344	2.386	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable to this item

A. Mission Description and Budget Item Justification

This project increases knowledge of terrain with a focus on improving the generation, management, analysis/reasoning, and modeling of geospatial data, and the exploitation of multi-sensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield. Results of this research are used to extract and characterize natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology and tactical geospatial sensor technology to provide real-time terrain intelligence, command and control, and targeting support. This research uses terrain and environmental data to improve situational awareness and enhance information dominance, leading to increased survivability, lethality, and mobility.

Work in this project provides theoretical underpinnings for PE 0602784A (Military Engineering Technology), Project 855 (Mapping and Remote Sensing).

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Sensor Phenomenology and Spatial-Temporal Pattern Discovery	2.878	2.233	2.259
Description: Funding provided for the following research.			
FY 2012 Accomplishments: Investigated the effects of underground anomalies on the spectral properties of surface vegetation; created a specific mathematical boundary for determining if a trajectory is an outlier.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 52C: *Mapping & Remote Sens*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Investigate a multi-parameter soil metabolic index to understand environmental impacts on emerging biological sensing; construct primitives to aid in efficiently solving concurrent complex queries in hierarchically represented spatial-temporal data; validate new infrasound signal propagation models against collected data applicable to remote assessment of hostile activity. ***FY 2014 Plans:*** Will investigate and define the concepts of neighborhood and scale for human terrain parameters, and examine clustering and topology in human terrain neighborhoods to understand how human terrain events propagate through Euclidean and social network space; investigate methodologies for transforming multi-dimensional spatial-temporal trajectory data into linear representation for discovering patterns and hierarchical structure; investigate approaches to estimating terrain physical properties from proprioceptive sensor data.			
Accomplishments/Planned Programs Subtotals	2.878	2.233	2.259

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 53A: *Battlefield Env & Sig*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
53A: *Battlefield Env & Sig*	-	3.412	3.534	3.572	-	3.572	3.621	3.583	3.642	3.708	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project focuses on research to seek an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology; the transport, dispersion, optical properties and characterization of chemical and biological aerosols; and the propagation of full-spectrum electro-magnetic and acoustic energy. The future Army will operate in very complex environments (e.g., urban, mountainous, forested and jungle terrain) requiring new approaches to understand, characterize, and depict environmental phenomena and their effects on military systems, personnel and operations. The lack of a complete understanding of the meteorological aspects of the complex microscale boundary layer in which the Army operates continues to impact our ability to provide predictable, actionable, accurate and timely tactical environmental intelligence to battlefield commanders and small Soldier units. This project focuses on producing the foundational environmental science research to characterize the atmospheric boundary layer and deliver novel capabilities and techniques including urban turbulence characterization for its effects on micro platforms and sensor payloads, high resolution urban wind flow modeling for more efficient and accurate prediction of the transport and dispersion of obscurants and chemicals, battlefield aerosol characterization and the interaction between aerosols and meteorological processes for Soldier health initiatives ,characterization and detection of bio-warfare agent aerosols, environmental effects on acoustic and electromagnetic signal propagation in urban and other complex domains for improved target location and imaging, exploration of previously unexploited regions of the acoustic and electro-magnetic spectrum, and formulation of objective analysis tools that can assimilate on-scene all-source weather observations, atmospheric composition, and fuse this information with forecasts to provide immediate Nowcast products and actionable information. These capabilities will have a direct impact on ensuring Soldier survivability, weapon system lethality, effective surveillance and reconnaissance, and the mobility required for future warfighter mission planning and execution operations.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD & White Sands Missile Range, NM.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Research in optical and acoustical propagation in the atmosphere	2.023	2.090	2.113
Description: Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance, and Reconnaissance capabilities for the future force to support situational understanding and rapid targeting.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 53A: *Battlefield Env & Sig*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Characterized atmospheric propagation effects on emerging technologies including Terahertz spectroscopy and imaging systems; Performed investigations and analyses of environmental impacts on thermal and infrared polarimetric images; Investigated the use of high resolution, multi-spectra, Light Detection And Ranging techniques for the detection of atmospheric aerosols and trace gases; Investigated the effects of ozone and other atmospheric constituents on the fluorescence spectra and other properties of bioaerosols; Measured fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents using laser-induced fluorescence and photoacoustic spectroscopy; Investigated the use of active wind screens for infrasound sensors to reduce sensor footprint on the ground; Investigated whether the influence of acoustic waves on the ionosphere can be used for the detection of anomalous events. ***FY 2013 Plans:*** Investigate how bioaerosol properties change with different atmospheric conditions (sunlight, humidity, oxidizing agents, etc.) so that bioaerosol viability and detectability can be added to transport and dispersion models for force protection and mission planning; measure spectrally resolved fluorescence and absorption cross sections of aerosolized bio-warfare simulants/ agents to enable more accurate assessments of the capabilities of biowarfare agent detectors; investigate Raman spectra of individual airborne bioparticles to provide increased capability for characterizing atmospheric particles, especially harmful particles, which are too small to detect with other techniques; perform multidisciplinary theoretical investigations for the remote sensing of precursors to atmospheric events affecting Army Operations to enhance force protection; establish functional relationships between mid-infrared (MidIR) and long-wave infrared (LWIR) polarimetric signatures as a function of atmospheric and meteorological conditions for improved target detection, classification, and identification. Extend terahertz (THz) propagation modeling to include path radiance and water vapor background noise to add these performance effects and improve the design of emerging passive THz imaging technology; Improve the fundamental theory for optical turbulence effects on short-exposure passive electro-optics and infrared imaging for new optimal designs for passive adaptive optics correction. ***FY 2014 Plans:*** Will investigate and model atmospheric water vapor impacts on Terahertz band communications propagation statistics for digital link quality for AMRDEC covert local wireless communications technology applications. Will measure and model optical turbulence to improve the prediction of strong turbulence effects on high energy laser propagation in complex terrain.			
Title: Predictive Modeling of the Boundary Layer	1.389	1.444	1.459
Description: Increase survivability and improve situational awareness for a variety of sensors optics and flying objects (projectiles, UAVs, etc&) through research to enhance accuracy of predictive modeling of the atmospheric boundary layer and improve the ability to function effectively in adverse conditions.			
FY 2012 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 53A: *Battlefield Env & Sig*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Verified and validated the 3D Atmospheric Boundary Layer Environment (ABLE) model against well established measured and modeled data from complex and urban domain; investigated modeling techniques deriving probabilistic weather impacts forecasts for future decision support tools; and developed new approaches to adverse weather route optimization algorithms for air and ground applications. ***FY 2013 Plans:*** Enhance the 3D ABLE model's turbulence parameterizations to extend modeling of high resolution dynamic turbulent flow effects of complex terrain to improve urban hazard dispersion and wind effects on robotic air vehicles; improve characterization and simulation of urban turbulence effects and bio-inspired control corrections that will improve Nano and Micro Air Vehicle control, hover stability and wind gust rejection; investigate the improvements in using sub-km Weather Research & Forecasting-based Weather Running Estimate-Nowcast (WRE-N) forecast/local now-cast model output as initial conditions to improve the fidelity and accuracy of predictions from the boundary layer 3D ABLE model for high resolution meteorology in complex terrain. ***FY 2014 Plans:*** Will formulate and evaluate numerical methods to improve ABLE model performance for Army decision aid applications. Will investigate biologically-inspired fast patterned responses to control surface wind flow changes to more effectively predict and mitigate boundary layer wind gust effects on micro air vehicle hover and stability. Will investigate and develop an experimental hybrid data assimilation approach to improve fine-scale weather forecast performance.			
Accomplishments/Planned Programs Subtotals	3.412	3.534	3.572

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *Human Engineering*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
74A: *Human Engineering*	-	7.886	8.265	8.413	-	8.413	8.642	8.816	8.880	9.040	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project focuses research on improving Soldier-system performance in future force environments by focusing on key phenomena underlying Soldier performance such as auditory spatial orientation (perception of azimuth, elevation and distance of sounds) within uncertain, degraded acoustic conditions; extending and protecting auditory and cognitive performance; human performance in automated, mixed-initiative (human control-machine control) environments; communications in hearing-degraded conditions; visual scanning and target detection; Soldier emotion and fatigue states; integration across multiple sensory modalities; perceptual-motor behavior ; collaborative (team) and independent multi-task, multi-modal, multi-echelon Soldier-system performance - all cast against the influx of emerging transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena in the consequent task due to situational complexity and ambiguity that characterize operations in the future force. Technical solutions are being pursued in the areas of data generation and algorithm development in these emerging environments in order to update and improve our understanding of performance boundaries and requirements and enable neuroengineering. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools for characterizing Soldier-system performance, and provide a shared conceptual and operational framework for militarily relevant research on cognitive and perceptual processes. In the area of translational neuroscience, which is the transition of basic neuroscience research to relevant applications, research is carried out to examine leading edge methodologies and technologies to improve the measurement and classification of neural states and behavior in operationally-relevant environments, to examine the potential application of neuroscience theories to autonomous systems to improve Soldier-system interactions, to model the relationship between brain structure and cognitive performance for understanding individual differences and injury, and to assess how neural pathways implicated in functional processing can be enhanced through dynamic system interface technologies for improving in-theatre performance and training.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Human Research and Engineering Directorate, Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Research to characterize and enhance Soldier performance	1.921	2.022	2.025

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Characterize and enhance human auditory performance of the dismounted warrior in complex environments while protecting the hearing of the Soldier. ***FY 2012 Accomplishments:*** Determined the effects of ear coverage, from wearing infantry helmets, on auditory localization for modeling of Soldier mission performance. ***FY 2013 Plans:*** Investigate the sound characteristics of weapon firing signatures to enable Soldiers' future ability to identify the specific weapons being fired and location of attack. ***FY 2014 Plans:*** Will quantify the effects of compression type on relative distance perception when wearing tactical communication and protection systems (TCAPS).			
Title: Soldier performance ***Description:*** Characterize key issues underlying Soldier decision making, such as computer modeling and social network analyses to investigate the quality of information flow in a defined command and control structure, investigations into situational understanding and prediction in uncertain environments, and identifying usability deficiencies and mismatches between battle command processes and technology enhancements. ***FY 2012 Accomplishments:*** Transfer lessons learned from the development of a cognitive model-based architecture for robotics control to the Robotics Collaborative Technology Alliance; continue studies which correlate electroencephalograph data with response times to perceptual stimulus events that will further the validation of the perceptual component of the cognitive model Adaptive Control of Thought-Rational (ACT-R). ***FY 2013 Plans:*** Continue to transition cognitive model-based architecture knowledge for robotics control to the Robotics Collaborative Technology Alliance and the Army Research Laboratory Robotics Enterprise allowing enhancement of recon capability to the level of "conceptual navigation", development of a genericlong-term memory capability to store collections of environmental data sets, and advances in object recognition and tracking; switch focus of research on the correlation of electroencephalograph data with response times to decision making studies which will further the validation of higher-level components of the Adaptive Control of Thought-Rational (ACT-R) cognitive modeling system. ***FY 2014 Plans:***	2.175	2.570	2.656

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will enhance object recognition of places and objects for the Symbolic and Sub-symbolic Robotics Intelligence Control System project by integrating multiple independent cues for perpetual processing to include contextual processing, depth processing, and color processing; will perform Engineering evaluation tests of key autonomous robotic functions for indoor navigation and recon such as navigation, object recognition, short- and long-term memory, and understanding and acting on verbal operator commands through natural language processing. Will expand the project on temporal network dynamics for the social-cognitive network science initiative by identifying specific behaviors of complex dynamical systems (i.e., networks) and by implementing techniques for capturing those behaviors using an enhanced version of the computer model C3TRACE, which will then allow us to develop a			
Title: Translational Neuroscience ***Description:*** Integrating neuroscience with traditional approaches to understanding Soldier behavior to enable systems designs that maximize Soldier performance. Formerly titled Research in Neuroergonomics. ***FY 2012 Accomplishments:*** Investigated closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/ fatigue state of the user; developed normative models that account for the variability in individual differences on performance; explored functional connectivity of multivariate datasets for assessment of performance measures; investigated predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals. ***FY 2013 Plans:*** Investigate sensory and motor neural processes with respect to effect on Soldier-systems within dynamic environments; examine validation techniques for measures of task performance in operational environments to develop future Soldier metrics; evaluate efficacy of predictive metrics for neural processing and/or cognitive performance among individuals for quantifying cognitive loads. ***FY 2014 Plans:*** Will enhance neuroimaging technologies for increased resolution, greater wearability by Soldiers, and enhanced interpretability of neural signatures in realistic environments; Will investigate the relationships between neuromodulators, brain electrical activity, and behavior for improved understanding of Soldier neurocognitive function.	3.020	2.412	2.459
Title: Cognition and Neuroergonomics ***Description:*** Devise and show fundamental translational principles for neuroscience-based research and theory to complex operations settings in three focus areas: Soldier-system information transfer, commander-level decision making, and individualized analysis and assessment of cognitive performance in operational environments. ***FY 2012 Accomplishments:*** Investigated closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/ fatigue state of the user; developed normative models that account for the variability in individual differences on performance;	0.770	1.261	1.273

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
explored functional connectivity of multivariate datasets for assessment of performance measures; and investigated predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals. ***FY 2013 Plans:*** Explore neural representations and develop novel measures for assessing individual differences in decision making, cognitive performance, and/or anatomical structure; explore network connectivity measures and patterns in both model simulations and empirical datasets. ***FY 2014 Plans:*** Will investigate sensitivity of identified individual difference measures to variability in performance across individuals, tasks, and cognitive states; will evaluate predictive capability of structural networks and/or functional processing for individualized performance assessment.			
Accomplishments/Planned Programs Subtotals	7.886	8.265	8.413

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *Pers Perf & Training*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
74F: *Pers Perf & Training*	-	5.560	7.094	5.719	-	5.719	5.838	5.958	6.083	6.219	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project fosters basic research in behavioral and social science in areas with high potential to improve personnel selection, training, leader development, human performance, and the human and social dynamics of network operations. Research covers areas such as assessment of practical intelligence as an aptitude that can be measured across job domains; develop principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; determine potential methods for faster learning, improved skill retention, and adaptable transfer of training to new tasks; discern likely methods for developing leader adaptability and flexibility as well as for speeding the maturation process; discover and evaluate the basic cognitive principles that underlie effective leader-team performance; better understand the role of emotions in regulating behavior; and improve the match between Soldier skills and their jobs to optimize performance. Research is focused on fundamental issues that will improve the Army's capability to: (1) select, classify, train, and/or develop Soldiers and leaders who are adaptable in novel missions and operational environments, can function effectively in digital, information rich, and semi-autonomous environments, can effectively collaborate in quickly formed groups and when distributed in high stress environments, and possess interpersonal and intercultural skills and attributes relevant to Joint-Service and multi-national operations; (2) accelerate the training of leadership, interpersonal, and emotional skills that traditionally develop over long periods of time and through direct experience; and (3) focus on the human cognitive and social domains - understanding individual, unit, and organizational behavior within the context of complex networked environments that will be essential for synergy between technology and human performance.

Work in this project is complements and is fully coordinated with PE 0602785A (Project 790) and PE 0603007A (Project 792).

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Human Behavior	4.086	5.024	3.909
Description: Funding is provided to better select, classify, train, and/or develop Soldiers and leaders.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *Pers Perf & Training*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Conducted research in the areas of the leadership and team performance in complex environments; analyze the impact of training methods on learner performance; investigated how a neurophysiologic state (i.e., affect) influences perception; identified cognitive strategies of experts that can be used to develop efficient training protocols. ***FY 2013 Plans:*** Developing data-driven models to assess the impact of training methods on task performance; identifying approaches to enhance experiential learning for guided self-development; and investigating tacit acquisition of cultural knowledge. ***FY 2014 Plans:*** Will investigate factors influencing on-the-job learning; will identify predictors of leader development and retention; and will identify contextual facets that influence decision making.			
Title: Network-Human Science ***Description:*** Funding is provided for better understanding individual, unit, and organizational behavior within the context of complex networked environments. ***FY 2012 Accomplishments:*** Conducted research to understand organizational dynamics and unit cohesion; conducted research on how language usage influences social dynamics; and analyzed the influences of human performance in complex networked environments. ***FY 2013 Plans:*** Investigating organizational leadership as transmitted through social network links; developing models of unit cohesion within multi-level organizational units. ***FY 2014 Plans:*** Will conduct research to understand social and organizational network variables that affect contextual control; will develop real-time assessment and feedback mechanisms to shape group relationships.	1.474	2.070	1.810
Accomplishments/Planned Programs Subtotals	5.560	7.094	5.719

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *Pers Perf & Training*

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT F20: *Adv Propulsion Rsch*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
F20: *Adv Propulsion Rsch*	-	3.940	4.211	4.256	-	4.256	4.307	4.283	4.357	4.435	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project fosters research to increase the performance of small air-breathing engines and power-trains to support improved system mobility, reliability, and survivability for air and/or ground vehicles; and ultimately serve to reduce the logistics cost burden for the future force. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, the lack of capability to accurately simulate the flow physics and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead Service in these technology areas and performs basic research in propulsion, as applicable to rotorcraft as well as tracked and wheeled vehicles. Technical solutions are being pursued through analysis, code generation, and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy sources and conversion, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls.

Work in this project complements and is fully coordinated with PE 62211 (Aviation Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Thermal Materials	2.418	2.495	2.522
Description: Investigate new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluate improved tools and methods that will accurately simulate the flow physics and the mechanical behavior of future engines and drive trains which will contribute to the design of more fuel efficient and reliable propulsion systems.			
FY 2012 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT F20: *Adv Propulsion Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Investigated a modeling and simulation capability that will be used to predict and compare the automotive, thermal, and electromechanical performance of next-generation Army wheeled tactical and combat vehicle power train concepts; and investigated the design of more fuel efficient propulsion systems. ***FY 2013 Plans:*** Determine loading and durability properties associated with hybrid ceramic bearings and hybrid composite gears for next generation Army wheeled tactical and combat vehicle power train concepts. ***FY 2014 Plans:*** Will investigate surface engineering techniques to reduce engine and transmission friction losses to improve vehicle fuel economy, reduce maintenance cost, and reduce logistic burden; and will establish the capabilities to assess high temperature materials and components for next-generation Army wheeled tactical and combat vehicle power train concepts.			
Title: Reliable Small Engines for Unmanned Systems ***Description:*** Develop improved tools and methods to enhance the reliability and fuel efficiency of small engines for air and ground vehicles and to enable the use of heavy fuels. ***FY 2012 Accomplishments:*** Evaluated the performance of a representative Army unmanned vehicle engines at simulated altitude conditions. ***FY 2013 Plans:*** Establish the capability to experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions to optimize combustion performance in future engine concepts. ***FY 2014 Plans:*** Using the capabilities established in FY13, will evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions to optimize combustion performance and using modeling and simulation coupled with experimentation will assess unmanned vehicle engines fueled with JP-8 and other heavy fuels. Will evaluate the performance of Army unmanned vehicle engines and small heavy fuel injectors to enable heavy fuel operability and to optimize performance and efficiency	1.522	1.716	1.734
Accomplishments/Planned Programs Subtotals	3.940	4.211	4.256

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT F20: *Adv Propulsion Rsch*

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT F22: *Rsch In Veh Mobility*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
F22: *Rsch In Veh Mobility*	-	0.577	0.606	0.612	-	0.612	0.621	0.630	0.642	0.654	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project conducts research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, vehicle-terrain interaction and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced engines, transient heat transfer, high temperature materials and thermodynamics. This project also supports state-of-the-art simulation technologies to achieve a more fundamental understanding of advanced mobility concepts. The subject research is directed at unique, state-of-the-art phenomena in specific areas such as: non-linear ground vehicle control algorithms, using off-road terrain characteristics; and unique mobility approaches, using advanced analytical and experimental procedures.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Tank and Automotive Research, Development and Engineering Center (TARDEC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Advanced Mathematical Algorithms for Improved Vehicle Efficiency	0.577	0.606	0.612
Description: Funding is provided for the following effort:			
FY 2012 Accomplishments: Expanded JP-8 ignition models to include wide varying ignition quality fuels; explored and developed robust multidisciplinary design optimization techniques with advanced materials for reducing ground vehicle weight while improving or maintaining ground vehicle mobility, reliability and survivability.			
FY 2013 Plans: Research ignition under high pressure injection conditions, and analyze heat release data for synthetic JP-8 fuel; research importance sampling techniques for accelerated testing for reliability quantification under stochastic input conditions; explore quantification of model uncertainty with enhanced identification ability; and research mobility models for small robot terra-mechanics, i.e. the interaction of wheeled or tracked vehicles on various surfaces.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT F22: *Rsch In Veh Mobility*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Research ignition under high-pressure injection conditions, and analyze heat release data for new fuels; research new analytical tools for characterizing vehicle duty cycles and physics-based vehicle and powertrain dynamics,; explore power available for mobility; and research mobility for small platforms (i.e. the interaction of wheeled or tracked vehicles on various surfaces).			
Accomplishments/Planned Programs Subtotals	0.577	0.606	0.612

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H42: *Materials & Mechanics*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H42: *Materials & Mechanics*	-	8.262	8.644	8.907	-	8.907	8.998	9.053	9.208	9.374	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project conducts basic research in materials science, which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. The current methodology of using materials to gain added functionality for Army systems is to use a layered approach, whereby each layer provides added capability (i.e. ballistic, chemical/biological, signature, etc.), but ultimately makes the system too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the future.

Work in this project complements and is fully coordinated with PE 0602105A, Project H84 (Materials).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Microscopic/Nanostructural Materials	2.386	2.571	2.615
Description: Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the future force.			
FY 2012 Accomplishments: Provided a theoretical basis for the selection of kinetically stabilizing alloying elements in nanocrystalline materials; and proved grain size stabilization in nanocrystalline metallic systems by experimental methods for better performing ceramic armor materials.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H42: *Materials & Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Research novel composite materials that demonstrate self-healing capability using bio-engineered concepts emerging basic research; and advance the principles of inverse materials design and apply to emerging material models for future armor designs. ***FY 2014 Plans:*** Will develop mathematical descriptions of full non-linear and transient coupling in armor grade piezoelectric ceramics for novel protection; report on the full-field penetration response of ultra high molecular weight polyethylene (UHMWPE) fabric and fabric systems for application to soldier protection; establish patterned thin film techniques to fabricate a metamaterial lens for corrosion detection under dielectric and paint coatings with high sensitivity; for composite armors, improve adhesion bioinspired polymer adhesives.			
Title: High Deformation Rate Materials ***Description:*** Develop fundamental understanding necessary to design, process and characterize materials specifically intended for high loading rate applications. ***FY 2012 Accomplishments:*** Modeled and experimentally determined property relationships in piezoelectric materials; and described the chemical state of emerging high rate materials with a view toward optimizing materials properties for ballistic environments. ***FY 2013 Plans:*** Develop models to describe specific strengthening mechanisms for novel aluminum alloys and use to cast coupon-scale ingots for experimental validation; and develop synthesis, processing and characterization methods specifically designed for materials in extreme dynamic environments. ***FY 2014 Plans:*** Will investigate first-principles modeling and simulation of clean and doped grain boundaries in boron-based armor ceramics; design novel, thermodynamically stable nanocrystalline alloys for shaped charge liners; determine the importance of composition and microstructure on rate dependent properties of epoxy resins; complete an initial 3D microstructural model of lightweight magnesium or aluminum alloys.	2.413	3.009	3.113
Title: Materials Research and Processing at Small Scale ***Description:*** Elucidate and exploit unique structure, processing, and property relationships that occur in materials at small length scales and develop methods to tailor the physical, chemical and mechanical response of these materials to enable unprecedented performance improvements in materials properties. ***FY 2012 Accomplishments:***	3.463	3.064	3.179

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H42: *Materials & Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Developed tools for the characterization of hierarchically structured materials for an understanding of the synthesis and mechanics of bio-inspired materials; and determined quantum effects on materials design to enable unprecedented performance improvements in materials properties. ***FY 2013 Plans:*** Develop novel polymeric materials which are thermally and chemically stable under extreme operating conditions; investigate and develop modeling and simulation methods specifically designed for materials used in extreme dynamic environments. ***FY 2014 Plans:*** Will validate new multi-axial mechanical characterization methods and apply to conventional and novel ballistic fibers to elucidate the effect of nanostructure; develop in-situ capabilities for electron microscopy to elucidate the mechanical response of soft tissue and polymer gels; characterize the water transport properties of polymer electrolyte materials.			
Accomplishments/Planned Programs Subtotals	8.262	8.644	8.907

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H43: *Research In Ballistics*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H43: *Research In Ballistics*	-	8.867	9.103	9.383	-	9.383	9.546	9.607	9.769	9.945	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project seeks to improve the understanding of the chemistry and physics controlling the propulsion, launch, and flight of gun-launched projectiles and missiles, and to understand the interaction of these weapons with armored targets. This research results in basic new knowledge, which allows the formulation of more energetic propellants, more accurate and non-lethal (NL)/lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems. This effort supports the Office of the Secretary of Defense Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use.

Work in this project complements and is fully coordinated with PE 0602618A, project H80 (Survivability and Lethality Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, Adelphi, MD, and Research Triangle Park, NC.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: National Advanced Energetics Initiative	2.890	2.913	3.011
Description: Expand and confirm physics based models and validation techniques to enable design of novel insensitive propellants/explosives with tailored energy release for revolutionary Future Force survivability and weapons effectiveness.			
FY 2012 Accomplishments: Investigated rapid energy release from new classes of materials subjected to extreme physical constraints and characterized through high performance computer models and experiments.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H43: *Research In Ballistics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Extend quantum mechanical based models to enable prediction of key performance and vulnerability properties; determine feasibility of nontraditional energetic materials containing stored structural energy (e.g. extended solids), and identify factors influencing stabilization for designing future disruptive energetic materials. ***FY 2014 Plans:*** Will synthesize and fabricate gram quantities of disruptive energetic materials that have two-fold energy content compared to conventional explosives. Will develop reactive variants of the dissipative particle dynamics method with multi-step chemical reactions and perform simulations of multi-scale coarse grain models to determine pressure dependent stress-strain behavior for input into plasticity model. Will refine and validate FY12 model via comparison with nano-indentation experiments.			
Title: Launch and flight of gun launched projectiles as well as missiles ***Description:*** Improve the fundamental understanding of the mechanisms controlling the launch and flight of gun launched projectiles and missiles, and understand the interaction of these weapons with armored targets. ***FY 2012 Accomplishments:*** Explored non-linear aerodynamics of complex shapes to advance next generation extended range precision munitions; Investigated nontraditional modeling techniques for using on-board projectile flight information to enable affordable non-GPS guidance; and performed first generation mapping of the shock and blunt impact effects on the mechanical state of human bone and tissues and the effects on specified connective centers in the human brain. ***FY 2013 Plans:*** Develop and validate coupled computational fluid dynamics, flight dynamics, and rigid body dynamics techniques in a single computational model to predict non-linear aerodynamic behavior of maneuvering precision munitions; characterize theoretically and experimentally coupled GPS and navigation concepts for the next generation of highly dynamic, spinning projectiles; investigate the fundamental mechanical interaction of human brain tissue with shock waves that occur during ballistic events. ***FY 2014 Plans:*** Will continue to develop first principles state-of-the-art computational aerodynamics techniques using coupled computational fluid dynamics (CFD), rigid body dynamics (RBD) and flight control systems (FCS) to exploit novel flow physics and enable a magnitude maneuverability increase for next generation, low cost, hyper-accurate munitions. Will add structural dynamics model to simulate guided maneuvers and unsteady effects and then compute a coupled calculation of a canard-controlled finned projectile using a skid-to-turn maneuver, compute and validate a roll maneuver with dynamic wind tunnel data, and simulate uncontrolled and controlled trajectories of a long flexible finned body.	2.429	1.732	1.768
Title: Extramural research in non-lethal (NL) control methods	0.976	1.262	1.275

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H43: *Research In Ballistics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. ***FY 2012 Accomplishments:*** Focused on the development of new models for automated image analysis and understanding, with emphasis on crowd behavior analysis through examining the spatio-temporal pattern of crowd behavior as well as abnormal event detection in crowds for situation awareness and crowd control; studied relationships between molecular structure, decomposition pathways, and potential energy surfaces for ground and excited electronic states of energetic compounds using laboratory based spectroscopic and advanced electronic structure methods to enable more accurate predictions of the performance properties of speculative energetic compounds. ***FY 2013 Plans:*** Study the decomposition pathways of energetic materials to elucidate the molecular decomposition behavior at the individual molecule scale; create new approaches and methods to reduce effects of complex noise and missing data for exploiting sparse hyperspectral and multimodal data; establish novel approaches for scalable indexing and retrieval of large image datasets that are necessary for effective analysis and exploitation of knowledge databases. ***FY 2014 Plans:*** Will develop statistical methods to analyze spatially and temporally evolving patterns designed to provide decision makers with the capability to distill concise meaning from large quantities of experimental observations.			
Title: Armor Research ***Description:*** Develop fundamental knowledge of mechanisms that can be exploited to ensure the next generation of lightweight and efficient armor technologies. ***FY 2012 Accomplishments:*** Evaluated novel reactive armor and electromagnetic armor mechanisms to include inferring real-time geometry of penetration into thick armor sections induced with electromechnical stresses. ***FY 2013 Plans:*** Develop the capability to measure electromechnical stress in very small samples deforming at very high strain rates and explore the effects of high magnetic field on the stress response within these deforming solids; develop fundamental underpinnings of the electrical conductivity within the shock cone that forms around hypervelocity penetrators. ***FY 2014 Plans:***	2.572	3.196	3.329

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H43: *Research In Ballistics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will develop a model for thermo-physical properties of plasmas and explore advanced electro-magnetic effects using hydrocodes and experimentation to better understand conductivity and fields in order to optimize electromagnetic armors. Will advance computational models by exploring dynamic effects in 3D. Will study the physics of using electromagnetic fields to enhance the detonation of energetic materials to include designing a new diagnostic tool to study the detonation zone.			
Accomplishments/Planned Programs Subtotals	8.867	9.103	9.383

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *Adv Sensors Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H44: *Adv Sensors Research*	-	9.778	10.219	10.347	-	10.347	10.658	10.943	11.127	11.327	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research to produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography, and spatial resolution of current radio frequency (RF) sensors. The technical approach is to exploit large scale electromagnetic (EM) models to predict and explain target and clutter scattering behavior, digital and image processing modules and algorithms, beam propagation and material modeling of nonlinear optical effects, hazardous material detection, remote sensing and intelligent system distributive interactive simulations, unique sensor development, sensor data feature and information fusion in the concept of Data-to-Decisions (D2D), and battlefield acoustic signal processing algorithms. Research performed under this project also supports survivable sensor systems, organic thin film transistor technology and organic light emitting diode technology for affordable rugged flexible displays. This project also funds research in the development of biologically inspired materials for use as sensors as well as for power generation and storage; and physics-based multi-scale models for electronic, optical, mechanical, and chemical materials. Payoffs include high-data-rate military communications, low cost compact flexible displays for the Soldier and for the Army, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband radar technology for detection of explosives including mine detection, through the wall sensing and robotics perception, improved sensor approaches and signal processing techniques for enhanced acoustic/seismic sensing systems in noisy environments, distributed sensor data fusion in ad hoc networks, improved cryptography techniques, improved understanding of the physics and atomic properties of materials, and capabilities in hazardous material and event sensing.

Work in this project complements and is fully coordinated with research at the Armaments Research, Development, and Engineering Center (ARDEC); the Communications-Electronics Research, Development, and Engineering Center (CERDEC), the Natick Soldier RDEC (NSRDEC) and the Edgewood Chemical Biological Center (ECBC).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Adaptive, Active, and Intelligent Optical Systems	1.700	1.833	1.860
Description: Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. ***FY 2012 Accomplishments:*** Developed image processing software that includes super resolution, fusion, and adaptive optics for application to enhance laser communication technologies and validated image processing software in realistic battlefield conditions to improve real-time situational awareness through greater fidelity of battlefield imagery. ***FY 2013 Plans:*** Investigate and develop advanced Army battle-space tactical and long-range atmospheric laser communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization, and allow utilization of advanced command and control techniques. Develop novel processing techniques to extend the use of quantum imaging to tactical environments in order to improve battlefield communications. ***FY 2014 Plans:*** Will develop application of advanced Army battle-space tactical, short-haul, and long-range atmospheric laser ultraviolet/ light-emitting diode/radio frequency (/UV/LED/RF) communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization, and allow utilization of advanced command and control techniques; including improving comprehensive link modeling and prediction of ultraviolet communication (UVC) and visible light communication (VLC), including atmospheric propagation, source and detection technology, and modulation and coding strategies. Will investigate advanced Army battle-space tactical and long-range atmospheric laser communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization. Will investigate and develop novel quantum physics and coupled processing techniques to provide tactically superior quantum imaging and battlefield communications particularly in obscured, obstructed, or adverse tactical environments			
Title: Improving Sensor and Display Capabilities	2.632	2.775	2.817
Description: Create more survivable and secure sensors and displays; improve hazardous material monitoring; and investigate new magnetic sensor technologies for personnel and improvised explosive device (IED) detection. ***FY 2012 Accomplishments:*** Fabricated and investigated metamaterial inspired antennas based on theoretical simulations; developed, applied and validated advanced computational models of 3-dimensional realistic ground surfaces to aid in defining theoretical performance limits of low frequency wideband radar technology for the detection of landmines and IEDs; researched phenomenology of features associated with sensing human motion and concepts for fusion of new features to reduce false alarms; optimized conductive			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
organic materials and high stability Organic Light Emitting Diodes (OLEDs) for transition into OLED displays to include developing thin-film transistors and transparent electrodes for flexible electronics applications. ***FY 2013 Plans:*** Develop sensor fusion algorithms to enable the aggregation of data features into information within the context of Data-to-decision (D2D). Develop theoretical understanding of metaferrites (using analytical and computer simulations) as an enabling technology for low-profile and embedded antenna enhancements. Analyze and develop algorithms to exploit co-registered video and radar imagery to enhance detection of landmines and IEDs with reduced false alarms. Enhance acoustic sensor and array performance through wind mitigation and adaptive algorithms for improved event classification. Evaluate conductive organic materials and high stability OLEDs for transition into OLED displays and emerging sensor applications. Develop 1/f noise resistant magnetic sensors to improve signal-to-noise ratio (SNR) and detection range for counter IED technologies. ***FY 2014 Plans:*** Will develop time-domain acoustic models that incorporate ground impedance and atmospheric effects to create synthetic sensor waveform data in various environments for training and evaluating acoustic classification algorithms. Will investigate utilization of spin-torque-oscillators for reading non-erasable magnetic memory. Develop algorithms and software for modeling non-linear signature response of RF devices in complex urban environments. Will perform theoretical and experimental analysis on metamaterials with randomly oriented unit cells and investigate the viability of their use in RF lens structures (e.g., a Rotman lens). Research organic devices and materials and diodes for large-area radiation and particle sensors utilizing charge-transfer electro-chemical designs.			
Title: Biologically-Inspired Sensing and Power Generation ***Description:*** Investigate biological systems to develop biologically-inspired materials for use as sensors as well as for power generation and storage. ***FY 2012 Accomplishments:*** Investigated methods to redesign cellular proteins to converge the signaling from different cellular receptors to a common output signal suitable for electronic device detection; manipulated bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterized the resulting complexes; completed characterization of 2-D assembly of nucleic acid templates in non-aqueous solvents for patterning of semiconductor seed particles for IR and photovoltaic devices; continued iterative modeling and experimental evaluation of models for remediation of energetics and generation of organic fuels to reflect new information collected from systems biology approaches. ***FY 2013 Plans:*** Evaluate biofilm contaminate-sensing genetic constructs against actual logistics fluid specimens for both JP-8 and potable water; manipulate bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterize	2.999	3.068	3.113

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
the resulting complexes; transition to larger 2-D assemblies appropriate for traditional electronic manufacturing; and analyze engineered strains against models for generation of organic fuels to evaluate information collected from systems biology approaches. Investigate the improvement of advanced modeling techniques through the use of an iterative approach of multi-scale modeling and increased biological characterization. Examine genotype to phenotype relationship of laboratory bacterial cultures to determine a means for identification. ***FY 2014 Plans:*** Will use synthetic biology building off of previous genetic sensing constructs, to engineer sense and respond module for neutralizing biological contamination; will develop 2nd generation peptide recognition elements using iterative process involving computational modeling coupled with experimental characterization for materials that perform in extreme environments; will use synthetic microbiology to engineer second generation strains for production commodity chemicals based upon predictions made in FY13; will use biological characterization data generated in FY13 to refine advanced modeling techniques of multi-scale modeling for prediction of improved biological interactions.			
Title: Multi-Scale Modeling for Novel Materials ***Description:*** Explore and develop multiscale modeling techniques to support fundamental studies of electronic and structural materials properties from the atomistic to the continuum. Resulting models are needed to design/ develop materials for more efficient, longer lifetime sensors and power and energy devices, and lighter materials for vehicle and soldier protection.. ***FY 2012 Accomplishments:*** Performed fundamental studies of materials to identify and model physics and atomic interactions that define the electronic, optical properties and characteristics, such as bandgap structure, carrier transport, diffusion rates, defects, control material deformation, progressive / catastrophic failure, and phase response across length scales. Developed interface physics between nano- and meso-scales up to the continuum; expanded upon and created new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions; developed web-based security scheme for external and internal project users; developed multi-scale computational science environment to facilitate coupling of different software; established methods to support high performance computing users and software developers. ***FY 2013 Plans:*** Conduct fundamental studies of materials to identify and model physics and atomic interactions that define their electronic and optical properties and characteristics. Evolve interface physics between nano- and meso-scales up to the continuum; expand upon and create new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions. Evolve web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; examine multi-scale computational science	2.447	2.543	2.557

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
environment to facilitate coupling of different software programs/algorithms; advance methods to support high performance computing users and software developers. ***FY 2014 Plans:*** Will Perform fundamental studies to identify and model physics and atomic interactions that define their structural, mechanical, electronic, and optical properties and characteristics and control material deformation, progressive / catastrophic failure, and phase response across length scales. Will establish fundamental underpinnings of physics between nano- and meso-scales up to the continuum. Will create new multi-scale experimental techniques and characterization methods to probe materials microstructure, including defects and interfaces, and response under extreme conditions. Will develop advanced computational models for multiscale modeling of electrochemical systems. Will investigate and develop scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems. Will create and disseminate web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; conduct research in multi-scale computational sciences and couple different modeling paradigms at the algorithm level; advance methods to support high performance computing users and software developers.			
Accomplishments/Planned Programs Subtotals	9.778	10.219	10.347

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H45: *Air Mobility*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H45: *Air Mobility*	-	2.393	2.515	2.552	-	2.552	2.588	2.625	2.671	2.719	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research in aerodynamics for manned and unmanned rotary wing aircraft. The goal of this effort is to develop improved tools and methods to analyze, evaluate, and assess rotorcraft-unique aerodynamic properties in conventional helicopter and tilt-rotor aircraft. The efforts in this project will result in a better understanding of rotorcraft aeromechanics and will result in improved performance, safety and, ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the future force. This project supports the future force by providing research into technologies that can improve tactical mobility, reduce logistics footprint, and increase survivability for rotary wing aircraft.

Work in this project complements, and is fully coordinated with, PE 62211 (Aviation Technologies).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Aviation & Missile Research, Development and Engineering Center, Aero-Flight Dynamics Directorate at NASA Ames Research Center, CA and Langley Research Center, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Rotary Wing Aerodynamics	2.393	2.515	2.552
Description: Funding is provided for the following effort			
FY 2012 Accomplishments: Assessed facility effects on existing highest-quality single-rotor hover data; investigated natural laminar flow wings for improved rotorcraft performance; and explored high performance computing methodology for difficult rotorcraft phenomenon.			
FY 2013 Plans: Experimentally investigate detailed helicopter wake structure for the existence of worm-like fluid phenomena seen in computational fluid dynamics (CFD) calculations; analytically/numerically investigate the oscillation encountered in CFD prediction			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H45: *Air Mobility*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
for hover performance; and assess the importance of the fuselage impedance on rotor blade structural loads and helicopter vibration. ***FY 2014 Plans:*** Will continue computational aero-science investigations using numerical methods including work on validation and development testing the physical assumptions forming the building blocks of the underlying theory. Will continue fundamental experiments aimed at the underlying physics of rotor downwash flow fields and rotorcraft testing techniques such as pressure sensitive paint.			
Accomplishments/Planned Programs Subtotals	2.393	2.515	2.552

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H47: *Applied Physics Rsch*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H47: *Applied Physics Rsch*	-	4.977	5.222	5.270	-	5.270	5.535	5.980	6.001	6.109	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project performs basic research on electronic materials and structures as well as technologies in energy harvesting and energetic materials, batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes nanoelectronic devices for low-power and high-frequency applications; sensors, emissive nonlinear and nanophase electrodes, and electronic materials; thin heterostructure systems where quantum confinement effects are important; advanced battery materials, thermoelectric devices, advanced photovoltaic and thermal photovoltaic devices as well as more efficient fuel cells for hybrid power; and the manipulation of cold atoms on a chip for application to very sensitive sensors and ultra-stable atomic clocks. These investigations will impact the development of power sources and specialty electronic materials for the Army's future force, including improved wide band gap semiconductor performance in electric vehicles, nanomaterials for batteries and fuel cells, quantum dots for increased photovoltaic efficiency and advanced radar systems. Applications of cold atom chips include gyroscopes and accelerometers for inertial navigation units in global positioning system (GPS) denied environments, gravitational sensors for detecting underground facilities, very-low-phase noise precision oscillators for low-velocity Doppler radar, and atomic clocks for GPS denied environments as well as for future space-based timing applications. Technical barriers affecting performance, weight, cost, and power consumption will be addressed.

The work in this project complements and is fully coordinated with research at the Armaments Research, Development, and Engineering Center (ARDEC); the Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the Natick Soldier Research, Development, and Engineering Center (NSRDEC).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Nanoelectronic Devices and Sensors	3.018	3.188	3.235
Description: Materials for advanced batteries; fuel cells and reformers for Soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band-gap semiconductors for high-power electronic applications; materials for			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H47: *Applied Physics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
advanced nano and micro devices; cold-atom chip devices for advanced sensors and ultra-stable atomic clocks; and integration of nanoenergetics and micro electro mechanical systems (MEMS) for fusing and microrobotic applications. ***FY 2012 Accomplishments:*** Studied the coherence properties of a split cold atom cloud in an atom chip waveguide; investigated energetic energy conversion methods for on-chip pulsed power; examined existing models for graphene materials growth for potential use in nanoelectronic devices; investigated next generation wide band gap power device materials such as Aluminum Nitride (AlN) and diamond, conducted modeling of electron transport in alkaline membrane electrode assemblies, and modeled physical properties of Silicon (Si) anodes for Lithium ion batteries and the structure property relationships of Si anodes. ***FY 2013 Plans:*** Experimentally validate multiscale models for electrochemical transport and charge transfer in electrochemical devices to optimize performance. Investigate novel nanostructures for battery and fuel cell electrodes for increased efficiency. Examine large area growth, material transfer, and substrate interactions of carbon based nanoelectronics for increased capabilities and reduced power consumption of battlefield electronics ; investigate 3-dimensional growth and patterning of piezoelectric materials for low power large displacement MEMS actuators; investigate methods and formulations for detonation using on-chip energetic materials; investigate, emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications. Characterize interference fringes using cold atoms on an atom chip; Investigate Gallium Nitride/Aluminium Galium Nitride (GaN/AlGaN) and other wide-bandgap materials and device structure characteristics under high power conditions for improved electrical efficiency and associated thermal management. ***FY 2014 Plans:*** Will study decoherence mechanisms and optical Raman techniques to coherently control cold atoms and atomic spin to improve the sensitivity of a chip-scale atom interferometer for inertial navigation in GPS denied environments. Will investigate and evaluate actuator designs using piezoelectric actuators using 3-dimensional growth and patterning techniques. Will investigate modes of propagation for on-chip energetic materials and determining factors that influence reaction rate. Will develop novel 2-Dimensional material growth, characterization, transfer and processing tech, and will conduct experiments to achieve electronic device quality materials for nanoelectronics and supercapacitors. Will investigate solid electrolyte interphase (SEI) formation on Si anodes for Li ion batteries, Will investigate GaN for high power conditions by improving breakdown voltage and crystalline via reduced contaminants with improved electrical efficiency and associated thermal management. Investigate materials structures for catalyst activities for energy conversion.			
Title: Advanced Energy Science Research ***Description:*** Conduct materials research and multi-scale modeling that will lead to advances in energy storage, harvesting, and conversion for a wide range of Army applications such as Soldiers, platforms, and microgrids.	1.959	2.034	2.035

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H47: *Applied Physics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Conducted research to design, fabricate and characterize materials properties in coordination with planned modeling and theoretical computations for energy storage and conversion materials; conducted research in developing computational tools in multi-scale modeling supporting electrochemical energy materials development; designed and experimented with novel energy harvesting (light, heat, vibration, isotope, biological energy, sources) methods; investigated emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, thin films, and energy conversion applications. ***FY 2013 Plans:*** Conduct research on the design, fabrication and characterization of material properties in coordination with modeling and theoretical computations for energy storage and conversion materials; Investigate methods for developing multi scale computational and simulation tools supporting the development of materials for electrochemical energy conversion and generation; Design and experiment with novel energy harvesting (light, heat, vibration, isotope, biological energy, sources) methods; investigate emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, and energy conversion applications. Investigate advanced device architectures for thermoelectric and photovoltaic devices for increased energy conversion efficiency. ***FY 2014 Plans:*** Will investigate wide bandgap semiconductor materials for direct photoelectrochemical production of hydrogen gas for use as fuel. Research novel device archetectures for solar energy conversion.			
Accomplishments/Planned Programs Subtotals	4.977	5.222	5.270

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *Battlespace Info & Comm Rsc*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H48: *Battlespace Info & Comm Rsc*	-	15.399	21.519	21.557	-	21.557	22.177	22.446	22.752	23.180	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable to this item

A. Mission Description and Budget Item Justification

This project supports basic research to enable intelligent and survivable command and control, communication, computing, and intelligence (C4I) systems for the future force. As the combat force structure decreases and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. This research supports the Army's Network Science initiative and in the process addresses the areas of information assurance, the related signal processing for wireless battlefield communications, document and speech machine translation, and intelligent systems for C4I. Major barriers to achieving the goals are the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, resource-constrained sensor networks, diverse networks with dynamic topologies, high-level multi-path interference and fading, jamming and multi-access interference, levels of noise in speech signals and document images, new low-density languages, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will produce highly relevant tactical events for mounted or dismounted commanders, leaders and soldiers; improve the timeliness, quality and effectiveness of actions; and speed the decision-making process of small teams operating in complex natural or urban terrain.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Communication for Tactical Networks	1.706	1.810	1.820
Description: Perform research to provide communications capability for a fully-mobile, fully-communicating, and situationally-aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Developed techniques to characterize the quality of information and developed an understanding and potential metrics for impact on network behavior. ***FY 2013 Plans:*** Develop techniques to enhance overall operational capacity and military effectiveness of networks by adaptive management of quality of information and user trust in composite networks. The results will contribute to novel capabilities in tactical mobile communication networks that enhance effective communications of Warfighters in the networks by maximizing delivery of information of highest quality as well as managing trust in the information and the network. ***FY 2014 Plans:*** Will develop a formal framework for modeling quality of information. This will enhance the communications capabilities of the Soldier by delivering more relevant information thereby enhancing decision making. Investigate non-traditional communication techniques (optical & ultra-violet (UV)) which will provide connectivity in RF-challenged environments. Will establish fundamental limits, and develop techniques and algorithms for unicast and multicast communications over hybrid networks (comprising fixed infrastructure and mobile ad hoc networks).			
Title: Data to Knowledge to Support Decision Making ***Description:*** Design and implement a laboratory-scale common information-processing infrastructure, inclusive of service oriented architecture for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. ***FY 2012 Accomplishments:*** Extended scene recognition to scene understanding algorithms, assessing them and their associated machine learning approaches on collaborating mobile platforms. ***FY 2013 Plans:*** Investigate techniques for more closely coupling decision algorithms with image processing techniques to enhance and accelerate current data collection and information retrieval algorithms to improve exploitation of tactical intelligence. ***FY 2014 Plans:*** Will investigate algorithms and techniques (in-house, academia, and industry) for exploiting context and value of information from unstructured full motion imagery and text including the leveraging of industry investment in graphic processing units (GPU) and cluster-based computing architectures. Will investigate adaptive data collection on collaborating mobile platforms in relevant environments. These efforts will improve current decision making capabilities.	1.469	2.632	2.653
Title: Information Protection for Mobile Ad-Hoc Networks (MANET)s	1.724	4.953	4.998

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. ***FY 2012 Accomplishments:*** Investigated and developed techniques for securing information flows in mobile wireless tactical environments. ***FY 2013 Plans:*** Develop new security protocols suitable for use in hybrid networks by leveraging and integrating techniques of both wireless and wired environments. The new protocols will contribute to novel capabilities that will enable the Warfighters to detect and defeat malicious activities of adversaries on tactical networks and hosts in MANETs, with a special focus in mobility effects. ***FY 2014 Plans:*** Will enhance security techniques and algorithms to decrease detection time and ensure information protection while maintaining suitability for operation in both tactical mobile and hybrid networking environments. These methods will improve the capability of Soldiers to detect and defeat malicious activities of adversaries on mobile tactical networks.			
Title: Multi-Lingual Computing Research ***Description:*** Establishes formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing. ***FY 2012 Accomplishments:*** Formalized techniques for adapting data flows to increase the effectiveness of multi-engine translation techniques; and developed methods to support decision making from machine translated segments. ***FY 2013 Plans:*** Develop novel techniques for quantifying language similarity across military domains and assess the effectiveness of those techniques in extending existing translation engines to new military decision constraints in order to improve Soldier effectiveness in foreign-language tactical environments. ***FY 2014 Plans:*** Will investigate use of extracted information from machine translated text in constructing task-based metrics and predictive models of machine translation quality for low resource languages and domains. This will enable situation awareness when information sources are multi-lingual in nature.	1.082	1.163	1.169
Title: Network Science for MANETs and Tactical Communications	0.968	1.022	1.027

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Study the behavior of mobile ad-hoc networks (MANETs) as part of the Army's Network Science initiative. Emphasis is on mobile communications networks research with the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology at the University of California - Santa Barbara. ***FY 2012 Accomplishments:*** Developed algorithms for the analysis of complicated large-scale network structures. ***FY 2013 Plans:*** Develop techniques and algorithms for assessing and optimizing the impact of social, cognitive and information structures on the behavior and performance of Army networks. The resulting techniques and algorithms will support future network technologies to enable Warfighters to anticipate and manage information, social and communication effects in network-enabled Mission Command. ***FY 2014 Plans:*** Will develop methodologies, techniques and algorithms for the analysis of realistic finite networks (finite size, finite spatial extent). This will lead to insights for the design and provisioning of tactical mobile ad hoc networks to improve network performance. Develop mathematical models of dynamic networks that will enable the representation of group interactions, the analysis of the behaviors of such networks, and the characterization of the fundamental limits on information flow within such networks.			
Title: Advanced Computing ***Description:*** Investigate computing and networking architectures, algorithms, as well as visualization for advanced battle command applications of C4I system. ***FY 2012 Accomplishments:*** Validated battle command applications developed on mobile hybrid computing architectures, namely, large-scale network electromagnetic propagation; develop real time algorithms for network emulations, and network simulators; developed new methods for battle command information visualization; investigated scalable programming models and battle command applications for the next generation Intel high performance computing architectures, namely, cloud on a chip, and secure enclaves. ***FY 2013 Plans:*** Implement new scalable programming models for cloud-computing and will perform benchmarking for Mobile Network Modeling Institute battle scenario of C4ISR-on the move. The advanced computing approaches will assist in taking supercomputing as a deployable asset to the battlefield enhancing real-time Situational Awareness in tactical environments. ***FY 2014 Plans:***	3.652	3.563	3.756

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will explore uncertainty quantification based mathematical approaches to assist the verification and validation methodologies. Closely work with CERDEC and ATEC in formulating the rudimentary scenarios for this verification and validation process. Will perform verification and validation of scalable programming models and software developed for tactical computing concept. These results will contribute to the development of new tools for the Soldier.			
Title: Network Science Technology Experimental Center ***Description:*** Supports in-house Network Science studies in conjunction with the Network Sciences CTA (0601104A/Project H50). ***FY 2012 Accomplishments:*** Expanded capabilities toward extensive integration of wireless communications emulation with academic and industrial experimental facilities developed under the Network Sciences CTA; Initiated a comprehensive program of multi-disciplinary experiments with wireless emulation utilized as hardware in the loop; documented experimental and theoretical results describing and predicting impact of mobility and adversarial attacks on the dynamics of information quality delivered through mobile communication networks to include observed phenomena of the characteristics of network reliability perceptions and trust on battle command decision making; researched social network analysis metrics and techniques for integrating these with traditional communications and information network analysis methods. ***FY 2013 Plans:*** Develop and validate approaches and techniques to characterize, assess, model, and predict the performance of a notional composite network. Examine the interaction of social, informational and communication processes as they adapt to changes in mission, adversarial attacks and changes in tactics, and structure. The results will contribute to the development of tools to equip Warfighters with the capability to anticipate and manage the effects of information, social and communication dynamics on tactical networks for mission command. ***FY 2014 Plans:*** Will expand the wireless emulation capabilities to include the interactions among communication, social, & information networks. Continue to develop techniques for modeling the performance of hybrid (wired & wireless) networks. These efforts will enable improved understanding of tactical network behaviors and improved network designs enabling Soldiers to communicate more efficiently. Will design, develop, analyze and validate composite trust management techniques and metrics that consider the interactions between social, information and communication networks. These techniques will enable secure information flows and decision making in tactical coalition networks and enhance mission command.	4.798	6.376	6.134
Accomplishments/Planned Programs Subtotals	15.399	21.519	21.557

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *Battlespace Info & Comm Rsc*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H52: *Equip For The Soldier*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H52: *Equip For The Soldier*	-	1.096	1.135	1.146	-	1.146	1.157	1.172	1.189	1.210	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research to achieve technologies for the Soldier of the future which focus on core technology areas that include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research. The research effort is targeted on enhancing the mission performance, survivability, and sustainability of the Soldier by advancing the state-of-the-art in the sciences underlying human performance, clothing, and protective equipment to defend against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and ration shortfalls.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Equipment for the Soldier	1.096	1.135	1.146
Description: This project supports basic research to achieve technologies for the Soldier of the future which include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research.			
FY 2012 Accomplishments: Investigated the aerodynamics and structural behavior of permeable structures under dynamic loads; explored the cognitive behavior of non-spatial influences on navigation through complex environments; and performed fundamental biomechanical research on exoskeleton design and human sciences towards optimization of user performance.			
FY 2013 Plans: Explore different methods to extract a concise feature vector to describe the shape of the human body: implement computational algorithms to extract the shape- vectors of three-dimensional (3D) scans from the US Army and Marine Corps 3D scan database;			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H52: *Equip For The Soldier*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
make modifications to available models to reflect the material dependencies on vapor concentration and solubility to understand experimental transport data for constituent membranes and laminates and linear permeation models. ***FY 2014 Plans:*** Will explore the permeation phenomena of multilayer films leading to improved barrier properties for the myriad needs for effective polymer films; investigate the cognitive foundations of spatial navigation for route planning through complex environments; continue to explore the aerodynamics and structural behavior of permeable structures under dynamic loads for improving parachute performance.			
Accomplishments/Planned Programs Subtotals	1.096	1.135	1.146

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H57: *Single Investigator Basic Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H57: *Single Investigator Basic Research*	-	76.109	78.050	80.385	-	80.385	80.047	82.675	84.357	85.875	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable

A. Mission Description and Budget Item Justification

This project fosters extramural basic research to create and exploit new scientific discoveries and technology breakthroughs, primarily from universities, that will improve the Army's transformational capabilities. Current technologies are unable to meet the operational requirements of the future force. The Army Research Office of the Army Research Laboratory (ARL) maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured, and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term future force needs in the physical sciences (physics, chemistry and life sciences), the engineering sciences (mechanical sciences, electronics, materials science and environmental science (atmospheric and terrestrial sciences)), and information sciences (mathematical sciences, computing sciences, and network sciences). Targeted research programs in nanotechnology, smart structures, multifunctional and micro-miniature sensors, intelligent systems, countermine, compact power, and other mission-driven areas will lead to a Future Force that is more strategically deployable, more agile, more lethal, and more survivable. The breadth of this basic research program covers approximately 900 active, ongoing research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, supporting research at nearly 250 institutions in 50 states.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed extramurally by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Basic Research in Life Sciences (formerly titled Basic research in molecular, physiological, and systems biology)	6.715	8.343	8.190
Description: Pursue fundamental discoveries in life sciences with the ultimate goal of facilitating the development of novel biomaterials to greatly enhance Soldier protection and performance. More specifically, i) molecular genetics research pursues fundamental studies in molecular and systems biology, and genetics, ii) neurosciences research investigate the physiology underlying perception, neuro-motor output, and potential methods of monitoring cognitive states during activity, iii) biochemistry research focuses on studies in structural and cell biology, metabolic processes, and biophysics; iv) research in microbiology			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
pursues studies in microbial physiology, ecology, and evolution, and v) social science research aims to elucidate the social, cultural, and other influences to human actions. In FY13 this section includes some research activities and funding previously described under research in brain-electronic interfaces. ***FY 2012 Accomplishments:*** Efforts continued to improve Soldier protection; investigated potential mechanisms to improve Soldier cognitive and physical performance; and methods to harness biological mechanisms for energy and fuel production were explored. ***FY 2013 Plans:*** Study fundamental genetic and physiological properties that impact human cognitive and physical performance under normal and stressed conditions; explore mechanisms that control the nanoscale organization of biomolecules and novel approaches to support biological activity outside of the cellular environment; elucidating mechanisms of microbial adaptation and antimicrobial resistance; study the fundamental physiology underlying cognition and novel non-invasive methods to monitor cognitive processes; and explore the basic theoretical foundations of human behavior across various temporal and spatial scales ***FY 2014 Plans:*** Will investigate the genetic plasticity of bacterial genomes during long-term stationary phase growth and develop an empirical understanding of the general mechanisms by which genomic (gene-based), transcriptomic (RNA-based), and proteomic (protein-based) prokaryotic features respond to alterations in the population-genetic environment, to ultimately enable accurate identification of the origin of biological threats; will investigate and characterize sensory auditory processing to determine how Soldiers can separate several streams of sounds into meaningful sequences in order to develop algorithms to augment both natural and automated hearing in noisy and confused environments; will assemble and characterize a synthetic biological receptor and signaling program within a bacterial strain capable of encapsulating itself within a natural cellulose filter, which may ultimately enable new chemical/biological detection applications; will characterize the resolution of holographic microscopy for visualizing microbes based on recent discoveries in lens-less holographic imaging, which in the long term may replace optical microscopes, enabling low-cost, rugged microscopes for field use; will design and validate robust optimal social system interventions based on a more formal understanding of feedback mechanisms with the objective of avoiding failed negotiations, socio-economic crises and societal collapse.			
Title: Basic Research in Environmental Sciences ***Description:*** Basic research in environmental science possesses three areas: atmospheric science research which enables the Army to use to operational advantage weather effects on combat operations, to include unmanned aerial vehicle employment, from the surface to the boundary layer (~14,000 feet) by possessing a fundamental understanding of the lower atmosphere; terrestrial science research to enable the Army to operate effectively in all military operating environments by understanding	3.495	3.807	3.774

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
fundamental terrain and land-based phenomena; and military habitation science, basic research to allow military power projection that meets operational needs in a sustainable manner. ***FY 2012 Accomplishments:*** Environmental sciences addressed the knowledge and capability gap between current operational weather prediction models and local atmospheric conditions affecting soldiers and systems through basic research in atmospheric dynamics and observational capability; research further examined the evolution of the nocturnal boundary layer structure using up to three Tethered Lift Systems with multiple, redesigned, sensor packages trailing from each; the focus was on quantifying the turbulent processes as a function of separation scales; both experimental and modeling work continued to be performed that investigated the effects of both soil heterogeneity plus water and heat flux conditions at the soil surface on subsurface moisture distribution at different spatial scales in the unsaturated zone. ***FY 2013 Plans:*** Environmental sciences is developing new approaches to improve the resolution and tradeoffs in high fidelity modeling of atmospheric and terrestrial physical processes; developing new approaches to spatially revise both theoretical and observational problems associated with the Monin-Obukhov theory such that scale-dependent intermittency statistics will be explicitly taken into account; optimizing and enhancing the performance of the sensor modalities used in UXO, landmine, and explosive device detection as well as developing constitutive models for near-surface processes. ***FY 2014 Plans:*** Will pursue atmospheric examinations in the convective boundary layer using vertically pointing clear-air Doppler radars and sodars to measure mean vertical velocities; will improve estimates of soil moisture throughout the vertical soil column at the hillslope scale through a data assimilation approach that utilizes remotely sensed soil moisture information at coarse spatial resolution and combines it with a physics-based land surface process model to produce soil moisture estimates at the fine spatial scales of Army operational interest.			
Title: Basic Research in Chemical Sciences ***Description:*** Focuses on the ultimate goals of achieving advanced energy control, improved threat detection, and novel responsive materials for Soldier protection. Research efforts in advanced energy control involve the study of electrochemistry and electrocatalysis, and physical and theoretical chemistry, which will lead to light-weight, reliable, compact power sources for the Soldier and more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage. Research in protective materials involves discoveries in polymer, inorganic, and organic chemistry, which will provide new approaches for shielding the Soldier and Army platforms from ballistic, chemical, and biological threats, and reducing signatures for identification by the enemy. Threat detection research involves studies in the fields of physical, theoretical, and	9.788	9.545	9.418

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
inorganic chemistry, which will lead to advances that provide advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals. ***FY 2012 Accomplishments:*** Investigated how material and morphology can effect electron transfer and electro catalysis; investigated novel approaches and designs for functionalized morphology, novel reactive monomers, and environmentally stable self-assembled materials; novel mechanophores previously integrated into composites were evaluated for responses to mechanical damage; initiated modeling and experimental studies to begin to uncover the physical properties that control chemical reactivity. ***FY 2013 Plans:*** Conduct research on ionic liquids in order to obtain an in-depth understanding of how their structure effects physical properties, such as transport, viscosity, and conductivity; explore series of switchable catalysts that are capable of altering their activities in response to changes in their oxidation states in an effort to produce precisely controlled microstructures; explore covalently immobilized peptides and proteins on non-biological surfaces to understand how the bio/abio interface can be manipulated to promote desired biological structure and function. ***FY 2014 Plans:*** Will explore and characterize the reaction pathways for nitroaromatics and nitramines (classes of compounds that include explosives) to determine mechanisms by which these molecules undergo dissociation to initial product species, which will enable the more efficient design of future explosives or propellants that are more powerful while also safer during transport and storage; will investigate nanoscale patterning of protein-based fibers on non-biological surfaces to understand how these surface properties can be manipulated to control the structure and function of biological molecules, and will test novel single-molecule probes to investigate proteins in near-surface environments at the molecular level, for potential long-term applications in chemical and biological defense; will investigate electrochemical systems utilizing new materials with controllable structures and chemical properties that may ultimately enable lighter, more efficient batteries or fuel sources.			
Title: Basic Research in Physics ***Description:*** Focuses on superior optics, signature management properties, ultra-sensitive sensors, precision guidance, quantum computing, and secure communications. Research efforts in superior optics, signature management properties, and ultra-sensitive sensors are made possible through discoveries in many subfields of physics, including optical physics and imaging science, and atomic and molecular physics. Research efforts in precision guidance involve the study of atomic and molecular physics, while the pursuit of the quantum computing and secure communications research topics is made possible from specific studies in the fields of quantum information sciences and condensed matter physics. ***FY 2012 Accomplishments:***	10.604	12.290	12.324

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Research continued advancing transformation optics toward eventual uses in cloaking applications and omni-directional light collection; developed new ultra-cold chemistry concepts heralding novel chemical synthesis routes; explored cross-platform qubit entanglement and evaluated potential applications in quantum entanglement-enhanced metrology and stealth imaging; assessed and improved theories to better understand and control defects in complex oxides, especially at interfaces. ***FY 2013 Plans:*** Investigate quantum optics of metamaterials including exploration of fundamentally new quantum effects including the photon spin and the interaction with negative index materials; explore the control of light filaments and long distance propagation; continuing attempts to demonstrate a 25 atto-second laser pulse; will begin studies of high intensity laser light; design and test alternative cooling techniques for use on molecules not amenable to traditional laser-cooling approaches; investigate protected states of matter in condensed matter as well as atomic and molecular systems; investigate non-equilibrium states in ultra-cold atomic optical lattices; implementing and characterizing multi-qubit states; seeking methodology for the rational design of novel quantum many-body states in complex oxide heterostructures; identifying the defect tolerance in a series of complex oxides; perform in-situ chemical analysis of complex oxides; identify and characterize new candidate materials for topological insulators with strong electronic interactions. ***FY 2014 Plans:*** Will investigate dynamics of thermally-isolated systems in atomic systems which will facilitate the future engineering of new materials with dynamic properties for the future warfighter; will design and demonstrate laser-plasma beams using ultra-short pulsed lasers and investigate the unique light-propagation characteristics in the atmosphere not possible with conventional lasers, which may ultimately enable standoff detection of explosive residue; will explore high-intensity lasers as a method for creating gamma ray beams that may ultimately provide a source of gamma rays obviating the need for conventional large, expensive, immobile, reactors or extremely hazardous reactive materials; will design and explore quantum systems, such as nitrogen in synthetic diamond, for low-power high-precision sensing and imaging exceeding the capabilities of current classical systems; will design and synthesize topological insulators (i.e., a novel type of material that changes electrical properties based on its three-dimensional structure); will discover and characterize the properties of these new topological insulators under varying magnetic and electrical conditions, which may enable new ultra-sensitive detectors and ultra-low power electronics.			
Title: Basic Research in Electronics and Photonics	11.369	11.218	10.905
Description: Focuses on electronic sensing, optoelectronics, solid state and high frequency science, electromagnetics, microwaves, and power electronics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency.			
FY 2012 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Determined the effect of antidote lattices (a novel material structure) on the bandgap in graphene; Evaluated vertical lasing based on photonic crystal Fano resonances using nanomembrane broadband reflectors. Designed and fabricated photonic bandgap structures for use in multifunctional radio, radar, and sensor systems; Used novel probes to investigate biological cells and large scale nano-materials.. ***FY 2013 Plans:*** Synthesize mercury cadmium selenide on gallium antimonide substrates and investigate its optical and structural characteristics for infrared detection. Develop novel vertical cavity transistor lasers with high modulation rates. Develop biologically-inspired RF direction finding antenna arrays and associated signal processing techniques based on the operation of the human auditory system. Investigating nanoscale constructs within cells and engineered nano-structures. ***FY 2014 Plans:*** Will improve optical quality and coherency of mid infrared lasers to facilitate free space optical communications, ladar and infrared countermeasures; will show feasibility of semiconductor-less infrared detection that utilizes electron tunneling; will explore time-frequency and non-laplacian phenomena to understand and extend the fundamental performance limits of radio, radar, and electronic warfare systems; will develop terahertz frequency photomixing arrays with 10x improvement in output powers to enable the remote detection of chemical, biological and explosive threats.			
Title: Basic Research in Materials Sciences (formerly titled Basic research in mechanical and material sciences) ***Description:*** Focuses on providing innovations in materials design and processing to enable unprecedented materials through the elucidation of fundamental relationships linking composition, microstructure, defect structure, processing and properties of materials. Revolutionary materials provide support for the Army in firepower, mobility, communications, personnel protection, infrastructure and installations, and will directly affect virtually all mission areas. In FY13, the Mechanical Sciences research description and associated funding is moved to the Mechanical Sciences section within this Project. ***FY 2012 Accomplishments:*** Developed an understanding at the microscopic level (single layer) for reaction processes and kinetics of reactive materials undergoing high speed impact; developed materials with stress-activated molecules that enhance macroscopic properties of interest when elastic force is applied; investigated a predictive theoretical framework to identify promising 2D free -standing crystalline oxides/ nitrides and nanocomposites; characterized how the instantaneous 3-D structure of a turbulent boundary changes in the presence of an adverse pressure gradient for the understanding of dynamic stall processes. ***FY 2013 Plans:*** Demonstrate novel materials with large electro-caloric effects for thermal management; achieve rapid fabrication and densification of nanostructured materials with unique combinations of high-pressure and electrical field; establish theory to guide the design and fabrication of multifunctional materials incorporating programmable responses and hierarchical constructs; fabricate novel	13.946	7.097	7.067

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
3D topological insulators with unsurpassed bulk resistivity and surface electron mobility; demonstrate the ability to translate biochemical activity onto inorganic surfaces. In FY13, the Mechanical Sciences research description and associated funding moves to the Mechanical Sciences section within this Project. ***FY 2014 Plans:*** Will establish the use of resonant optical effects to achieve size sorting of microspheres in solution with unprecedented precision; will demonstrate a new class of materials for low power sensing based on variable temperature conduction; will provide a robust computational methodology to predict the relationships between a material's electronic structure, its local elastic properties, and its composition for the vast majority of transition metal critical points; will fabricate novel fully transparent materials with record hardness and toughness for advanced protection.			
Title: Basic Research in Computing Sciences (formerly titled basic research in mathematical sciences and computing sciences)	11.113	6.054	7.724
Description: Provides the backbone for performing complex, multi-system analysis, modeling and simulation for understanding information systems. Advancements in computer sciences have a direct impact on enhancing the warfighters' decision-making, situation awareness, command and control, as well as on the overall performance of weapon, intelligence, transportation and logistics systems. In FY13, the Mathematical Sciences research description and associated funding moves to the Mathematical Sciences section within this Project. ***FY 2012 Accomplishments:*** Investigated trusted computing that is adaptive to both social and culture influences, and developed new capabilities for warfighters deployed in areas of different social and culture interactions; investigated adaptive change detection procedures for composite hypotheses in cyber security for comparison of several change point detection methods; developed computer network security and surveillance, clutter rejection and nonlinear filtering algorithms. ***FY 2013 Plans:*** Continue to explore and investigate new effective computing architectures, computational methods and software tools, and develop new methods for data sensing and fusion over large volumes of social data. Long term efforts in developing methods for the tomography of social networks, for predicting individual and collective human behaviors in the war against terrorism, and development of structural methods for automatic machine translation are ongoing. In FY13, the Mathematical Sciences research description and associated funding moves to the Mathematical Sciences section within this Project. ***FY 2014 Plans:*** Will explore the establishing of robust computational methodologies for large dataset processing and analysis with optimized data representations and obtaining optimal realization of Real-Time Multi-core Systems to support complex, resource-demanding, real-time Intelligence, Surveillance, and Reconnaissance (ISR) applications. Will create new image data feature analysis and pattern classification methods for object detection, recognition, and long-term tracking under challenging dynamic conditions, and develop			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
quantification and metrics for effective analysis of social-interaction phenomena and for better prediction of unusual social events in asymmetric defense			
Title: Basic Research In Network Sciences ***Description:*** Focuses on gaining an understanding of the fundamental aspects of how networks develop, function, and adapt to the environmental and the rate of information flow in manmade and naturally occurring networks. This understanding will have a direct impact on net-centric force operations, such as better communication system design and operations, and more efficient logistics or communications support. ***FY 2012 Accomplishments:*** Emphasis was on the understanding of human networks and, in particular, how information mathematically spreads through a network; the impact of the work provided a better understanding of how decisions are made in groups, and network effects of hard-line members of a group; commonalities between communication and human networks were investigated, and how they can be analyzed in tandem. ***FY 2013 Plans:*** Experimental evaluation of mathematical models of how information spreads through groups/networks using a Behavioral Game Theory framework. Develop mathematical models of decision making using neuroscience experiments in collaboration with Life Sciences with attention being paid to errors in human judgment. Investigate game theory derived from observational data to understand microbe adaptations and micro-scale locomotion and control for micro-bio-robots. ***FY 2014 Plans:*** The notion of tipping point, when a society changes its views, will be studied from a Statistical Mechanics perspective and from a Behavioral Game Theory perspective, with attendant efforts to reconcile the two views. Ongoing mathematical modeling of neuronal structures informed by experiments to grow neurons will be extended to capture cognitive intelligence that arises from networks of neurons. Games derived from observation will be studied with respect to equilibrium and robustness properties and validated on problems related to reasoning about adversarial networks. Study of Micro-scale locomotion and control of micro-robots will be extended to turbulent fluid flow. Finally, effect of human networks on communication networks will be studied with the goal of finding effective bandwidth/spectrum/resource utilization.	3.040	6.663	8.260
Title: Basic Research in Bioforensics - in FY13 this effort moves to Life Sciences and Chemical Sciences ***Description:*** Focuses on understanding how microbes adapt to complex and changing environments. The long term goal of this research is to discover and characterize the genetic, proteomic, and metabolic changes in response to a given environment, enabling the ability to determine where microbes originated, how closely related they are, and their recent growth environment. This research could ultimately reveal the identity and feasibility of bacterial signatures that could be used to trace the history of an	1.813	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
organism to provide a means of tracking the cause, potential danger, and source of a biological event, whether naturally occurring or nefarious. In FY13 research activities and associated funding moves to Life Sciences and Chemical Sciences sections. ***FY 2012 Accomplishments:*** Efforts determined the locations and compositions of palindromic repeats (i.e., structures acting as bacterial 'gene memory'); methods were investigated to control individual bacteria with external stimuli (chemical, optical or electrical) with appropriate spatial and temporal resolution; bacteria were transferred from natural environments to the laboratory and identified mutations that arose after transfer to laboratory culture environment; gene expression patterns of bacterial outer membrane proteins in multiple combinations of environmental factors, including temperature, pH, and iron limitation were mapped.			
Title: Basic Research in Oxide Electronics and Brain-electronic Interfaces - in FY13 this effort moves to Life Sciences ***Description:*** Focuses on advancing the theory, materials growth, and characterization of artificially-layered complex oxides with the ultimate goal of discovering emergent phenomena in this material system that may ultimately provide far-reaching opportunities for new technological capabilities, and deciphering the coding of neural systems with the long-term goal of discovering and developing methods for the non-invasive decoding and modulation of neural systems, the sensing and decoding the complex brain signals responsible for specific muscle movements, and ultimately the bridging of the living/nonliving interface in peripheral nerves that may lead to future applications in silent communication and mental control of equipment such as the natural and full control of prosthetic limbs. ***FY 2012 Accomplishments:*** Research expanded predictive theories to accurately model materials and then verified accuracy; expansion of heteroepitaxial capabilities continued; solutions to eliminate or mitigate dominant defects were explored; luminescence diagnostic studies of material defects were pursued; experimental methods for potential to 'decode' brain signals to determine how particular thoughts can be used as control inputs for engineered systems were developed and examined; and potential methods for interfacing electronics with the brain were investigated.	1.813	0.000	0.000
Title: Basic Research in Quantum Imaging and Defect State Enabled Spintronics - in FY13 this effort moves to Physics. ***Description:*** Focuses on advancing the theory, materials growth, and characterization of artificially designed and fabricated materials with the ultimate goal of discovering emergent phenomena that may ultimately provide far-reaching opportunities for new technological capabilities. Material systems of interest include for example, artificially structured complex oxides, topological insulators, nanoscale electronic systems that provide a fundamentally-new paradigm beyond semiconductor-based electronics because these systems have properties that depart from the characteristics of the building blocks. ***FY 2012 Accomplishments:***	2.413	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Research expanded predictive theories to accurately model materials and then verified accuracy; continued to expand heteroepitaxial capabilities with molecular beam epitaxy and pulsed laser deposition; explored solutions to eliminating or mitigating dominant defects; pursued luminescence diagnostic studies of material defects; explored topological insulator material quality improvements to uncover unique physical phenomena; investigated the application of new optical spectroscopic techniques to topological insulators.			
Title: Basic Research in Mechanical Sciences ***Description:*** Focuses on improved understanding of propulsion and combustion for improved efficiency and fuel flexibility, energetics initiation for insensitive munitions, fluid dynamics for rotorcraft, complex dynamic systems for novel sensors, energy generation and multi-dimensional systems, and solid mechanics especially at high strain rates in composite materials for novel armor and protection systems. In FY13, this section includes research plans in Mechanical Sciences moved from the Materials and Mechanics section. ***FY 2013 Plans:*** Establish the differential geometry (geometric mechanics) of multi-body/granular media interactions; develop an understanding to enable JP-8 surrogate fuels for diesel engine cycle studies; investigate novel nano-thermodynamic corrections for prediction of hot spots in energetic material; investigate the flow mechanisms associated with transitory aerodynamic loading effected by flow control on the boundaries of stationary and moving platforms. ***FY 2014 Plans:*** Will conduct counter-flow burner studies for investigating high molecular weight hydrocarbon fuel and jet fuel chemistry at elevated pressures up to 2.5MPa; will investigate novel transparent fully cross-linked Molecular Interpenetrating Polymer Composites (MIPCs) under high strain rate loading conditions; will develop a new representation of the Navier-Stokes equations providing rapid convergence when compared to existing solvers for equivalent flow field models, grid types and grid sizes; will elucidate the fundamental physical interactions responsible for energy dissipation and quality factor magnification within prototypical nano-electromechanical systems.	0.000	6.498	6.445
Title: Basic Research in Mathematical Sciences ***Description:*** Pursue the creation of new mathematical tools, methods for performing complex, multi-system analysis and modeling to enhance soldier and overall weapon system performance. More specifically, the focus will be on creating mathematical principles and practical algorithms for modeling complex systems, analysis and control of biological systems, geometric analysis and topological modeling for complex systems, stochastic analysis and control, and numerical computation of infinite dimensional systems. Research in this section was previously described under Computational and Mathematical Sciences.	0.000	6.535	6.278

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2013 Plans: Create new numerical methods and algorithms that facilitate improved aerodynamic performance of helicopters in adverse conditions as well as enabling optimal design of supersonic projectiles. Continue to develop a multivariate heavy-tail statistical theory and develop algorithms to improve modeling capability for complex systems. Create new mathematical tools, computational algorithms, and capabilities that deepen understanding of protein-ligand docking. ***FY 2014 Plans:*** Will conduct innovative basic research in statistical analysis, commutative and quantum stochastics and control, multiscale computational methods, computational cell and molecular biology and fundamental laws of biology in order to revolutionize methodologies for information assurance, counter-terrorism, next generation communication networks, weapon design, testing, and evaluation, and coordination and collective decision-making.			
Accomplishments/Planned Programs Subtotals	76.109	78.050	80.385

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H66: *Adv Structures Rsch*	-	1.929	1.999	2.018	-	2.018	2.046	2.069	2.022	2.058	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project funds basic research for improved tools and methods to enable the structural health monitoring capabilities and condition-based maintenance for rotorcraft and ground vehicles. This research also enables the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms identified by the Army Modernization Strategy. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic modeling and simulation; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structural modeling are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused on: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term investigation of integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Army Aviation requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. This is the only basic research project supporting investigations for rotorcraft and ground vehicle structures within the Department of Defense.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), using facilities located at NASA Langley Research Center, Hampton, VA, and at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Structural Analysis and Vibration Methods	1.929	1.999	2.018

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H66: *Adv Structures Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: This research explores new structural analyses and validation methods to achieve more accurate predictions of durability and damage tolerance in composite and metallic rotorcraft structures and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed system components of future aircraft. ***FY 2012 Accomplishments:*** Used enhanced and selected Fatigue Crack Growth algorithms to validate damage tolerance (DT) methods through analytical redesign of a full-scaled rotorcraft component to meet DT requirements for Joint Future Theater Lift; investigated Prognostics & Diagnostics (P&D) frameworks for remaining useful life computations using flight evaluation data; validated emerging P&D methods to establish probability of damage/flaw detection, analyzed usage credits, and established fracture mechanics-based P&D technology. ***FY 2013 Plans:*** Validate progressive failure analysis methods and fatigue damage model of composites under various loadings and composite configurations to address failures in Army vehicle composite structures. Assess sensor technologies embedded in composite materials to enable multifunctional structures and to improve the capability to predict the remaining useful life of Army vehicle structures. Investigate an advanced sensing method used for prognostics and diagnostics to reduce maintenance man-hours and to increase the availability of Army weapon systems. ***FY 2014 Plans:*** Will investigate adaptive seat damper materials and strategies for improved vibration reduction on different types of terrains and for different gross vehicle weight configurations; will develop and demonstrate a virtual testing capability by integrating probabilistic methods, reliant on current and historical data, into existing physics-based models for lightweight composite structures; will develop signal processing algorithm for tracking damage transients; and will investigate three-dimensional printing of novel multifunctional materials for micro air and ground vehicle applications.			
Accomplishments/Planned Programs Subtotals	1.929	1.999	2.018

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
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E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H67: *Environmental Research*	-	0.987	1.020	1.031	-	1.031	1.054	1.065	1.084	1.104	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project focuses basic research on innovative technologies for industrial pollution prevention (P2) that directly supports the Army production base and weapon systems and addresses non-stockpile chemical warfare (CW) site remediation. Work in pollution prevention invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems, with the goal of reducing the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces.

Work in this project complements and is fully coordinated with the Army Environmental Requirements Technology Assessment (AERTA) requirements. The program element contains no duplication with any effort within the Military Departments.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the U.S. Army Armament, Research, Development and Engineering Center, Picatinny, NJ.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Industrial Pollution Prevention	0.987	1.020	1.031
Description: This effort conducts research on innovative environmentally- friendly technologies that support the warfighter (focusing on pollution prevention technologies).			
FY 2012 Accomplishments:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Began a new three year cycle of projects with a full call for proposals sent to the RDECOM laboratories. ***FY 2013 Plans:*** Continue research efforts that were reviewed by the Peer Panel during the Gate Reviews in September 2012; conduct research on mechanics of antibiotic and disinfectant resistance from wastewater treatment and research into synthesis of biofuels. ***FY 2014 Plans:*** Will review FY13 efforts and accept new start proposals to be reviewed by the Peer Panel during Gate Reviews in September 2013: research includes gasification/biofuels technology, green technologies for energetic/propellants to eliminate hazardous materials, next generation of bio-based materials from sustainable resources and microbial resistance to disinfectants.			
Accomplishments/Planned Programs Subtotals	0.987	1.020	1.031

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
S13: *Sci BS/Med Rsh Inf Dis*	-	10.693	12.099	10.702	-	10.702	10.656	11.119	11.249	11.657	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project fosters basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research for this project provides an understanding of the mechanisms that make organisms infectious and mechanisms that render the human body response effective to prevent diseases caused by infectious agents. Understanding the biological characteristics of infectious organisms also enables the development of point-of-care and laboratory-based diagnostic tools. Understanding of disease transmission by insects and other organisms helps in developing new interventions to prevent transmission of such diseases. Infectious disease threats from malaria, diarrhea, and dengue (a severe debilitating disease transmitted by mosquitoes), which are common in Africa, Central, European, Southern, and/or Pacific Commands, are the highest priorities for basic research.

Research conducted in this project focuses on the following five areas:
(1) Prevention/Treatment of Parasitic (living in or on another organism) Diseases
(2) Vaccines for the Prevention of Malaria
(3) Bacterial Disease Threats
(4) Viral Disease Threats
(5) Diagnostics and Disease Transmission Control

Work is managed by USAMRMC in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all Department of Defense naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

Work in this project complements and is fully coordinated with PE 0602787A, project 870.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology, focus areas and the Army Modernization Strategy.

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR) and NMRC, Silver Spring, MD, and their overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Prevention/Treatment of Parasitic Diseases	3.644	4.203	3.810

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: This effort conducts basic research to better understand the biology of malaria and leishmaniasis (a skin-based disease transmitted by sand flies) parasites and to gain the necessary foundation for discovering medical countermeasures to protect military personnel from infection. Malaria, which can cause fatal and chronic disease, is the most significant military infectious disease threat. Because the malaria parasite becomes resistant to drugs over time, it is necessary to continually search for parasite weaknesses that can be exploited with new, effective drugs and vaccines. ***FY 2012 Accomplishments:*** Identified compounds to down-select for advance screening studies and evaluated their potential for future development as anti-parasitic drugs. ***FY 2013 Plans:*** Modify candidate compounds active against malaria and Leishmania parasites to improve their anti-parasitic activity with a goal to transition these compounds to pre-clinical studies in an animal model. ***FY 2014 Plans:*** Will continue optimization of candidate anti-parasitic drugs by chemically modifying them to improve their safety, efficacy, and bio-availability. These modified compounds will be evaluated in animal models for down-selection of best compounds of interest.			
Title: Vaccines for Prevention of Malaria ***Description:*** This effort conducts basic research to better understand and identify new proteins in the design of candidate vaccines for various types of malaria including the severe form of malaria (Plasmodium falciparum) and the less severe but relapsing form (Plasmodium vivax). A highly effective vaccine could reduce/eliminate the use of antimalarial drugs and also reduce the development of drug resistance to current/future drugs. ***FY 2012 Accomplishments:*** Identified new protein molecules as vaccine candidates against malaria to down-select for advance screening studies and evaluate their potential for future development; studied the mechanism of developing antibodies against these new molecules in animal models; conducted research to develop methods of formulating new vaccine candidates for effective delivery inside the human body by using cutting-edge technologies. ***FY 2013 Plans:*** Formulate and evaluate newly identified vaccine candidates and assess mechanisms of protection in animal models and compare novel formulations of malaria vaccines for protective effectiveness in animal models. ***FY 2014 Plans:***	2.188	2.440	2.307

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will assess immunogenicity (immunity or an immune response) and protective effectiveness of new vaccine candidates in small-animal models to determine suitability in formulations of multiple antigen vaccines (an antigen is a substance, usually a protein, on the surface of a cell or bacterium that stimulates the production of an antibody).			
Title: Bacterial Disease Threats ***Description:*** This effort conducts research to better understand the biology of bacterial organisms and their effects on humans, as well as how to prevent wound infections, diarrhea (a significant threat during initial deployments), and scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics). ***FY 2012 Accomplishments:*** Assessed results of epidemiologic studies (studies of factors affecting the health and illness of populations) of bacterial diarrhea and wound infections to ensure formulation of the best vaccine candidates for diarrhea and the best prevention practices to mitigate wound infections and transitioned best basic wound management measures to preclinical (animal model) testing. ***FY 2013 Plans:*** Undertake discovery of and evaluate new vaccine components needed for vaccine protection for severe bacterial diarrhea based on prior studies; evaluate different components from pathogens causing diarrhea for their ability to induce protection against these organisms; and develop further knowledge of bacterial wound infection pathogens to develop effective treatments. ***FY 2014 Plans:*** Will study the mechanism by which diarrheal pathogens stick to the wall of the intestine to develop countermeasures against these pathogens and will study novel methods of formulating vaccine candidates to effectively deliver them inside the human body. Will study mechanism of bacterial wound infection pathogens to develop effective treatments.	1.450	1.432	1.537
Title: Viral Threats Research ***Description:*** This effort conducts research to better understand human immunodeficiency virus (HIV) and other highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (severe viral infection that causes internal bleeding) such as dengue hemorrhagic fever and hantaviruses (severe viral infection that causes internal bleeding and is contracted from close contact with rodents). Basic research includes understanding risk of disease prevalence to the Warfighter, viral biology (including structure, function, life cycle, and interactions with the environment), the disease process, and disease interaction with the human body. ***FY 2012 Accomplishments:*** Continued to study and evaluated the basis of the dengue disease and how the immune system reacts to it; conducted research on defining factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; and	1.706	2.109	1.577

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
also developed methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection. ***FY 2013 Plans:*** Study and evaluate the basis of dengue disease and how the immune system reacts to it; evaluate factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; develop methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection; determine the contribution of various cells present in human body to provide protection against dengue infection and/or dengue disease; study and evaluate pathogenesis of hemorrhagic fever caused by hantaviruses (a family of deadly viruses transmitted by rodents); and study the biology of HIV to understand the impact of human genes on HIV acquisition and progression to inform vaccine development. ***FY 2014 Plans:*** Will study the role of human cells and antibodies to develop medical countermeasures to prevent and/or treat diseases caused by hantaviruses (a deadly virus responsible of hemorrhagic fever with renal syndrome) and dengue; will conduct epidemiological studies (study of the causes and transmission of disease within a population) to determine the prevalence and incidence of dengue fever and dengue hemorrhagic fever over time in diverse populations; and will use the epidemiological information to develop and/or maintain vaccine test site infrastructure for the purpose of evaluating promising dengue vaccine candidates for safety and effectiveness.			
Title: Diagnostics and Disease Transmission Control ***Description:*** This effort conducts research to investigate the biology of biting insects (including mosquitoes and leishmaniasis-infected sand flies) and other organisms that transmit disease (disease vectors) and their control. This effort also expands medical diagnostic and disease surveillance capabilities in the field. This research will help to direct new interventions into preventing disease transmission. ***FY 2012 Accomplishments:*** Developed new trapping methods to improve sand fly surveillance; developed tools to identify mosquito species that transmit malaria parasites; and developed a detection method for scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics) in the Pacific Commands area of operation. ***FY 2013 Plans:***	1.705	1.915	1.471

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Identify novel fast-acting, directly targeted, insecticides that rapidly degrade to harmless by-products; investigate next-generation risk assessment tools for evaluating potential infectious disease transmission in insects (beyond modeling); and develop identification keys for medically important insect vectors. ***FY 2014 Plans:*** Will develop identification keys for the medically important arthropod (e.g., ticks, mosquitos, and sandflies) vectors in alternative geographic areas not previously studied but potentially deployable locations and will evaluate new technologies selected as part of the new-generation diagnostic systems for use in the deployed setting for detection of pathogens in humans.			
Accomplishments/Planned Programs Subtotals	10.693	12.099	10.702

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S14: *Sci BS/Cbt Cas Care Rs*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
S14: *Sci BS/Cbt Cas Care Rs*	-	9.424	10.197	9.172	-	9.172	9.302	9.161	9.721	9.607	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project supports basic research to understand the fundamental mechanisms of severe trauma to advance treatment and surgical procedures to save lives and improve medical outcomes for the Soldier. Experimental models are developed to support in-depth trauma research studies. This project includes studies of predictive indicators and decision aids for life-support systems, studies to heal and repair burned or traumatically injured tissue, traumatic brain injury (TBI), sight and face trauma, and transplant technology. Such efforts will minimize lost duty time from and provide military medical capabilities for far-forward medical/surgical care of injuries, as well as post-evacuation restorative and rehabilitative care.

Research conducted in this project focuses on the following five areas:
(1) Damage Control Resuscitation
(2) Combat Trauma Therapies
(3) Combat Critical Care Engineering
(4) TBI
(5) Clinical and Rehabilitative Medicine

Work in this project complements and is fully coordinated with PE 0602787A, Project 874.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology, priority focus areas and the Army Modernization Strategy.

Work in this project is performed by WRAIR, Silver Spring, MD; the U.S. Army Dental Trauma Research Detachment and the U.S. Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX; and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Damage Control Resuscitation	1.303	1.433	1.618
Description: This effort conducts studies of genetic pathways and metabolic mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma.			
FY 2012 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S14: *Sci BS/Cbt Cas Care Rs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Conducted studies of immune system interaction with the coagulation (blood clotting) system and the effect of trauma on fibrinogen (a blood clot component) formation. ***FY 2013 Plans:*** Conduct studies aimed at reducing effects on cells caused by hemorrhage (bleeding) in an animal model during resuscitation to determine the role of an enzyme in protecting cells. ***FY 2014 Plans:*** Will perform studies of re-engineered blood products to control traumatic bleeding and treat shock and will perform studies to better understand the genetic basis of survival from hemorrhage.			
Title: Combat Trauma Therapies ***Description:*** This effort conducts studies of trauma to tissues and organs and ways to mitigate and/or repair this damage. Research addresses cellular repair/growth mechanisms to treat TBI, dental (facial and oral) injuries, extremity wounds and fractures, and burns. ***FY 2012 Accomplishments:*** Realigned neuroprotection research to the TBI program area and regenerative efforts in craniomaxillofacial trauma (soft tissue and skeletal injuries to the face, head, and neck) to the Clinical and Rehabilitative Medicine Research Program and researched potential bone defect models to find one that is clinically relevant to combat trauma. ***FY 2013 Plans:*** Continue to study the relevant model of bone defect to create a model for use in evaluating new therapies and identify factors capable of minimizing the development of chronic inflammation. ***FY 2014 Plans:*** Will study mechanisms to manipulate the molecules, cells, and structure of the skin to optimize healing, appearance, and function..	0.929	0.836	0.784
Title: Combat Critical Care Engineering ***Description:*** This effort conducts basic science studies of vital sign responses to trauma as predictors of medical outcomes and as a basis for developing life-saving interventions. This research area started in FY2012. ***FY 2012 Accomplishments:***	0.748	0.699	0.858

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S14: *Sci BS/Cbt Cas Care Rs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Began basic research studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss. ***FY 2013 Plans:*** Continue studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss as a path to tailoring resuscitation to individuals. ***FY 2014 Plans:*** Will perform research on decision support algorithms that use non-traditional vital signs to assess patient physiologic status and will continue studies of algorithms for early identification of individuals with high- and low-tolerance to blood loss to optimize resuscitation.			
Title: Traumatic Brain Injury ***Description:*** This effort conducts basic research in poly-trauma (multiple injuries)/Traumatic Brain Injury (TBI) model, cellular mechanisms of cell death, and the discovery of novel drugs and medical proceedures to mitigate the effects of TBI. ***FY 2012 Accomplishments:*** Realigned neuroprotection research from the Combat Trauma Therapies task area to the TBI task area; continued basic research in poly-trauma (multiple injuries)/TBI model, cellular mechanisms of cell death and discovery of novel drugs to mitigate TBI. ***FY 2013 Plans:*** Conduct research to further understand cell death and neuroprotection (protecting degeneration of the nervous system) mechanisms, and identify critical thresholds for secondary injury (i.e., polytrauma) complicating TBI. ***FY 2014 Plans:*** Will apply systems biology metrics to models of mild and severe TBI to aid in discovery of novel proteins in the blood that appear as a result of traumatic injury, which may aid in diagnosis of TBI; will perform basic research to study the brain and nervous system during the first 2 months following head injury to identify predictors of long-term consequences of TBI; and will continue research to understand cell death and neuroprotection (protection of the brain) mechanisms and determine critical thresholds for secondary injuries (polytrauma) complicating TBI.	0.959	0.660	0.991
Title: Clinical and Rehabilitative Medicine ***Description:*** This effort conducts basic studies of mechanisms of tissue growth and traumatic injury to gain an understanding that will assist or facilitate the healing or transplantation process. The focus is placed on severe blast trauma to the limbs, head, face (including eye), and genitalia, abdomen and burns. ***FY 2012 Accomplishments:***	5.485	6.569	4.921

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S14: *Sci BS/Cbt Cas Care Rs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Continued research in eye trauma to understand the cellular and neuronal mechanisms of eye injury and continued the process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase. ***FY 2013 Plans:*** Explore the mechanisms of eye trauma injury and the epidemiology (studying incidence or prevalence of injury) of eye trauma wounds and explore innovative strategies to regenerate tissues and advance promising approaches to the applied research phase. ***FY 2014 Plans:*** Will evaluate the cellular mechanisms of eye trauma injuries to identify promising therapies for eye trauma wounds and explore the epidemiology (studying incidence or prevalence of injury) (including severity) of eye trauma injuries and will explore innovative strategies to regenerate tissues and advance promising approaches to the applied research phase to repair extremities (arms and legs), craniomaxillofacial (head, neck, face, and jaw), genital, and abdominal regions.			
Accomplishments/Planned Programs Subtotals	9.424	10.197	9.172

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S15: *Sci BS/Army Op Med Rsh*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
S15: *Sci BS/Army Op Med Rsh*	-	6.246	5.683	7.370	-	7.370	7.320	6.977	7.056	7.307	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project fosters basic research on physiological and psychological factors limiting Soldier effectiveness and on the characterization of health hazards generated by military systems and resulting as a consequence of military operations. This project includes research on the neurobehavioral aspects of post-traumatic stress and suicide and develops concepts for medical countermeasures to prevent or mitigate the effects of muscle and bone injury as well as to reduce the effects of sleep loss and other stressors on Warfighter performance. The hazards of exposure to directed energy, repetitive use, fatigue, heat, cold, and altitude are also investigated under this project.

Research conducted in this project focuses on the following four areas:
(1) Injury Prevention and Reduction
(2) Physiological Health
(3) Environmental Health and Protection
(4) Psychological Health and Resilience

Work in this project complements and is fully coordinated with PE 0602787A, project 869.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology, priority focus areas and the Army Modernization Strategy.

Work in this project is performed by WRAIR, Silver Spring, MD; USAISR, San Antonio TX; and the U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Injury Prevention and Reduction	1.083	0.970	1.185
Description: This effort identifies biological patterns of change in Soldiers during states of physical exertion, identifies physiological mechanisms of physical injury and exertion that will predict musculoskeletal injury, and establishes laser dose-response for eye tissue.			
FY 2012 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S15: *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Examined the prevalence of Warrior eye injuries sustained in recent operations in Iraq and Afghanistan by category and outcome which can be applied to the development of protective technologies, diagnostic tools, and treatment strategies. Investigated how near-infrared wavelengths can be used to non-invasively detect retinal injury caused by blast, laser insult or other ocular (eye) trauma. Examined the mechanisms of laser-induced retinal injury and their dependence on pulse duration, pulse repetition and total number of pulses. ***FY 2013 Plans:*** Identify indicators of cellular responses to determine efficacy of intervention strategies related to injury susceptibility in the skeletal muscle; diagnose and characterize repeated and long-duration exposure from military lasers; and characterize ocular injury as a function of shock wave (resulting from explosion of an improvised explosive device) impulse in a large-eye animal model to establish advanced triage, treatment, and prevention methodologies. These data will lead to our understanding of multiple ocular injuries from a single blast or laser exposure and will also anchor predictive biophysical models to prevent or mitigate Soldier eye injury from blast. ***FY 2014 Plans:*** Will explore musculoskeletal injury and repair mechanisms to identify possible therapeutic targets that regulate skeletal muscle and bone function; will assess damage to the retina (a light-sensitive membrane in the back of the eye that receives an image from the lens and sends it to the brain through the optic nerve) of the eye following changes to long-duration exposures using advanced ophthalmic (eye) imaging systems and retinal scanning devices; and will establish ocular (eye) injury metrics for blast exposures.			
Title: Physiological Health ***Description:*** This effort conducts research on the physiological mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being. ***FY 2012 Accomplishments:*** Identified menus, food service practices, and labeling and educational materials to promote healthy eating behavior in military dining facilities and identified the hormonal and metabolic responses of human fat tissue during periods of underfeeding, followed by overfeeding. Investigated the mechanism of preventing cellular toxicity (cell death) caused by environmental factors can be inhibited by a certain group of phytonutrients (plant-derived compounds that interact with cells in the body). Examined the correlation between protein synthesis (proteins being made inside the cell) in the brain and different phases of sleep and how this contributes to recuperative sleep patterns. Also investigated the impact of caffeine on performance sustainment. ***FY 2013 Plans:***	2.748	3.068	3.045

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S15: *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Determine muscle metabolic responses to nutritional deficit; identify the relationship between micronutrient and bone adaptation during military training; and identify the effects of energy deficits on human brain function and cognitive performance. These results will lead to an increased understanding of the benefits of adequate nutrition for the Warfighter. ***FY 2014 Plans:*** Will determine whether electrical brain stimulation can be used to induce sleep; will explore promoting sleep during intervals between missions when sleep is not physiologically required; will establish nutritional requirements for optimizing muscle formation and repair; will determine the effects of various nutritional interventions on cell function; will explore various nutritional interventions that might enhance resistance to cellular injury; and will explore nutritional interventions that might promote physiological improvements to training and enhance recovery from physical injury.			
Title: Environmental Health and Protection ***Description:*** This effort conducts research on the physiological mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. ***FY 2012 Accomplishments:*** Identified mechanisms of heat stroke-induced organ damage in a mouse model. ***FY 2013 Plans:*** Identify how clinical pathways alter progression and extent of organ damage following heat injury/stroke. These studies will determine the role of inflammation in multi-organ failure, and the results will be used to develop protective treatments against damage to internal organs resulting from heat exposure. ***FY 2014 Plans:*** Will identify metabolic pathways that are regulated by inflammation, which increases heat stroke susceptibility and/or alters the time course and extent of organ damage following heat injury that results in multi-organ failure, and will explore treatments to protect against organ damage resulting from heat injuries.	1.187	0.245	0.804
Title: Psychological Health and Resilience ***Description:*** This effort conducts research into the basic mechanisms of psychological resilience (i.e., mental toughness and the ability to overcome traumatic events) and post-concussion related mental and physical challenges and includes determination of suicide risk and understanding underlying mechanisms driving suicidal behavior, as well as underlying neurobiological mechanisms related to post-traumatic stress disorder (PTSD) and depression. ***FY 2012 Accomplishments:***	1.228	1.400	2.336

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S15: *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Identified deployment-related measures to assess intervention effectiveness (e.g., mitigating functional impairment, transition, risky behaviors) for the treatment of PTSD; examined underlying psychosocial and biological theories of suicidal behavior; and examined underlying neural systems' response to depression treatment. ***FY 2013 Plans:*** Identify markers to indicate the effectiveness of candidate medications for PTSD treatments, and through exploration with an animal model, existing candidate compounds are evaluated for efficacy in the treatment of PTSD. Neural systems' response to depression treatment is used to inform development of optimized treatment regimen for depression. ***FY 2014 Plans:*** Will determine whether a sleep-related intervention strategy can enhance resilience to concussion/mild TBI effects in a proof-of-concept rodent model and will evaluate the extent to which sleep is effective for enhancing resilience to concussion, which will potentially provide a preventative strategy to decrease negative consequences of concussions; will establish cellular mechanisms for regulation of PTSD symptoms associated with increased stress sensitivity and increased anxiety in a rodent model of PTSD.			
Accomplishments/Planned Programs Subtotals	6.246	5.683	7.370

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T22: *Soil & Rock Mech*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T22: *Soil & Rock Mech*	-	4.824	4.034	4.579	-	4.579	4.780	4.978	5.056	5.147	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project fosters basic research to correlate the effects of the nano- and micro-scale behavior on the macro-scale performance of geological and structural materials to provide a foundation for the creation of future revolutionary materials and to revolutionize the understanding of sensor data within a heterogeneous geological systems. This research encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research includes: underlying physics and chemistry that controls the mechanics and electromagnetic behavior of geological and structural materials, new techniques that provide measurements at the fundamental scale, and fundamental theories for relating nano- and micro-scale phenomena to macro-scale performance.

Work in this project provides the basis for applied research in PE 0602784A (Military Engineering Technology), Project T40 (Mobility/Weapons Effects Technology). The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Military Engineering Basic Research	2.372	2.209	2.320
Description: Funding is provided for this activity			
FY 2012 Accomplishments: Completed a particle scale model to study the effects of two naturally occurring bonding agents on the suspension of particulates from naturally occurring soils.			
FY 2013 Plans: Develop basic wave propagation/sensor interaction knowledge, modifications to current and future data analysis, processing, and classification algorithms to account for use of conduit, and produce a modeling framework for future variable manipulation.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T22: *Soil & Rock Mech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will quantify the amplitude, frequency content, and time series of seismic loads caused by the impact of tools on granular media; determine the effect of snow grain shape on near-infrared reflectance; estimate soil texture and moisture from polarimetric imaging.			
Title: Materials Modeling for Force Protection ***Description:*** This effort moved from PE 0601102 Project T23 in FY 11 to this Project T22 in FY 12. The long-term goal of this task is to develop a structural ceramic composite that could replace steel and aluminum for most applications at one third the weight. To accomplish this goal, a technical ceramic such as silicon carbide will have to be improved five-fold in tensile strength and fracture toughness. ***FY 2012 Accomplishments:*** Performed fundamental research to explore characteristics of natural materials with exceptional mechanical properties in order to develop the foundational understanding that will lead to advances in blast and ballistic protection through engineered material models. This work moves from PE0601102A-T23 Facilities Research in FY12. ***FY 2013 Plans:*** Create experimental techniques that provide measurements at the nano- to micro-scale to allow for validation and verification of simulations of material. These techniques will allow for better understanding of how bio-lamina are created and how or if those processes can be exploited for synthesis and self-healing. ***FY 2014 Plans:*** Will model deformation and change in particles using a novel Mixed Least Squares method for Finite Elements that permits discontinuities in the displacement field of the particles; determine if polycrystalline ceramics can theoretically be improved by multiple-fold current values of fracture toughness and tensile strength; determine energy dissipation mechanisms in nano-coiled vertically aligned carbon nanotubes with a stiffness gradient under dynamic loading conditions.	2.452	1.825	2.259
Accomplishments/Planned Programs Subtotals	4.824	4.034	4.579

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T22: *Soil & Rock Mech*

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T23: *Basic Res Mil Const*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T23: *Basic Res Mil Const*	-	1.863	1.659	1.773	-	1.773	1.715	1.732	1.964	1.999	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

Work in the project fosters basic research and supports facilities research initiatives. The research is focused on forming an explicit and mathematically robust set of algorithms for geometrical reasoning; assessing the conceptual feasibility of applying nanoparticle technology to real-time sensors, thermal conductivity, and high strength materials; and developing novel and advanced concepts for mitigating the effect of chemical and biological agents in built structures. These efforts provide basic research leading to improved design in a range of facilities to optimize facility mission performance, enhance facility security, reduce design and construction errors and omissions, reduce resource requirements, and reduce the environmental burdens over the facility's life. This project provides leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustainment of deployed facilities, and energy and utility infrastructure.

Work in this project provides the basic research basis for applied research in PE 0602784A (Military Engineering Technology), Projects T41 (Military Facilities Engineering Technology) and T45 (Energy Technology Applied to Military Facilities).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Facilities Research	1.863	1.659	1.773
Description: Funding is provided for the following effort.			
FY 2012 Accomplishments: Explored the controlled dissociation of either methane or ammonia in order to produce pure hydrogen gas; determined the effects of temperature on the quantum dot output spectrum in order to increase understanding for improved sensor development.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T23: *Basic Res Mil Const*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Complete investigations of enhanced heat transfer of hybrid surfaces and switching mechanisms in bioinspired polymers. ***FY 2014 Plans:*** Will determine the relationship between amino acid sequence and nanostructure self-assembly properties in a unique protein motif; redirect electron flux from highly reduced organic fermentation products towards hydrogenase production.			
Accomplishments/Planned Programs Subtotals	1.863	1.659	1.773

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T24: *Signature Physics And Terrain State Basic Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T24: *Signature Physics And Terrain State Basic Research*	-	1.605	1.495	1.601	-	1.601	1.539	1.547	1.656	1.686	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research to increase knowledge in the areas of terrain state and signature physics. It investigates the knowledge base for understanding and assessing environmental impacts critical to battlespace awareness. Projects include fundamental material characterization, investigation of physical and chemical processes, and examination of energy/mass transfer applicable to predicting state of the terrain, which control the effects of the environment on targets and target background signatures and mobility in support of the materiel development community. The terrain state area of terrestrial sciences investigates weather-driven terrain material changes and sensing/inferring subsurface properties. The signature physics area of terrestrial sciences focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures, and energy propagation in response to changing terrain state and near surface atmosphere.

Work in this project provides a foundation for applied research in PE 0602784A (Military Engineering Technology), Project 855 (Topographical, Image Intel and Space) and T42 (Terrestrial Science Applied Research).

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Analysis for Signal and Signature Phenomenology (Previously titled - Terrain State and Signature Physics)	1.605	1.495	1.601
Description: Funding is provided for the following effort. ***FY 2012 Accomplishments:*** Determined if radars can better detect subsurface disturbances through improved coherent waveform detection, and understanding of volume scatter loss rates; formulated methods for near real-time calculation of sound fields in complex environments; constructed a 3D numerical model of gas transport in soil that incorporates convection and diffusion and will			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T24: *Signature Physics And Terrain State Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
determine the role of soil microstructure in gas movement through porous media in the near-surface ground, which will support emerging methods of subsurface target detection; investigated a novel approach to represent terrain state spatial and temporal patterns and relationships to significantly reduce computational complexity and intensity required to model soil moisture and surface temperature. ***FY 2013 Plans:*** Formulate new statistical approaches for improved sensing and communication systems operating in complex terrestrial environments with new quantitative measures for heterogeneity and intermittency of random terrestrial media; formulate a methodology for assessing motivational intensities (cognitive-based processes) contributing to movement patterns in constrained landscapes. ***FY 2014 Plans:*** Will investigate and quantify full waveform Light Detection and Ranging (LiDAR) backscatter characteristics and known system response to enhance sensor calibration models for increased target identification in variable terrain environments; research and define annually repeating spatial snow patterns as a function of topography, vegetation, and weather, and determine the efficacy and utility of this new knowledge to improve satellite derived snow mapping estimates of depth and density for enhancing water storage estimates and mobility products.			
Accomplishments/Planned Programs Subtotals	1.605	1.495	1.601

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T25: *Environmental Science Basic Research*	-	8.027	6.888	7.175	-	7.175	7.170	7.293	8.254	8.403	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research to investigate fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts include: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment, or neutralization of organics in water, soil, and sediments resulting from military activities; adhering to applicable federal, state, and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; reducing pollution associated with military activities; and the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative.

Work in this project provides a fundamental basis for applied research in PE 0602720A (Environmental Quality Technology), Project 048 (Industrial Operations Pollution Control Technology), Project 835 (Military Medical Environmental Criteria) and Project 896 (Base Facilities Environmental Quality).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants	3.879	3.272	2.798
Description: Funding is provided for the following effort.			
FY 2012 Accomplishments: Investigated bioassay response to climate and contaminant stress on a standard laboratory organism (Daphnia) to elucidate impacts on other species of concern to Military installations; characterized metals-rich granules (MRG) produced by lead (Pb)			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
exposed soil invertebrates to determine bioavailability and potential for bacteria to release the Pb back into the environment in a biologically available form; construct a neuro-endocrine feedback mechanism ex vivo to replicate the neuroendocrine system in environmental monitoring species (fish) for advancement of high throughput screening and analyses, and computation modeling of contaminates; investigated the linkage of oxidative stress to behavior and animal survival impacts using real time-time imaging of gene expression and behavioral tracking. ***FY 2013 Plans:*** Initiate research on amphibian response to various militarily relevant chemicals and materials to develop an understanding of if and how these unique organisms are impacted; develop an understanding of transport of compounds through cellular channels that will allow information for more sensitive nano-sensors; investigate the new insensitive munitions behavior and persistence in environmental condition and media. ***FY 2014 Plans:*** Will understand the fundamental physics that control transport of both ionic and neutral species through nanochannels; rapidly characterize structural changes in integral membrane proteins upon ligand binding; determine soil mobility and bioavailability of IMX-101 in terrestrial systems; expand the metabolic capacity of aerobic RDX- degrading bacteria to enable degradation of 4-nitro-2,4-diazabutanal.			
Title: Remediation of Explosives, Energetics, and UXO ***Description:*** Funding is provided for the following effort. ***FY 2012 Accomplishments:*** Determined the potential for abiotic and biotic degradation of insensitive explosives, NTO and FOX-7, potential insensitive replacements for RDX; investigated non-traditional concentration response relationships for prediction of environmental risks supporting development of novel energetics. ***FY 2013 Plans:*** Investigate the mineralization of depleted uranium munitions and effects on solubility, sorption, and mobility; explore novel microbial systems for degrading energetic compounds; and will study the bioavailability implications of interactions between munitions constituents and performance enhancing nano-material in mixtures. ***FY 2014 Plans:*** Will determine the potential for bioaccumulation and food-chain transfer of 2,4 Dinitroanisole; isolate and chemically identify predominant phytosiderophores and/or organic acids exuded by two grass plants that may serve to complex lead; identify	2.297	1.967	2.296

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
and characterize novel biocatalysts involved in the direct incorporation of molecular oxygen into amines resulting in a green biosynthesis route to energetics			
Title: Training Land Natural Resources ***Description:*** Funding is provided for the following effort. ***FY 2012 Accomplishments:*** Defined multiple-stressor assessment techniques to identify and evaluate the relative contribution of interacting stressors that impact military lands and critical natural resources; investigated how geographical fragmentation affects the pollination dynamics and gene flow within species populations to advance the fundamental knowledge for management of rare and endemic plant and pollinator species on Army ranges; through dermal and dietary exposure in plant and animal tissue determined the magnitude of tungsten bioavailability impacting firing range sustainability as well as advanced ecological assessment capabilities. ***FY 2013 Plans:*** Investigate how climate induced change affects the adsorption and biotransformation characteristics of northern peat-land ecosystems; conduct mechanistic investigations of Lead (Pb) chemical separation by plant exudates to advance understanding on the potential for plant exudates to mobilize Pb in the presence of environmentally relevant completing interactions; analyze pollination networks and nectar-dwelling yeast communities and discern shared dynamics and structural interactions between two systems to continue to advance the fundamental knowledge for management of rate and endemic plant and pollinator species on Army ranges. ***FY 2014 Plans:*** Will devise a mathematical description of multiple scattering of impulsive signals that includes variability due to spatial and size distributions of scattering objects; determine how climate induced change affects the adsorption and biotransformation characteristics of peatland ecosystems; characterize and compare munitions compounds and insenstitive munitions impacts on critically sensitive larval stages of amphibian development.	0.749	0.616	1.007
Title: Network Science ***Description:*** Funding is provided for the following effort. ***FY 2012 Accomplishments:*** Investigated first principle phenomenology describing spontaneous formation of highly regular biological networks by bacteria to determine spatial pattern relationships in bacteria colonies; determined cognitive elements associated with attention and memory	1.102	1.033	1.074

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
allowing heterogeneity in vigilance across a population to emerge naturally in a form conducive to social network resilience and adaptive behavior under predatory threat. ***FY 2013 Plans:*** Investigate the molecular architecture that dictates the highly specific ligand preference of insect pheromone receptors based on amino acid networks for intelligent receptor design; investigate genetic and genomic basis of intra-species variance in sensitivity to munitions and reduced uncertainty in risk/toxicity assessment of military sites; explore the trade-offs between adaptability and susceptibility within self-organizing biological networks. ***FY 2014 Plans:*** Will investigate genetic and genomic basis for differences in chemical sensitivity between different asexually or sexually reproducing populations; characterize sensitivity to traditional (lead) and insensitive (dinitroanisole) munitions over time under ideal and stressful conditions; quantify the long-term contribution of environmental stress to sensitivity drifting in age stratified, reproducing populations.			
Accomplishments/Planned Programs Subtotals	8.027	6.888	7.175

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T63: *Robotics Autonomy, Manipulation, & Portability Rsh*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T63: *Robotics Autonomy, Manipulation, & Portability Rsh*	-	1.797	1.956	1.991	-	1.991	2.025	2.059	2.094	2.132	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project supports basic research in areas that will expand the autonomous capabilities, utility, and portability of small robotic systems for military applications, with a focus on enhanced intelligence, biomimetic functionality, and robust mobility, to permit these systems to serve as productive tools for dismounted Soldiers. The ability of the Warfighter to command a suite of small unmanned systems (air, ground, and hybrid vehicles) will reduce exposure of the Soldier to harm and will improve the efficiency by which a dismounted unit achieves tactical objectives such as securing a targeted zone. Example missions requiring enhanced autonomy, manipulation, and man-portability include rapid room clearing and interior structure mapping; detection of human presence, chemical/biological/nuclear/radiological/ explosive (CBNRE), and booby-traps; surveillance; and subterranean passage detection and exploration. Because of their relatively small size, light weight, and service in dismounted environments, small unmanned systems have unique challenges in perception, autonomous processing, mobility mechanics, propulsive power, and multi-functional packaging that transcend similar challenges associated with large unmanned systems. The Army Research Lab will conduct research in related disciplines, including machine perception, intelligent control, biomimetic robotics, manipulator mechanics, and propulsive power and drives to foster the development of technologies for lightweight, small-volume, environmentally-harsh robotics applications. Machine perception research includes the exploration of lightweight ultra-compact sensor phenomenology and the maturation of basic machine vision algorithms that enable small unmanned systems to more fully understand their local environment. Intelligent control research includes the maturation of autonomous processing capabilities and the advancement of artificial intelligence techniques that lead to reliable autonomous behavior in a large-displacement, highly-dynamic environment and permit unmonitored task performance. Research in biomimetic robotics and manipulator mechanics includes the advancement of mechatronic and biomimetic appendages to enable agile high-speed locomotion, dexterous task-performance, and environmental-manipulation; and the maturing of nonlinear control algorithms to support robust, stable mobility. Propulsion power and drives research includes investigations of engine cycles and alternative hybrid energy conversion techniques to provide compact, lightweight, quiet, low-emission, high-density power sources that support highly-portable unmanned systems capable of performing long-endurance missions.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL) at the Aberdeen Proving Ground, MD.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T63: *Robotics Autonomy, Manipulation, & Portability Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Robotics autonomy and human robotic interface research	1.797	1.956	1.991
Description: In-house research with a focus on enabling robust autonomous mobility for small robotic systems, including autonomous operations in Global Positioning System (GPS) denied areas, planning, behaviors, intelligent control, and the interface of perception technologies to accomplish Army missions in the area of unmanned systems. These efforts will include research activities in micromechanics conducted in association with the Micro Autonomous Systems and Technology Collaborative Technology Alliance. ***FY 2012 Accomplishments:*** Evaluated novel modes of air and ground mobility for micro-mechanical systems. ***FY 2013 Plans:*** Conduct experimental studies to create a fundamental model of flapping wing locomotion to enable future micro-scale unmanned aerial vehicle systems. Examine basic concepts and underpinning mechanics of grasping and manipulating unknown and arbitrarily shaped objects. ***FY 2014 Plans:*** Will conduct experimental studies to investigate the fundamental flow behavior of small scale flyers as it impacts range and endurance; will investigate cognitive approaches for machine perception; will explore concepts from game theory and machine learning to determine adversarial intent from sensor observations; will examine mechanics and control related to whole body manipulation; and will examine novel locomotion mechanisms focusing upon energy efficiency and mobility.			
Accomplishments/Planned Programs Subtotals	1.797	1.956	1.991

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T64: *Sci BS/System Biology And Network Science*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
T64: *Sci BS/System Biology And Network Science*	-	2.128	2.824	2.959	-	2.959	2.930	2.972	3.022	3.038	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project fosters research investigations through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. The information gained from these studies provides a better understanding of the overall biological system and its molecular network of interactions, which leads to improved early strategic decision-making in the development of preventive and treatment solutions to diseases. This approach establishes a model for application of systems biology processes and knowledge of biological networks to discover medical products that prevent and/or treat diseases or medical conditions. This more complex, yet integrated approach, to studying biological systems could potentially reduce both the time and expense of medical product development for the Army.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology, priority focus areas and the Army Modernization Strategy.

Work in this project is performed by USAMRMC, Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Network Sciences Initiative	2.128	2.824	2.959
Description: This effort supports research to conduct studies through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies.			
FY 2012 Accomplishments: Validated the accuracy of the models and applied the models to identify markers for TBI.			
FY 2013 Plans: Expand the identification of TBI biomarkers to include key biological pathways, leading to the development of diagnostic assays and identification of potential drug targets.			
FY 2014 Plans: Will validate and extend algorithm for discovery of biomarkers (key molecular or cellular events that link a specific environmental exposure to a health outcome) for severe TBI to include moderate and mild TBI; will develop systems biology algorithms to			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T64: *Sci BS/System Biology And Network Science*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
establish new strategies to identify drug targets and therapeutics for malaria- and trauma-induced coagulopathy (abnormal blood clotting); will exploit novel in-silico (performed on computer via simulation) models to identify sensitive biomarkers and determine the time course of wound healing; and will develop mathematical models to characterize how viruses escape immune response to support the development of anti-viral drugs.			
Accomplishments/Planned Programs Subtotals	2.128	2.824	2.959

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT VR9: *Surface Science Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
VR9: *Surface Science Research*	-	2.178	1.936	2.010	-	2.010	2.328	2.631	2.675	2.723	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project fosters basic research to establish and maintain a core capability to enable a molecular level understanding of properties and behaviors of materials relevant to the Army; by developing understanding and ability to manipulate nanostructured materials as a means to tune properties which meet desired performance requirements; by advancing the scientific understanding of surface properties and interfacial dynamics of complex materials; and by providing scalable processes grounded in a molecular understanding of materials. This project funds basic research in the characterization of chemical and biochemical phenomena occurring at or near solid surfaces and interfaces; the interactions between chemical reactions and transport processes on surfaces; theory and modeling of processes at complex surfaces; and the synthesis and characterization of catalysts that function at the nanoscale. Investment in basic research centered on the surface science disciplines will enable growth of a knowledge base that will result in improved understanding of the interactions of complex materials in real world environments.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science andTtechnology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Edgewood Chemical and Biological Center (ECBC), Research, Development and Engineering Command, in Aberdeen, Maryland.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Surface Science Research	2.178	1.936	2.010
Description: The activities in this program are related to performing basic and early applied research in chemistry, biology and physics on fundamental problems related to surfaces, interfacial dynamics, thin film materials, chemical-biological catalysis and opto-electronic/sensory technologies.			
FY 2012 Accomplishments: Investigated the complex behavior of mass transport in microporous systems; designed rational molecular and nano-system functional abiotic structures; conducted fundamental studies and modeling of the interfacial phenomena of particulate matter			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT VR9: *Surface Science Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
(solid/liquid) with surfaces and the interaction of matter and mechanisms of transfer of energy at the nanoscale and at biological interfaces. ***FY 2013 Plans:*** Develop a robust set of surface science tools, both experimentally and theoretically, that can be used to further our understanding of surface properties and interfacial dynamics of complex materials; investigate rational design approaches to metal-metal oxide nano-architectures; systematically model engineered functional systems; investigate the mechanisms governing specific binding or adherence of biological molecules to abiotic surfaces; and perform structural determination and in silico modeling of trans-membrane proteins from human induced pluripotent cells. ***FY 2014 Plans:*** Will perform structural determination and computational modeling of trans-membrane proteins; building on FY13 efforts, continue to develop a set of surface science tools that further our understanding of surface properties and interfacial dynamics of complex materials; continue to investigate rational design approaches to metal-metal oxide nano-architectures; continue to systematically model engineered functional systems; investigate the mechanisms governing specific binding or adherence of biological molecules to abiotic surfaces.			
Accomplishments/Planned Programs Subtotals	2.178	1.936	2.010

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.