Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*							
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
Total Program Element	-	197.690	221.783	238.167	-	238.167	239.560	242.172	242.570	247.401	-	-
305: *ATR Research*	-	2.028	2.280	2.003	-	2.003	2.041	2.067	2.102	2.142	-	-
31B: *Infrared Optics Rsch*	-	2.621	2.859	3.307	-	3.307	2.860	2.896	2.942	2.999	-	-
52C: *Mapping & Remote Sens*	-	2.191	2.258	2.004	-	2.004	2.042	2.068	2.102	2.142	-	-
53A: *Battlefield Env & Sig*	-	3.302	3.570	2.610	-	2.610	3.777	3.824	3.889	3.964	-	-
74A: *Human Engineering*	-	7.576	8.409	14.614	-	14.614	13.411	13.422	13.051	11.066	-	-
74F: *Pers Perf & Training*	-	6.309	5.716	5.321	-	5.321	5.498	5.580	5.675	5.778	-	-
F20: *Adv Propulsion Rsch*	-	3.886	4.253	4.108	-	4.108	4.184	4.239	4.309	4.391	-	-
F22: *Rsch In Veh Mobility*	-	0.553	0.612	0.701	-	0.701	0.713	0.723	0.736	0.749	-	-
H42: *Materials & Mechanics*	-	7.865	8.902	9.308	-	9.308	8.662	8.784	8.933	9.098	-	-
H43: *Research In Ballistics*	-	8.299	9.378	8.810	-	8.810	8.462	8.579	8.722	8.886	-	-
H44: *Adv Sensors Research*	-	9.403	10.342	9.810	-	9.810	7.714	7.664	7.742	8.000	-	-
H45: *Air Mobility*	-	2.275	2.550	2.303	-	2.303	2.345	2.377	2.417	2.463	-	-
H47: *Applied Physics Rsch*	-	4.838	5.268	5.306	-	5.306	5.200	5.271	5.360	5.460	-	-
H48: *Battlespace Info & Comm Rsc*	-	19.563	21.545	25.320	-	25.320	25.633	25.821	25.662	23.909	-	-
H52: *Equip For The Soldier*	-	1.056	1.146	1.103	-	1.103	1.124	1.137	1.156	1.179	-	-
H57: *Single Investigator Basic Research*	-	69.342	80.342	81.245	-	81.245	87.862	89.077	88.046	93.767	-	-
H66: *Adv Structures Rsch*	-	1.853	2.017	2.006	-	2.006	2.044	2.068	2.102	2.142	-	-
H67: *Environmental Research*	-	0.935	1.030	0.903	-	0.903	0.920	0.931	0.946	0.965	-	-
S13: *Sci BS/Med Rsh Inf Dis*	-	11.172	10.696	11.005	-	11.005	11.248	11.378	11.560	11.789	-	-
S14: *Sci BS/Cbt Cas Care Rs*	-	8.794	9.167	10.553	-	10.553	9.827	9.970	10.141	10.325	-	-
S15: *Sci BS/Army Op Med Rsh*	-	5.013	7.366	6.815	-	6.815	6.636	6.720	6.831	6.961	-	-
T22: *Soil & Rock Mech*	-	3.951	4.577	5.704	-	5.704	4.484	4.548	4.624	4.710	-	-
T23: *Basic Res Mil Const*	-	1.618	1.772	2.102	-	2.102	1.733	1.757	1.787	1.820	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army													Date: March 2014
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601102A *I DEFENSE RESEARCH SCIENCES*								
T24: *Signature Physics And Terrain State Basic Research*	-	1.424	1.600	2.005	-	2.005	1.635	1.655	1.681	1.715	-	-
T25: *Environmental Science Basic Research*	-	5.620	7.171	7.303	-	7.303	7.028	7.129	7.251	7.385	-	-
T63: *Robotics Autonomy, Manipulation, & Portability Rsh*	-	1.760	1.990	7.000	-	7.000	7.286	7.218	7.443	8.140	-	-
T64: *Sci BS/System Biology And Network Science*	-	2.726	2.958	2.398	-	2.398	2.952	2.996	3.048	3.102	-	-
VR9: *Surface Science Research*	-	1.717	2.009	2.500	-	2.500	2.239	2.273	2.312	2.354	-	-

The FY 2015 OCO Request will be submitted at a later date.

Note

FY 13 decreases attributed to Congressional General Reductions (-397 thousand); SBIR/STTR transfers (-4.168 million) and Sequestration Reductions (-16.925 million)

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 U.S. Army Research Laboratory (ARL), Adelphi, MD; the U.S. Research, Development and Engineering Command (RDECOM), Aberdeen, MD; the U.S. Army Medical Research and Materiel Command (MRMC), Ft. Detrick, MD; the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army					Date: March 2014
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 1: *Basic Research*		R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*			
B. Program Change Summary ($ in Millions)	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO**	**FY 2015 Total**
Previous President's Budget	219.180	221.901	224.167	-	224.167
Current President's Budget	197.690	221.783	238.167	-	238.167
Total Adjustments	-21.490	-0.118	14.000	-	14.000
• Congressional General Reductions	-0.397	-0.118			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-4.168	-			
• Adjustments to Budget Years	-	-	14.000	-	14.000
• Other Adjustments 1	-16.925	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) 305 / *ATR Research*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
305: *ATR Research*	-	2.028	2.280	2.003	-	2.003	2.041	2.067	2.102	2.142	-	-

The FY 2015 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 U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the U.S. Army Edgewood Chemical Biological Center (ECBC).

Work is this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0606270A (Electronic Warfare Technology)/Project 906 (Tactical Electronic Warfare Applied Research).

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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: ATR Algorithms	1.229	1.338	1.218
Description: Investigate new algorithms to improve aided/unaided target detection and identification.			
FY 2013 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 305 / *ATR Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Investigated methods for object and event detection and classification using multimodal and hyperspectral imaging sensors to support Data-to-Decision capabilities; and conducted research for optimal sensor fusion and novel feature selection techniques to enhance Automatic Target. ***FY 2014 Plans:*** Investigate methods for human detection, cross-modality face recognition, and robust spectral signature analysis to enhance Data-to-Decision capabilities; and develop ATR algorithms insensitive to signature variations and environmental changes. ***FY 2015 Plans:*** Will investigate methods for automatic human and vehicle activity detection and classification, and multimodal biometrics for improved situational understanding and reduced soldier workload; research methods to select relevant data for enhanced decision making; and develop machine learning algorithms for scene understanding.			
Title: Tagging, Tracking and Locating (TTL) ***Description:*** Conduct basic research to support advances in state-of-the-art clandestine (Transistor-transistor logic) 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 directly supports the U.S. ARL's efforts in applied research and the U.S. Army CERDEC's advanced research in clandestine TTL. ***FY 2013 Accomplishments:*** Investigated and designed advanced algorithms, components, sensors, and techniques applicable to Transistor-transistor logic (TTL); assessed the use of inherent target signatures including hyperspectral signatures to provide enhanced TTL standoff capabilities; further investigated the application of nanotechnology and microelectromechanical systems (MEMS) to TTL technologies; examined advanced technologies across the electromagnetic spectrum including ultraviolet, infrared, and radio frequency for enhanced range performance and covertness; and advanced flexible electronics and non-cooperative biometric identification for TTL applications. ***FY 2014 Plans:*** Develop multimodal methods to monitor, extract and disseminate information related to targets' changing characteristics and the means to influence target behavior to create measurable signatures of interest; and 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. ***FY 2015 Plans:***	0.799	0.942	0.785

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 305 / *ATR Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will investigate methods for robust location and tracking of vehicles in surveillance and wide area motion images in the presence of occlusions using augmented three-dimensional terrain maps; investigate virtual tags for tracking humans using hyperspectral signatures; and investigate electromagnetic sensor and processing techniques to extract target characteristics from new signatures and exploit vulnerabilities.			
Accomplishments/Planned Programs Subtotals	2.028	2.280	2.003

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) 31B / *Infrared Optics Rsch*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
31B: *Infrared Optics Rsch*	-	2.621	2.859	3.307	-	3.307	2.860	2.896	2.942	2.999	-	-

The FY 2015 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. This 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 midwavelength IR lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semiconductor 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 U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC).

Work in this project supports key Army needs and provides the technical underpinning to several Program Elements (PEs)to include PE 0602709A (Night Vision Technology)/Project H95 (Night Vision and Electro-Optic 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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 31B / *Infrared Optics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Electro-Optic Materials Research, RF Photonics for Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance(C4ISR), and Photonics Research for Electronic Warfare	2.621	2.859	3.307

Description: Conduct research into infrared focal plane arrays (IR FPAs), radio-frequency (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 2013 Accomplishments:
Advanced investigations of environmental effects on radio-frequency (RF) photonic devices and reduced their vibration and temperature sensitivity for improved reliability; experimentally validated the RF-photonic time domain signal auto-correlation processor for signals intelligence applications; developed nano-photonic devices and nano-fabrication techniques for chip-scale opto-electronic integrated circuit devices with reduced size, weight and power; investigated plasmonic materials, metamaterials, photonic crystals and resonating materials on the quantum efficiency of Quantum Well Infrared Photodetectors (QWIPS); extended 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 FPAs; and investigated possible methods of improving power output of quantum cascade lasers with potential transition to infrared countermeasures applications.

FY 2014 Plans:
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; 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; establish a 3-dimensional, finite element electromagnetic model to calculate quantum efficiency (QE) for any infrared detector structures; design novel semiconductor metastructure photonic devices to provide the basic building blocks for future chip scale processing; investigate frontier optical effects to design high QE detectors;and improve power output of quantum cascade lasers.

FY 2015 Plans:
Will grow and characterize new long-wave infrared (LWIR) bulk semiconductor materials used in new detector designs with potential for low-cost, high performance applications; investigate the physical limitations in a variety of RF-Photonic signal generation, transport, and processing schemes to optimize system resolution and bandwidth for C4ISR applications (e.g., position, navigation, and timing applications) that require very high phase precision; investigate optical and physical properties of novel semiconductor metamaterial and metastructure devices for applications such as chip scale chem/bio sensors and lighter and

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 31B / *Infrared Optics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
cheaper radios; and study electro-optical (EO) modulator based on nano-crystal silicon for next generation high speed chip scale communication.			
Accomplishments/Planned Programs Subtotals	2.621	2.859	3.307

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) 52C / *Mapping & Remote Sens*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
52C: *Mapping & Remote Sens*	-	2.191	2.258	2.004	-	2.004	2.042	2.068	2.102	2.142	-	-

The FY 2015 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 2013	FY 2014	FY 2015
Title: Sensor Phenomenology and Spatial-Temporal Pattern Discovery	2.191	2.258	2.004
Description: Funding provided for the following research.			
FY 2013 Accomplishments: Investigated a multi-parameter soil metabolic index to understand environmental impacts on emerging biological sensing; constructed primitives to aid in efficiently solving concurrent complex queries in hierarchically represented spatial-temporal data; validated new infrasound signal propagation models against collected data applicable to remote assessment of hostile activity.			
FY 2014 Plans: 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			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 52C / *Mapping & Remote Sens*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. ***FY 2015 Plans:*** Will investigate aerosol effects on the integrity of Light Detection and Ranging (LiDAR) signals to improve signal and data collection capabilities; will explore methods of describing objects in massive unstructured datasets through novel machine learning techniques to advance Big Data capabilities; will investigate multi-source signal decomposition and characterization from single acoustic sensors to increase monitoring capabilities; will theorize metrics for the quantification of adaptive capacity of human populations resulting from environmental change to monitor instability.			
Accomplishments/Planned Programs Subtotals	2.191	2.258	2.004

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) 53A / *Battlefield Env & Sig*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
53A: *Battlefield Env & Sig*	-	3.302	3.570	2.610	-	2.610	3.777	3.824	3.889	3.964	-	-

The FY 2015 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.

Work in this project supports key Army needs and provides the theoretical underpinnings for Program Element (PE) 0602784A (Military Engineering Technology)/Project H71 (Meteorological Research for Battle Command).

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 2013	FY 2014	FY 2015
Title: Research in optical and acoustical propagation in the atmosphere	1.937	2.110	-

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 53A / *Battlefield Env & Sig*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. ***FY 2013 Accomplishments:*** Investigated how bioaerosol properties change with different atmospheric conditions (sunlight, humidity, oxidizing agents, etc.) so that these properties can be added to transport and dispersion models for force protection and mission planning; measured fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents to enable more accurate assessments of the capabilities of biowarfare agent detectors; investigated Raman spectra of individual airborne bioparticles to provide increased capability for characterizing atmospheric particles; established 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; extended 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; and improved 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:*** Investigate and model atmospheric water vapor impacts on THz band communications propagation statistics for digital link quality for U.S. Army Aviation and Missile Research, Development and Engineering Command (AMRDEC) covert local wireless communications technology applications. 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 ***Description:*** Increase survivability and improve situational awareness for a variety of sensors, optics and flying objects (projectiles, unmanned aircraft systems, 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 2013 Accomplishments:*** Enhanced the three dimensional (3-D) Atmospheric Boundary Layer Environment (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; improved 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; and investigated using Weather Research & Forecasting-based Weather Running Estimate-Nowcast (WRE-N) forecast/local now-cast model output as	1.365	1.460	2.610

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 53A / *Battlefield Env & Sig*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
initial conditions to improve the fidelity and accuracy of predictions from the boundary layer 3-D ABLE model for high resolution meteorology in complex terrain. ***FY 2014 Plans:*** Formulate and evaluate numerical methods to improve ABLE model performance for Army decision aid applications; 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; and investigate and develop an experimental hybrid data assimilation approach to improve fine-scale weather forecast performance. ***FY 2015 Plans:*** Will finalize and implement an experimental hybrid data assimilation approach into microscale and mesoscale numerical weather prediction models to improve fine-scale weather forecast performance; research options for implementing a computationally efficient WRE-N model to produce localized probabilistic forecast grids suitable for tactically-deployed unit hosting; explore novel approaches for developing an agile feedback loop that incorporates model-driven sensing and collection, and uses boundary layer sensing for near real-time model adaptation and corrected predictions; and determine feasibility of atmospheric energy harvesting for small scale applications.			
Accomplishments/Planned Programs Subtotals	3.302	3.570	2.610

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) 74A / *Human Engineering*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
74A: *Human Engineering*	-	7.576	8.409	14.614	-	14.614	13.411	13.422	13.051	11.066	-	-

The FY 2015 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 that improves Soldier-system performance in future force environments by looking at 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 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.

Work in this project supports key Army needs and provides the technical underpinnings to several PEs to include PEs 0601104A (University and Industry Research Centers)/Project H09 (Robotics Collaborative Technology Alliance) and 0602716A (Human Factors Engineering Technology)/H70 (Human Factors Engineering System Development).

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 U.S. Army Research Laboratory (ARL), Human Research and Engineering Directorate, Aberdeen Proving Ground, MD.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 74A / *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Research to Characterize and Enhance Soldier Performance	2.022	2.025	2.883
Description: Characterize and enhance human auditory performance of the dismounted warrior in complex environments while protecting the hearing of the Soldier. ***FY 2013 Accomplishments:*** Investigated 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:*** Quantify the effects of compression type on relative distance perception when wearing tactical communication and protection systems (TCAPS). ***FY 2015 Plans:*** Will conduct Soldier-oriented research to understand the auditory conditions that lead to misinterpretation of auditory events in a complex sensory environment; quantify and describe spatial range across which detection of auditory location changes are unlikely to be detected; and characterize the environmental elements and contexts that may be vulnerable to misinterpretation.			
Title: Soldier performance	1.881	2.656	2.531
Description: Conduct fundamental research on human performance in military-relevant environments to include operations, command, and training. Use approaches such as computational cognitive modeling and social network analyses to investigate the factors affecting the information flow, situational understanding and prediction, and technology-mediated collaboration under conditions of stress and uncertainty. Determine the environmental and context factors affecting performance, learning, and retention in immersive and simulated environments; establish realism/fidelity boundary conditions for perceptual, cognitive, and physical parameters for experimentation and for training. ***FY 2013 Accomplishments:*** Continued to transition cognitive model-based architecture knowledge for robotics control to the Robotics Collaborative Technology Alliance (PE 0601104/project H09) and the ARL Robotics enterprise; developed a generic long-term memory capability to store collections of environmental data sets; advanced object recognition and tracking; and switched 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:*** Enhance 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			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 74A / *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
processing; perform engineering evaluation tests of key autonomous robotic functions for navigation, object recognition, short- and long-term memory, and understanding and acting on verbal operator commands through natural language processing; 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 implementing techniques for capturing those behaviors using an enhanced version of the computer model Command, Control and Communications Technologies for Reliable Assessment of Concept Execution (C3TRACE), which will allow development of a "network sandbox"; and conduct research investigating the effects of operationally relevant stressors on Soldier performance during tactical operations (for the cognitive readiness initiative). ***FY 2015 Plans:*** Will further the development of human performance information processing models addressing network challenges using formal mathematical approaches and task-network modeling and simulation to integrate information across network layers for better information management and planning; establish a theoretical foundation for human networking behavior yielding testable predictions for laboratory experiments (modeling effort); continue the development of object recognition of places and objects (cognitively-inspired intelligent robotic technology); leverage the results of industry efforts in shape recognition features; conduct experiments in realistic contexts with human interaction; conduct experiments to fill data voids and develop models describing and able to predict the key simulation parameters affecting perception, cognition, and physical performance independently (simulation and training); and outline experimentation required to determine simulation parameters affecting the interactions across perception, cognition, and physical performance.			
Title: Translational Neuroscience ***Description:*** Integrating neuroscience with traditional approaches to understanding Soldier behavior to enable systems designs that maximize Soldier performance. ***FY 2013 Accomplishments:*** Investigated sensory and motor neural processes with respect to effect on Soldier-systems within dynamic environments; examined validation techniques for measures of task performance in operational environments to develop future Soldier metrics; and evaluated efficacy of predictive metrics for neural processing and/or cognitive performance among individuals for quantifying cognitive loads. ***FY 2014 Plans:*** Enhance neuroimaging technologies for increased resolution, greater wearability by Soldiers, and enhanced interpretability of neural signatures in realistic environments; and investigate the relationships between neuromodulators, brain electrical activity, and behavior for improved understanding of Soldier neurocognitive function. ***FY 2015 Plans:***	2.412	2.455	4.200

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 74A / *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will develop and refine active machine learning algorithms for improving the task performance of brain-based technologies that combine neural signals extracted from the Soldier with semi-autonomous computer systems; examine effects of environmental context on cognitive brain state assessments; explore analytical approaches for interpreting brain activity in unstructured tasks; and investigate how different signal processing approaches affect the detection of brain network signal estimates in order to support future development of brain-based technologies.			
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. Beginning in FY15, will be incorporated into Translational Neuroscience. ***FY 2013 Accomplishments:*** Explored neural representations and developed novel measures for assessing individual differences in decision making, cognitive performance, and/or anatomical structure; and explored network connectivity measures and patterns in both model simulations and empirical datasets. ***FY 2014 Plans:*** Investigate sensitivity of identified individual difference measures to variability in performance across individuals, tasks, and cognitive states; and evaluate predictive capability of structural networks and/or functional processing for individualized performance assessment.	1.261	1.273	-
Title: Human System Integration – Cybernetics ***Description:*** Apply a cybernetic approach (theoretical study and comparison of communication and control processes in biological and artificial systems) to human systems integration to achieve tighter control of devices and communication among humans and between machines and humans. Use social, computational, and information approaches to extend the scope of interaction beyond individual systems to the full network context. ***FY 2015 Plans:*** Will determine areas of convergence for cognitive, social, information and computational sciences to develop and apply the cybernetic approach to human centered design of complex systems; invoke neural, information, and social-cybernetic modeling approaches to identify and begin to address the human system integration gaps at the millisecond level and at the team level; examine issues in the design and implementation of cybernetic systems that will enable leveraging of the human nervous system's abilities to integrate, interpret, and utilize multimodal information in the sensory-perceptual-motor decision-making cycle; conduct	-	-	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 74A / *Human Engineering*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
research using novel paradigms, such as wearable computing and augmented reality technologies to identify key temporal and context parameters in multi-sensory integration; and lay foundation for scaling up to societal-level cybernetics.			
Accomplishments/Planned Programs Subtotals	7.576	8.409	14.614

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) 74F / *Pers Perf & Training*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
74F: *Pers Perf & Training*	-	6.309	5.716	5.321	-	5.321	5.498	5.580	5.675	5.778	-	-

The FY 2015 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 provides the funding to develop innovative theories, models, and methods to improve personnel assessment, training, and leader development, as well as provide a better understanding of individual, unit, and organizational behavior and performance within the context of complex organizational and operational environments. The research within these domains will enable advances in psychometrics to support the development of the next generation of psychological assessments for selection, classification, and assignment. The research also will target how to improve the assessment of difficult-to-measure skills and enable theoretical advances to inform and support the accelerated development of complex cognitive and social skills. This research lays the foundation for future applications that address the behavioral and organizational dynamics that impact Army flexibility, effectiveness, and resilience.

Work in this project 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 Human Capital Strategy.

Work in this project is performed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Ft. Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Personnel Measures (previously Human Behavior)	4.471	3.906	1.800
Description: Funding is provided for basic research to develop innovative theories, models, and methods to improve personnel assessment, training, and leader development. In FY15, funds within this Project are realigned to better reflect current efforts.			
FY 2013 Accomplishments: Developed data-driven models to assess the impact of training methods on task performance; identified approaches to enhance experiential learning for guided self-development; and investigated tacit acquisition of cultural knowledge.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** 74F / *Pers Perf & Training*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Investigating factors that influence on-the-job learning; identifying predictors of leader development and retention; and identifying contextual facets that influence decision making. ***FY 2015 Plans:*** Will initiate the development of measurement theory and performance-based measurement methods to improve selection, classification, and assignment.			
Title: Climate, Readiness, and Resilience (previously Human in Complex Organizations) ***Description:*** Funding is provided for basic research that will provide a better understanding of individual, unit, and organizational behavior and performance within the context of complex organizational and operational environments. In FY15, funds within this Project are realigned to better reflect current efforts. ***FY 2013 Accomplishments:*** Investigated organizational leadership as transmitted through social network links; developed models of unit cohesion within multi-level organizational units. ***FY 2014 Plans:*** Conducting research to understand social and organizational network variables that affect contextual control; developing real-time assessment and feedback mechanisms to shape group relationships. ***FY 2015 Plans:*** Will initiate research to develop group and organizational measures of organizational cohesion, resilience, and effectiveness.	1.838	1.810	3.521
Accomplishments/Planned Programs Subtotals	6.309	5.716	5.321

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) F20 / *Adv Propulsion Rsch*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F20: *Adv Propulsion Rsch*	-	3.886	4.253	4.108	-	4.108	4.184	4.239	4.309	4.391	-	-

The FY 2015 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 provides the technical underpinnings for Program Element (PE) 0602211A (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 U.S. Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Thermal Materials	2.303	2.519	2.400
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 2013 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** F20 / *Adv Propulsion Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Determined 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:*** Investigate surface engineering techniques to reduce engine and transmission friction losses for improved vehicle fuel economy, reduced maintenance cost, and reduced logistic burden; and establish the capabilities to assess high temperature materials and components for next-generation Army wheeled tactical and combat vehicle power train concepts. ***FY 2015 Plans:*** Will conduct thermo-mechanical fatigue experiments on new bulk ceramic materials, polymer composites, and metal alloys to enable reduced production/maintenance costs, and to achieve increased performance factors with improved temperature capability; and develop advanced computational damage models and conduct mechanical diagnostics experiments to improve the understanding of failure progression and diagnostics in drive train mechanical components, such as gears and bearings.			
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 2013 Accomplishments:*** Established the capability to experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions in order to optimize combustion performance in future engine concepts. ***FY 2014 Plans:*** Experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions to optimize combustion performance; use modeling and simulation coupled with experimentation to assess unmanned vehicle engines fueled with JP-8 and other heavy fuels; and evaluate the performance of Army unmanned vehicle engines and small heavy fuel injectors to enable heavy fuel operability and to optimize performance and efficiency. ***FY 2015 Plans:*** Will evaluate transient spray and combustion characteristics of heavy fuel injectors under simulated engine conditions to optimize engine combustion, performance, and efficiency; and develop more accurate and reliable modeling and simulation tools to predict spray and combustion characteristics under complex fluid dynamics conditions that will enable effective design of small engines for a range of Army applications.	1.583	1.734	1.708
Accomplishments/Planned Programs Subtotals	3.886	4.253	4.108

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** F20 / *Adv Propulsion Rsch*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) F22 / *Rsch In Veh Mobility*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F22: *Rsch In Veh Mobility*	-	0.553	0.612	0.701	-	0.701	0.713	0.723	0.736	0.749	-	-

The FY 2015 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, vehicle control, 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.

Work in this project provides the theoretical underpinnings for PE 0602601A (Combat Vehicle and Automotive Technology).
Work in this project is performed by the Tank and Automotive Research, Development and Engineering Center (TARDEC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Advanced Mathematical Algorithms for Improved Vehicle Efficiency	0.553	0.612	0.701
Description: Funding is provided for the following effort: ***FY 2013 Accomplishments:*** Researched ignition under high pressure injection conditions, and analyzed heat release data for synthetic JP-8 fuel; researched importance sampling techniques for accelerated testing for reliability quantification under stochastic input conditions; explored quantification of model uncertainty with enhanced identification ability; and researched mobility models for small robot terra-mechanics, i.e. the interaction of wheeled or tracked vehicles on various surfaces. ***FY 2014 Plans:*** 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). ***FY 2015 Plans:*** Will research new physics based analytical tools for more accurately and rapidly predicting vehicle terrain interaction effects; will explore new methodologies/relationships for improving intelligent mobility including latency.			
Accomplishments/Planned Programs Subtotals	0.553	0.612	0.701

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** F22 / *Rsch In Veh Mobility*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) H42 / *Materials & Mechanics*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
H42: *Materials & Mechanics*	-	7.865	8.902	9.308	-	9.308	8.662	8.784	8.933	9.098	-	-

The FY 2015 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 (e.g., 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 supports key Army needs and provides the technical underpinnings for several Program Elements (PE) to include PE 0602105A (Materials Technology)/ Project H84 (Materials) and PE 0602786A (Warfighter Technology)/H98 (Clothing & Equipment 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 U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2013**	**FY 2014**	**FY 2015**
Title: Microscopic/Nanostructural Materials	2.210	2.615	2.608
Description: Devise new materials and design capabilities based upon fundamental concepts derived at the microscopic and nanostructural levels for the future force.			
FY 2013 Accomplishments: Researched novel composite materials that demonstrate self-healing capability using bio-engineered concepts emerging basic research; and advanced the principles of inverse materials design and applied to emerging material models for future armor designs.			
FY 2014 Plans: 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			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H42 / *Materials & Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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; improved adhesion bioinspired polymer adhesives for composite armors. ***FY 2015 Plans:*** Will create numerical models and experimental techniques to design energy-absorbing, adaptive, damage-tolerant nanocomposites; develop new paradigms for thermodynamically stable nanostructured materials systems that overcome traditional property trade-offs; and pursue revolutionary new polymeric building block materials for structural, membrane, sensor, and power/energy applications.			
Title: High Deformation Rate Materials ***Description:*** Develop fundamental understanding necessary to design, process and characterize materials specifically intended for high loading rate applications, as in armor and armaments. ***FY 2013 Accomplishments:*** Developed models to describe specific strengthening mechanisms for novel aluminum alloys and used to cast coupon-scale ingots for experimental validation; and developed synthesis, processing and characterization methods specifically designed for materials in extreme dynamic environments. ***FY 2014 Plans:*** Investigate 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; and complete an initial three dimensional (3-D) microstructural model of lightweight magnesium or aluminum alloys. ***FY 2015 Plans:*** Will develop multiscale, multidisciplinary models and related experimental techniques to elucidate fundamental physics of materials response to include: thermoelastic, yield, failure, and fracture behavior at high deformation rates; create novel experimental research tools to enable the study of these high deformation rate phenomena with greater resolution; incorporate microstructural and high deformation response into robust multiscale computational codes; and begin to create new materials specifically designed to enhance performance at high deformation rates in applications ranging from armor to new armaments.	2.802	3.113	3.400
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.	2.853	3.174	3.300

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H42 / *Materials & Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
FY 2013 Accomplishments: Developed novel polymeric materials which are thermally and chemically stable under extreme operating conditions; investigated and developed modeling and simulation methods specifically designed for materials used in extreme dynamic environments. ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will develop an integrated computational materials science capability that clarifies relevant physical mechanisms and enables the rational design of small scale (nanoscale) and bio-inspired building blocks; utilize thermodynamic and kinetic studies of self-assembly processes to design, create, and characterize nanostructured surfaces and interfaces; and create and utilize small scale materials characterization techniques to further the fundamental understanding of small scale materials and processes.			
Accomplishments/Planned Programs Subtotals	7.865	8.902	9.308

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) H43 / *Research In Ballistics*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
H43: *Research In Ballistics*	-	8.299	9.378	8.810	-	8.810	8.462	8.579	8.722	8.886	-	-

The FY 2015 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 supports key Army needs and provides the theoretical unerpinnings to several Program Elements (PEs) to include PE 0602618A (Ballistics Technology)/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 U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, Adelphi, MD, and Research Triangle Park, NC.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Advanced Energetics Initiative	2.689	3.011	3.600
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 2013 Accomplishments: Extended quantum mechanical based models to enable prediction of key performance and vulnerability properties; determined feasibility of nontraditional energetic materials containing stored structural energy (e.g., extended solids), and identified factors influencing stabilization for designing future disruptive energetic materials.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H43 / *Research In Ballistics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Synthesize and fabricate gram quantities of disruptive energetic materials that have two-fold energy content compared to conventional explosives; 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; and refine and validate existing model via comparison with nano-indentation experiments. ***FY 2015 Plans:*** Will exploit material micro/nanostructure, high pressure synthesis, and managed energy release mechanisms to develop energetic materials with 2-10 times the energy content of conventional explosives; further advance theory required to develop accurate descriptions and models of condensed phase processes, quantum mechanical reactive potential energy surfaces, shock impact, initiation and detonation phenomena, and ignition and combustion; and further develop synthetic capabilities to produce high-nitrogen containing materials.			
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 2013 Accomplishments:*** Developed and validated 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; characterized theoretically and experimentally coupled global positioning system (GPS) and navigation concepts for the next generation of highly dynamic, spinning projectiles; and investigated the fundamental mechanical interaction of human brain tissue with shock waves that occur during ballistic events. ***FY 2014 Plans:*** 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 increase maneuverability for next generation, low cost, hyper-accurate munitions; add structural dynamics model to simulate guided maneuvers and unsteady effects; and 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). ***FY 2015 Plans:*** Will further development of computational aerodynamics capabilities, coupled with the development of next-generation guidance, navigation, and control solutions to enable new paradigms in maneuverability to achieve ultrahigh precision.	1.599	1.768	1.710
Title: Extramural Research in Non-Lethal (NL) Control Methods	1.061	1.275	-

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H43 / *Research In Ballistics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Description: Extramural research in NL control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. ***FY 2013 Accomplishments:*** Studied the decomposition pathways of energetic materials to elucidate the molecular decomposition behavior at the individual molecule scale; created new approaches and methods to reduce effects of complex noise and missing data for exploiting sparse hyperspectral and multimodal data; and established 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:*** 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 2013 Accomplishments:*** Developed the capability to measure electromechnical stress in very small samples deforming at very high strain rates and explored the effects of high magnetic field on the stress response within these deforming solids; and developed fundamental underpinnings of the electrical conductivity within the shock cone that forms around hypervelocity penetrators. ***FY 2014 Plans:*** 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; advance computational models by exploring dynamic effects in three dimensions (3-D); and 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. ***FY 2015 Plans:*** Will establish capabilities to extract electron temperature data from time resolved imaging spectroscopy measurements of shaped charge jet induced plasma for comparison to numerical simulation predictions; develop hierarchical multiscale methodology for transfer of relevant information from mesoscale computation to macroscale constitutive and failure models; and develop coupled finite element and physiological numerical modeling methods to evaluate the dynamic response of the human head as a structure under short-time blast loading to enable effective design of protection concepts.	2.950	3.324	3.500
Accomplishments/Planned Programs Subtotals	8.299	9.378	8.810

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H43 / *Research In Ballistics*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) H44 / *Adv Sensors Research*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
H44: *Adv Sensors Research*	-	9.403	10.342	9.810	-	9.810	7.714	7.664	7.742	8.000	-	-

The FY 2015 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 supports key Army needs and provides the theoretical underpinnings to several Program Elements (PEs) to include PE 0602786A (Warfighter Technology)/Project H98 (Clothing & Equipment Technology).

Work in this project complements and is fully coordinated with research at the U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC), the U.S. Army Natick Soldier RDEC (NSRDEC) and the U.S. Army 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.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H44 / *Adv Sensors Research*

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Adaptive, Active, and Intelligent Optical Systems	1.687	1.860	1.810
Description: Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. ***FY 2013 Accomplishments:*** Investigated and developed 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; developed novel processing techniques to extend the use of quantum imaging to tactical environments in order to improve battlefield communications. ***FY 2014 Plans:*** 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); and 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. ***FY 2015 Plans:*** Will complete the optimization of the pointing, acquisition, and tracking sub-systems of the Free-Space Optical (FSO) networked multi-gigabit communication system; conduct a performance evaluation of the FSO and its related control software; and develop ARL visible light multispectral quantum imager capable of imaging through turbulence and demonstrate its capability in turbulence and low light field experiments to beyond 1 km.			
Title: Improving Sensor and Photonics Research (Nano)	2.554	2.817	3.000
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 2013 Accomplishments:*** Developed sensor fusion algorithms to enable the aggregation of data features into information within the context of data-to-decision (D2D); developed theoretical understanding of metaferrites (using analytical and computer simulations) as an enabling technology for low-profile and embedded antenna enhancements; analyzed and developed algorithms to exploit co-registered video and radar imagery to enhance detection of landmines and IEDs with reduced false alarms; enhanced acoustic sensor			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H44 / *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
and array performance through wind mitigation and adaptive algorithms for improved event classification; evaluated conductive organic materials and high stability organic light emitting diode (OLEDs) for transition into OLED displays and emerging sensor applications; and developed noise resistant magnetic sensors to improve signal-to-noise ratio (SNR) and detection range for counter IED technologies. ***FY 2014 Plans:*** 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. 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; 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); and research organic devices and materials and diodes for large-area radiation and particle sensors utilizing charge-transfer electro-chemical designs. ***FY 2015 Plans:*** Will research methods to improve acoustic classification robustness in diverse environments; study a physics-based tracker algorithm for extremely long-range infrasound (low-frequency sound) detections; research methods to improve sensitivity and miniaturize interface of magnetic tunnel junction sensor sensitivity and interface for reading non-erasable magnetic memory permeability bits of stored information; and investigate signal processing algorithms for exploiting flexible and adaptable low frequency ultra-wideband (UWB) waveforms that support stepped frequency radar technology.			
Title: Engineered Biotechnology ***Description:*** Use a multi-scale modeling approach to investigate biological systems to develop biologically-inspired sensors as well as bio-inspired power generation and storage techniques. ***FY 2013 Accomplishments:*** Evaluated biofilm contaminate-sensing genetic constructs against actual logistics fluid specimens for both JP-8 and potable water; manipulated bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterized the resulting complexes; transitioned to larger two dimenstional (2-D) assemblies appropriate for traditional electronic manufacturing; analyzed engineered strains against models for generation of organic fuels to evaluate information collected from systems biology approaches; investigated the improvement of advanced modeling techniques through the use of an iterative approach of multi-scale modeling and increased biological characterization; and examined genotype to phenotype relationship of laboratory bacterial cultures to determine a means for identification. ***FY 2014 Plans:***	2.822	3.108	-

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H44 / *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Use synthetic biology, building off of previous genetic sensing constructs, to engineer sense and respond module for neutralizing biological contamination; develop second generation peptide recognition elements using an iterative process involving computational modeling coupled with experimental characterization for materials that perform in extreme environments; use synthetic microbiology to engineer second generation strains for production commodity chemicals based upon predictions made in FY13; and 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	2.340	2.557	3.000
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. This efforts includes crosscutting research that leverages two 5-year Collaborative Research Alliances. ***FY 2013 Accomplishments:*** Conducted fundamental studies of materials to identify and model physics and atomic interactions that define their electronic and optical properties and characteristics; evolved 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 at interfaces and response under extreme conditions; evolved web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; and examined multi-scale computational science environment to facilitate coupling of different software programs/algorithms; advanced methods to support high performance computing users and software developers. ***FY 2014 Plans:*** Use FY13 results to design and expand 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; establish fundamental underpinnings of physics between nano- and meso-scales up to the continuum; continue to develop new multi-scale experimental techniques and characterization methods to probe materials microstructure, including defects and interfaces, and responses under extreme conditions; develop advanced computational models for multiscale modeling of electrochemical systems; 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; 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; and advance methods to support high performance computing users and software developers. ***FY 2015 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H44 / *Adv Sensors Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will continue to perform fundamental studies to identify and model the 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; validate multi-scale experimental techniques and characterization methods; continue to develop advanced computational models for multiscale modeling of electrochemical systems; 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; and conduct research in multi-scale computational sciences and couple different modeling paradigms at the algorithm level.			
Title: Bio-inspired Materials and Devices Research ***Description:*** Create synthetic biological materials for electronic devices and force protection. ***FY 2015 Plans:*** Will investigate the underlying biology that enables natural and synthetic biological materials and systems to monitor, control, enhance, and predict bacterial metabolism and products for improved logistics and force protection; study novel synthetic recognition reagents in response to new and emerging threats that possess superior performance, stability and adaptability; and research hybrid biological/electronic/photonic materials capabilities based on bio-engineered cellular machinery or specific properties of bio-interfacial chemistry.	-	-	2.000
Accomplishments/Planned Programs Subtotals	9.403	10.342	9.810

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H45 / *Air Mobility*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H45: *Air Mobility*	-	2.275	2.550	2.303	-	2.303	2.345	2.377	2.417	2.463	-	-

The FY 2015 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 provides the theoretical underpinnings for PE 0602211A (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 2013	FY 2014	FY 2015
Title: Rotary Wing Aerodynamics	2.275	2.550	2.303
Description: Funding is provided for the following effort			
FY 2013 Accomplishments: Experimentally investigated detailed helicopter wake structure for the existence of worm-like fluid phenomena seen in computational fluid dynamics (CFD) calculations; analytically / numerically investigated the oscillation encountered in CFD prediction for hover performance; and assessed the importance of the fuselage impedance on rotor blade structural loads and helicopter vibration.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H45 / *Air Mobility*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. Continue fundamental experiments aimed at the underlying physics of rotor downwash flow fields and rotorcraft testing techniques such as pressure sensitive paint. ***FY 2015 Plans:*** Will continue computational aero-science investigations aimed at developing novel numerical methods for rotorcraft unique flow phenomena and will continue fundamental aeromechanics experiments; will conduct an experimental investigation of rotor wake physics including worm-like flow instabilities; will investigate flow phenomena in unsteady flow separation; and will develop and improve testing techniques for aerodynamics / fluid flow such as pressure sensitive paint and particle image velocimetry.			
Accomplishments/Planned Programs Subtotals	2.275	2.550	2.303

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H47 / *Applied Physics Rsch*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H47: *Applied Physics Rsch*	-	4.838	5.268	5.306	-	5.306	5.200	5.271	5.360	5.460	-	-

The FY 2015 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; advanced battery materials, thermoelectric devices, 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 for more electric platforms, 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.

Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0602705A (Electronics and Electronic Devices)/Project H94 (Electronics & Electronic Devices). Work in this project complements and is fully coordinated with research at the U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC); and the U.S. Army 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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Nanoelectronic Devices and Sensors	2.954	3.235	3.006
Description: Conducts research for advanced battery materials; 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;			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H47 / *Applied Physics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
materials for 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 2013 Accomplishments:*** Experimentally validated multiscale models for electrochemical transport and charge transfer in electrochemical devices to optimize performance; investigated novel nanostructures for battery and fuel cell electrodes for increased efficiency; examined large area growth, material transfer, and substrate interactions of carbon based nanoelectronics for increased capabilities and reduced power consumption of battlefield electronics; investigated three dimensional (3-D) growth and patterning of piezoelectric materials for low power large displacement MEMS actuators; investigated methods and formulations for detonation using on-chip energetic materials; investigated emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications; characterized interference fringes using cold atoms on an atom chip; and investigated 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:*** 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; investigate and evaluate actuator designs using piezoelectric actuators using 3-dimensional growth and patterning techniques; investigate modes of propagation for on-chip energetic materials and determining factors that influence reaction rate; develop novel two-dimensional (2-D) material growth, characterization, transfer and processing technology and conduct experiments to achieve electronic device quality materials for nanoelectronics and supercapacitors; investigate solid electrolyte interphase (SEI) formation on silicon (Si) anodes for lithium (Li) ion batteries; investigate GaN for high power conditions by improving breakdown voltage and crystalline via reduced contaminants with improved electrical efficiency and associated thermal management; and investigate materials structures for catalyst activities for energy conversion. ***FY 2015 Plans:*** Will investigate transport of cold atoms along chip-scale wires for applications in inertial navigation in GPS denied environments and for applications in environmental sensing, including magnetometry; investigate integration of 3-D piezoelectric materials and processes with flexible substrate and circuit technologies for radio frequency (RF) MEMS and millimeter scale robotics; study and characterize the growth and electrical properties of stacked 2-D electronic materials for application to RF and/or logic devices; and refine the early development of on-chip energetic materials and processing for supplying slow, high temperature thermal sources.			
Title: Advanced Energy Science Research	1.884	2.033	2.300

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H47 / *Applied Physics Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. ***FY 2013 Accomplishments:*** Conducted research on the design, fabrication and characterization of material properties in coordination with modeling and theoretical computations for energy storage and conversion materials; investigated methods for developing multi-scale computational and simulation tools supporting the development of materials for electrochemical energy conversion and generation; designed and experimented 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, and energy conversion applications; and investigated advanced device architectures for thermoelectric and photovoltaic devices for increased energy conversion efficiency. ***FY 2014 Plans:*** Investigate wide-band gap semiconductor materials for direct photoelectrochemical production of hydrogen gas for use as fuel; and research novel device architectures for solar energy conversion. ***FY 2015 Plans:*** Will study the physical limits of wide-band gap materials for direct photoelectrochemical production of hydrogen for use as fuel; investigate the effect of plasmonic arrays on the catalysis of oxygen reduction and ethanol oxidation as alternative methods for fuel production; and develop advanced superconducting materials by metal organic chemical vapor deposition (MOCVD) processes to aid in energy conversion.			
Accomplishments/Planned Programs Subtotals	4.838	5.268	5.306

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H48 / *Battlespace Info & Comm Rsc*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H48: *Battlespace Info & Comm Rsc*	-	19.563	21.545	25.320	-	25.320	25.633	25.821	25.662	23.909	-	-

The FY 2015 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 addresses the areas of information assurance, 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. These C4I technologies must accommodate heterogeneous security infrastructures and information exchange/security mechanisms between multiple levels of security. The intelligent systems for C4I research focuses 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.

Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0602783A(Computer and Software Technology)/Project Y10(Computer/Information Science Technology).

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 Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Communication for Tactical Networks	1.635	1.822	1.900

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H48 / *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. ***FY 2013 Accomplishments:*** Developed 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 contributed 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:*** Develop a framework for modeling quality of information, which enhances communications by delivering more relevant information (enhancing decision making); research use of non-traditional communication technologies (optical & ultra-violet (UV)) to support connectivity in radio frequency (RF) challenged environments; and identify and develop limits, techniques and algorithms for unicast and multicast communications over hybrid networks (wired and wireless networks). ***FY 2015 Plans:*** Will conduct analysis, simulation, and experiments to develop new communications networking capability in harsh tactical environments (exploitation of low frequency communications, mobility and autonomy to maintain connectivity, and mapping connectivity regions to blend with mobility planning and sensing); develop quality of information theories based upon human-in-the-loop analysis; and develop mathematical representations for the quality of information of static and dynamic data and its effectiveness for situational awareness.			
Title: Data to Knowledge to Support Decision Making ***Description:*** Design and implement a laboratory-scale common information-processing infrastructure, inclusive of cloud computing for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. ***FY 2013 Accomplishments:*** Investigated 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:*** 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	2.377	2.653	2.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H48 / *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
cluster-based computing architectures; investigate techniques for adaptive data collection on collaborating mobile platforms to improve current decision making capabilities. ***FY 2015 Plans:*** Will research the effect of context-dependent information exploitation on the situation awareness of intelligence analyst and soldiers at the edge by constraining the problem domain in an effort to reduce computational complexity and increase accuracy of specific baseline algorithms; experimentally validate the value of information construct within a tactical military decision support system; and investigate algorithms for intelligent exploration and focused data collection in relevant environments using collaborative mobile platforms.			
Title: Information Protection for Mobile Ad-Hoc Networks (MANET)s ***Description:*** Perform research in protecting information in highly mobile wireless tactical environments, where networks must operate under severe bandwidth, energy, and processing constraints, and without reliance on centralized security services. Beginning in FY15, includes work previously conducted under Network Science for MANETs nd Tactical Communications. ***FY 2013 Accomplishments:*** Developed new security protocols suitable for use in hybrid networks by leveraging and integrating techniques of both wireless and wired environments. The new protocols contribute to novel capabilities that enable the Warfighters to detect and defeat malicious activities of adversaries on tactical networks and hosts in MANETs, with a special focus on mobility effects. ***FY 2014 Plans:*** Enhance security techniques and algorithms 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. ***FY 2015 Plans:*** Will develop security processes and techniques to provide information protection in mobile dynamic environments, where mobile devices are connected to coalition networks serving as forward-deployed devices at the edge; develop techniques to minimize energy required to support security functions; develop security protocols and processes for using tactical cloudlets as a shared resource among Warfighters and coalition forces; and develop and characterize algorithms for detection and analysis of adversarial malicious operations on networks that involve the above mentioned complexity of mobility, resource constraints, inconsistency and shared resources.	4.371	4.998	6.100
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.	1.050	1.169	1.100

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H48 / *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
FY 2013 Accomplishments: Developed 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:*** Investigate use of information extracted 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. ***FY 2015 Plans:*** Will identify and extract event-based information from large amounts of text written in different genres in different languages and dialects to support temporal and spatial relation analyses in situational awareness; and examine the extension of linguistics analysis techniques to image processing.			
Title: Network Science for MANETs and Tactical Communications ***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 Biotechnologies at the University of California, Santa Barbara (PE 0601104A/Project H05). In FY15 this effort is moved to Information Protection for MANETs. ***FY 2013 Accomplishments:*** Developed 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 support network technologies to enable Warfighters to anticipate and manage information, and social and communication effects, in network-enabled Mission Command. ***FY 2014 Plans:*** Develop methodologies, techniques and algorithms for the analysis of realistic finite networks, that will provide insights for the design and provisioning of tactical, mobile, ad-hoc networks to improve network performance; and 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.	0.923	1.027	-
Title: Advanced Computing ***Description:*** Investigate computing and networking architectures, algorithms, and visualization techniques to support advanced battle command applications for Command, Control, Communications, Computer, and Intelligence (C4I) systems.	3.358	3.756	3.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H48 / *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
FY 2013 Accomplishments: Implemented new scalable programming models for cloud-computing and performed benchmarking for the ARL Mobile Network Modeling Institute battle scenario of C4ISR-on the move. The advanced computing approaches support taking supercomputing as a deployable asset to the battlefield enhancing real-time Situational Awareness in tactical environments. ***FY 2014 Plans:*** Explore use of mathematical approaches that allow the prediction of certain outcomes using incomplete information and develop scenarios for verification and validation; and verify and validate scalable programming models and software developed for tactical computing concept. ***FY 2015 Plans:*** Will explore novel models to represent advanced computing coupled with real-time battlefield information processing while meeting tactically relevant turn-around and scheduling requirements and constraints; and extend models to include power and performance metrics as part of the wider knowledge base in forming an application signature-processor pairing that can be used to perform intelligent processor selection on a case-by-case basis.			
Title: Network Science Technology Experimental Center ***Description:*** Supports in-house Network Science studies in conjunction with the Network Sciences Collaborative Technology Alliance (PE 0601104A/Project H50). ***FY 2013 Accomplishments:*** Developed and validated approaches and techniques to characterize, assess, model, and predict the performance of a notional composite network;examined 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 contributed 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:*** Examine the interaction of social, informational and communication processes as they adapt to changes in mission, adversarial attacks and changes in tactics, and structure; begin designing and developing composite trust management tehniques and metrics that consider the interactions between social, information and communication networks; and begin developing techniques to model a hybrid network (wired and wireless). ***FY 2015 Plans:*** Expand the wireless emulation capabilities to include the interactions among communication, social, and information networks; continue to develop techniques for modeling the performance of hybrid networks; and develop, analyze and validate composite	5.849	6.120	5.220

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H48 / *Battlespace Info & Comm Rsc*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
trust management techniques and metrics that consider the interactions between social, information and communication networks. These efforts will provide improved understanding of tactical network behaviors, improved network designs, secure information flows and enhanced decision-making.			
Title: Quantum Information Sciences ***Description:*** Perform research to enable new techniques for ultra-precise navigation, timing, communications and imaging using atomitronics and spintronics (quantum measurement and sensing devices based upon atoms and spin, respectively, instead of electrons). Conventional techniques for sensing magnetic fields, gravity, and timing have reached a plateau in their performance, and will be severely impacted in future contested-battlefield environments. This research brings forth new insights regarding the use of quantum science to enhance Warfighter effectiveness. ***FY 2015 Plans:*** Will study physics of compact (wrist-watch scale) atom chips (an atom chip uses quantum properties of atoms to sense gravity and acceleration) needed for a precise position/navigation/timing (PNT) sensor; study fundamental atomic physics of quantum repeaters, for an eventual hybrid quantum communication system, based on transmission of single photons that are quantum mechanically entangled with quantum memories; and obtain new insights into "writing" and "reading" laser-cooled rubidium atoms to store and later retrieve a single photon from the atomic ensemble over long haul optical fiber.	-	-	5.000
Accomplishments/Planned Programs Subtotals	19.563	21.545	25.320

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H52 / *Equip For The Soldier*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H52: *Equip For The Soldier*	-	1.056	1.146	1.103	-	1.103	1.124	1.137	1.156	1.179	-	-

The FY 2015 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.

Work in this project provides theoretical underpinnings for PE 0602786A (Warfighter 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 is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Equipment for the Soldier	1.056	1.146	1.103
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 2013 Accomplishments: Explored different methods to extract a concise feature vector to describe the shape of the human body: implemented computational algorithms to extract the shape-vectors of three-dimensional (3D) scans from the US Army and Marine Corps 3D scan database; made 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:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H52 / *Equip For The Soldier*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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. ***FY 2015 Plans:*** Will examine thermal degradation mechanisms in selected natural materials as basis for potential flame/fire protection approaches; create nonwoven electrospun composites of unique composition and examine their properties and material behavior to provide foundation for robust, Soldier-based sensing of pathogens in food and ambient environment.			
Accomplishments/Planned Programs Subtotals	1.056	1.146	1.103

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H57 / *Single Investigator Basic Research*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H57: *Single Investigator Basic Research*	-	69.342	80.342	81.245	-	81.245	87.862	89.077	88.046	93.767	-	-

The FY 2015 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, training and simulation, 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.

Work is this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 62618A (Ballistics Technology)/Project H80 (Survivablity and Lethality Technology).

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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Basic Research in Life Sciences	7.768	8.190	8.300
Description: Pursues 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 investigating the physiology			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H57 / *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015

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 pursues studies in microbial physiology, ecology, and evolution, v) social science research aims to elucidate the social, cultural, and other influences to human actions, and vi) auditory and signal processing research to map the cognitive implications of multisensory information integration.

FY 2013 Accomplishments:

Efforts studied fundamental genetic and physiological properties that impact human cognitive and physical performance under normal and stressed conditions; explored mechanisms that control the organization of biomolecules, and novel approaches to support biological activity outside of the cellular environment; elucidated mechanisms of microbial adaptation and antimicrobial resistance; studied the fundamental physiology underlying cognition and novel non-invasive methods to monitor cognitive processes; and explored the basic theoretical foundations of human behavior across various temporal and spatial scales.

FY 2014 Plans:

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; 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; 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; 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; and 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.

FY 2015 Plans:

Will identify the genetic networks and epigenetic factors that enable the survival of bacteria in extreme stress conditions, which may reveal new insight into stress resilience and survival in eukaryotic organisms, and ultimately enable the engineering of microorganisms better suited to rugged industrial production conditions; expand studies of previously-demonstrated DNA assembly method to determine whether diverse nanostructured shapes can be carved from a common three dimensional (3-D) DNA block, which may provide a future template for generating hybrid materials with the advantages of both biological and synthetic systems; characterize the molecular dynamics and evolution of associative memory in bacteria, which will be an important step towards understanding microbial adaptation potential for use as a potential tool to be exploited for microbial

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H57 / *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
forensics analyses; and devise a model for the automated synthesis of neuro-cognitive computational models derived from brain activity to determine whether it is possible to mathematically link functional brain data to cognitive states, which could ultimately lead to new applications for assessing and improving Soldier mental performance such as battlefield training, and treatment of disorders such as post-traumatic stress diorder (PTSD).			
Title: Basic Research in Environmental Sciences ***Description:*** Basic research in the environmental sciences is needed for the Army to operate effectively because terrestrial and atmospheric conditions and processes affect virtually all aspects of Army activities. The earth's surface environment is a multifaceted and dynamic system, and there is an increasing need for multidisciplinary approaches to address important research questions within the atmospheric and terrestrial sciences. ***FY 2013 Accomplishments:*** Environmental sciences developed new approaches to improve the resolution and tradeoffs in high fidelity modeling of atmospheric and terrestrial physical processes; developed new approaches to spatially revise both theoretical and observational problems associated with the Monin-Obukhov theory; optimized and enhanced the performance of the sensor modalities used in unexploded ordnance (UXO), landmine, and explosive device detection; and developed constitutive models for near-surface processes. ***FY 2014 Plans:*** Pursue atmospheric examinations in the convective boundary layer using vertically pointing clear-air doppler radars and sodars to measure mean vertical velocities; and improve estimates of soil moisture 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. ***FY 2015 Plans:*** Will exploit recent theoretical and experimental advances in soft-matter physics to isolate and examine the granular dynamics of fluid-driven sediment transport, focusing on bed load transport in rivers.	3.028	3.774	2.000
Title: Basic Research in Chemical Sciences ***Description:*** Basic research to achieve advanced energy control, improved threat detection, and novel responsive materials for Soldier protection. Research efforts will lead to: light-weight, reliable, compact power sources, more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage, new approaches for shielding the Soldier and Army platforms from ballistic, chemical, and biological threats, and reducing signatures for identification by the enemy, and advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals. ***FY 2013 Accomplishments:***	8.640	9.418	9.600

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H57 / *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Conducted 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; explored 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; and explored 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:*** 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; 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 testing 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; and investigate electrochemical systems utilizing new materials with controllable structures and chemical properties that may ultimately enable lighter, more efficient batteries or fuel sources. ***FY 2015 Plans:*** Will investigate and characterize the ionic states of energetic compounds which will enable the design of safer (e.g. during transport and storage), more powerful explosives and propellants; identify fundamental mechanisms and properties that control the assembly and dissociation of supramolecular systems upon influence of external stimuli, such as toxic chemicals, enzymes, or changes in pH, which will ultimately lead to new capabilities for protection from, and inactivation of, chemical and biological warfare agents and toxic industrial chemicals; synthesize polymeric materials employing unique building motifs with the goal of creating a self-assembled complex ensemble - the ensemble's response to a variety of conditions will be used to determine how the state of the system can be controlled in a nonlinear manner, which may ultimately lead to new materials or coatings that can detect and repair defects; and probe transport processes in confined media to reveal an improved understanding of ion transport, which will provide new long-term applications such as fuel cell membranes with higher ionic conductivity to provide the Soldier with more effective portable power systems.			
Title: Basic Research in Physics	10.953	12.281	12.800
Description: Focuses on research in many subfields of physics, including condensed matter physics, optical physics, atomic and molecular physics and quantum information, with an emphasis on discovering new realms of quantum and optical phenomena. Pursuit of fundamental physics in these subfields provides new opportunities for future developments in superior optics, ultra-sensitive sensors, and novel electronic architectures for classical and quantum computing.			
FY 2013 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Investigated quantum optics of metamaterials including exploration of fundamentally new quantum effects including the photon spin and the interaction with negative index materials; explored the control of light filaments and long distance propagation; continued attempts to demonstrate a 25 atto-second laser pulse; began studies of high intensity laser light; designed and tested alternative cooling techniques for use on molecules not amenable to traditional laser-cooling approaches; investigated protected states of matter in condensed matter as well as atomic and molecular systems; investigated non-equilibrium states in ultra-cold atomic optical lattices; implemented and characterized multi-qubit states; researched methodology for the rational design of novel quantum many-body states in complex oxide heterostructures; identified the defect tolerance in a series of complex oxides; performed in-situ chemical analysis of complex oxides; and identified and characterized new candidate materials for topological insulators with strong electronic interactions. ***FY 2014 Plans:*** 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; 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; explore high-intensity lasers as a method for creating gamma ray beams that may ultimately obviate the need for conventional large, expensive, immobile, reactors or extremely hazardous reactive materials; 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; design and synthesize topological insulators (e.g., a novel type of material that changes electrical properties based on its three-dimensional structure); and 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. ***FY 2015 Plans:*** Will explore the infrared and optical responses of electrostatically-induced effects in correlated oxides, such as metal-to-insulator transitions, which may lead to advanced electronic technologies for sensing and computational hardware; investigate new synthetic physics in cold quantum gases, which will ultimately contribute to the development of cold-atom interferometers for ultra-accurate navigation and quantum computing applications for secure communication; detect single molecular ion spectra using laser-cooled atomic ions by exploiting previous research on trapped ions for quantum information science, which may ultimately lead to capabilities beyond what is possible with classical systems, such as resource optimization, optimal wargaming, efficient and secure command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) that will greatly benefit the DoD, airline, financial, and telecommunications industries; demonstrate and characterize microjoule-level laser pulse energies for 150 attosecond pulses in the 30-70 eV photon energy range (>1,000 times higher than the current world record), which may enable future applications in standoff explosives detection and sensing through obscurants.			
Title: Basic Research in Electronics and Photonics	9.854	10.905	11.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Description: Pursues discoveries in 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 2013 Accomplishments:*** Synthesized mercury cadmium selenide on gallium antimonide substrates and investigate its optical and structural characteristics for infrared detection; developed novel vertical cavity transistor lasers with high modulation rates; developed biologically-inspired RF direction finding antenna arrays and associated signal processing techniques based on the operation of the human auditory system; and investigated nanoscale constructs within cells and engineered nano-structures. ***FY 2014 Plans:*** Improve optical quality and coherency of mid infrared lasers to facilitate free space optical communications, ladar and infrared countermeasures; show feasibility of semiconductor-less infrared detection that utilizes electron tunneling; explore time-frequency and non-laplacian phenomena to understand and extend the fundamental performance limits of radio, radar, and electronic warfare systems; and develop terahertz frequency photomixing arrays with 10x improvement in output powers to enable the remote detection of chemical, biological and explosive threats. ***FY 2015 Plans:*** Will show independent tuning of the temperature coefficient of resistance and noise in bolometers to improve signal to noise ratio of room temperature infrared detectors; show electrically injected, high-speed 1.55 μm nanoscale lasers on a silicon (Si) platform for potential gains in energy efficiency of computational and sensor systems; show that plasmonic antennas can mitigate efficiency degradation of conventional antennas at terahertz and optical frequencies to investigate the potential of free-space interconnects for efficient data communications and energy harvesting; and create and investigate a novel sensor based on optical dark modes in nanorods for use in biomolecule, chemical sensing, and near-field imaging.			
Title: Basic Research in Materials Sciences ***Description:*** Research that provides innovations in materials design and process 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 moved to the Mechanical Sciences section within this Project. ***FY 2013 Accomplishments:*** Demonstrated novel materials with large electro-caloric effects for thermal management; achieved rapid fabrication and densification of nanostructured materials with unique combinations of high-pressure and electrical field; established theory to	6.333	7.067	7.200

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
guide the design and fabrication of multifunctional materials incorporating programmable responses and hierarchical constructs; fabricated novel three dimensional (3-D) topological insulators with unsurpassed bulk resistivity and surface electron mobility; and demonstrated the ability to translate biochemical activity onto inorganic surfaces. ***FY 2014 Plans:*** Establish the use of resonant optical effects to achieve size sorting of microspheres in solution with unprecedented precision; demonstrate a new class of materials for low power sensing based on variable temperature conduction; 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; and fabricate novel fully transparent materials with record hardness and toughness for advanced protection. ***FY 2015 Plans:*** Will elucidate the molecular mechanisms by which living cells regulate intracellular biochemical activity with mechanical force and design novel materials with force-activated control; provide novel functional materials with unprecedented physical properties through strongly linked multi-scale models developed specific to the materials systems; and complete a vigorous investigation of two-dimensional non-graphitic atomic layers and heterostructures and identify advanced material properties and capabilities.			
Title: Basic Research in Computing Sciences ***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 moved to the Mathematical Sciences section within this Project. ***FY 2013 Accomplishments:*** Continued to explore and investigate new effective computing architectures, computational methods and software tools; developed new methods for data sensing and fusion over large volumes of social data; and continued long term efforts to develop methods for the tomography of social networks, for predicting individual and collective human behaviors in the war against terrorism, and developed structural methods for automatic machine translation. ***FY 2014 Plans:*** Explore robust computational methodologies for large dataset processing and analysis with optimized data representations, and obtain optimal realization of Real-Time Multi-core Systems to support complex, resource-demanding, real-time Intelligence, Surveillance, and Reconnaissance (ISR) applications; create new image data feature analysis and pattern classification methods	5.518	7.724	8.145

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H57 / *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
for object detection, recognition, and long-term tracking under challenging dynamic conditions; and develop quantification and metrics for effective analysis of social-interaction phenomena for better prediction of unusual social events in asymmetric defense. ***FY 2015 Plans:*** Will establish new knowledge in acquiring, computing, and analyzing big data in a trusted fashion, and investigate novel techniques for processing multi-modal data that may be in the form of text, photo, video, and audio so that actionable intelligence and timely information can be extracted and derived for better situation awareness and better decision making; investigate new concepts such as value of information, and invest in new research opportunity areas such as social informatics; and pursue efforts on information assurance with a special focus on hardware based resilient techniques.			
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 environment 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 2013 Accomplishments:*** Evaluated mathematical models of how information spreads through groups/networks using a Behavioral Game Theory framework; developed mathematical models of decision making using neuroscience experiments in collaboration with Life Sciences, with attention being paid to errors in human judgment; and investigated game theory derived from observational data to understand microbe adaptations and micro-scale locomotion and control for micro-bio-robots. ***FY 2014 Plans:*** Explore the notion of a tipping point (e.g., when a society changes its views) from a Statistical Mechanics perspective and from a Behavioral Game Theory perspective, with attendant efforts to reconcile the two views; continue mathematical modeling of neuronal structures informed by experiments to grow neurons and extend to capture cognitive intelligence that arises from networks of neurons; study games derived from observation with respect to equilibrium and robustness properties and validate on problems related to reasoning about adversarial networks; and study the effect of human networks on communication networks with the goal of finding effective bandwidth/spectrum/resource utilization. ***FY 2015 Plans:*** Will study interconnected networks and how failure in a network spreads to other networks; investigate rigorous mathematical theories that bring together statistical mechanics, operations research, game theory and reliability theory that could predict how failures propagate and when/how failures could be controlled; explore new game theory inspired models for how economic and social factors lead to large societal changes, such as Arab spring style revolutions; and study tensor decomposition of spectral	5.912	8.260	8.400

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
graphs that arise from big data in social networks with a view towards automatically learning the structure of networks and their properties.			
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. ***FY 2013 Accomplishments:*** Established the differential geometry (geometric mechanics) of multi-body/granular media interactions; developed an understanding to enable JP-8 surrogate fuels for diesel engine cycle studies; investigated novel nano-thermodynamic corrections for prediction of hot spots in energetic material; and investigated the flow mechanisms associated with transitory aerodynamic loading affected by flow control on the boundaries of stationary and moving platforms. ***FY 2014 Plans:*** Conduct counter-flow burner studies for investigating high molecular weight hydrocarbon fuel and jet fuel chemistry at elevated pressures up to 2.5MPa; investigate novel transparent fully cross-linked Molecular Interpenetrating Polymer Composites (MIPCs) under high strain rate loading conditions; 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; and elucidate the fundamental physical interactions responsible for energy dissipation and quality factor magnification within prototypical nano-electromechanical systems. ***FY 2015 Plans:*** Will gain understanding of oxidizer behavior in energetic materials via determination of how the morphology and phase behavior is evolving during the heating and reaction process; will demonstrate new capabilities to actively control entropy production and free energy exchange in arrays of molecular motors; develop a reduced-order methodology suitable for the study of the large parameter design space associated with "dynamic stall"; and develop a numerical modeling approach capable of quantifying the formation of shear bands and dynamic crack propagation of structural materials under high strain rate loading.	5.649	6.445	6.700
Title: Basic Research in Mathematical Sciences ***Description:*** Pursue the creation of new mathematical tools and methods for performing complex, multi-system analysis and modeling to enhance soldier and weapon-system performance. More specifically, the focus is on creating mathematical principles and practical algorithms for stochastic analysis and control, analysis and control of biological systems, numerical computation of infinite-dimensional systems and modeling of irregular geometric and social phenomena.	5.687	6.278	6.600

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
FY 2013 Accomplishments: Created new numerical methods and algorithms that facilitate improved aerodynamic performance of helicopters in adverse conditions as well as enabled optimal design of supersonic projectiles; continued to develop a multivariate heavy-tail statistical theory and developed algorithms to improve modeling capability for complex systems; and created new mathematical tools, computational algorithms, and capabilities that deepens understanding of protein-ligand docking. ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will conduct innovative basic research in statistical analysis, infinite-dimensional stochastics and control, multiscale procedures that transfer information among multiple sets of scales, identification and quantification of fundamental principles of biological dynamics often through multiscale modeling, representation of three dimensional (3-D) terrain and new metrics for small-group social and sociolinguistic phenomena. This mathematical sciences research will lead to improved conventional and quantum information networks and information processing, soldier health and performance, decision making, training, simulation and mission planning.			
Accomplishments/Planned Programs Subtotals	69.342	80.342	81.245

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) H66 / *Adv Structures Rsch*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
H66: *Adv Structures Rsch*	-	1.853	2.017	2.006	-	2.006	2.044	2.068	2.102	2.142	-	-

The FY 2015 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.

Work in this project supports key Army needs and provides the technical underpinnings to Program Element (PE) 0602211A (Aviation Technology).

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 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 2013	FY 2014	FY 2015
Title: Structural Analysis and Vibration Methods	1.853	2.017	2.006

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H66 / *Adv Structures Rsch*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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 2013 Accomplishments:*** Validated progressive failure analysis methods and fatigue damage model of composites under various loadings and composite configurations to address failures in Army vehicle composite structures; assessed 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; investigated 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:*** Investigate adaptive seat damper materials and strategies for improved vibration reduction over a variety of terrains and for different gross vehicle weight configurations; develop and demonstrate a virtual testing capability for lightweight composite structures by integrating probabilistic methods, which are reliant on current and historical data, into existing physics-based models; develop signal processing algorithm for tracking damage transients; and investigate three-dimensional printing of novel multifunctional materials for micro air and ground vehicle applications. ***FY 2015 Plans:*** Will investigate strategies for improvement of durability of vehicle platforms through the introduction of novel composite materials; develop and demonstrate a probabilistic tool for the development of novel composite materials to address specific structural performance requirements; develop the capability to capture and quantify precursors to damage in structural components that will enhance the operation and sustainability of future vehicle systems; and demonstrate three-dimensional printing of multifunctional structural components for air and ground vehicle applications.			
Accomplishments/Planned Programs Subtotals	1.853	2.017	2.006

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
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E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) H67 / *Environmental Research*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H67: *Environmental Research*	-	0.935	1.030	0.903	-	0.903	0.920	0.931	0.946	0.965	-	-

The FY 2015 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 provides the technical underpinnings for PE 0602618A (Ballistics Technology).

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 2013	FY 2014	FY 2015
Title: Industrial Pollution Prevention	0.935	1.030	0.903
Description: This effort conducts research on innovative environmentally-friendly technologies that support the warfighter (focusing on pollution prevention technologies).			
FY 2013 Accomplishments: Conducted research on mechanics of antibiotic and disinfectant resistance from wastewater treatment and research into synthesis of biofuels.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** H67 / *Environmental Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Research 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. ***FY 2015 Plans:*** Will research green technologies for new energetics/propellants, airborne lead reduction in Army weapon systems, and environmentally friendly technologies to support Army soldier systems; will select projects to support the Army Environmental Requirements and Technology Assessments (AERTA).			
Accomplishments/Planned Programs Subtotals	0.935	1.030	0.903

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) S13 / *Sci BS/Med Rsh Inf Dis*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
S13: *Sci BS/Med Rsh Inf Dis*	-	11.172	10.696	11.005	-	11.005	11.248	11.378	11.560	11.789	-	-

The FY 2015 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 (use for the identification of the nature and cause of a particular disease). 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 (organism 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 (Medical 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 Walter Reed Army Institute of Research (WRAIR) and NMRC, Silver Spring, MD, and their overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Prevention/Treatment of Parasitic (organism living in or on another organism) Diseases	3.521	3.810	3.900

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S13 / *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
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 2013 Accomplishments:*** Modified 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:*** Optimize 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. ***FY 2015 Plans:*** Will continue to identify new lead candidate drugs and combinations to stay ahead of emerging drug resistance in malaria parasite. Will identify new technologies to deliver drugs into the human body by using novel formulations.			
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 2013 Accomplishments:*** Formulated and evaluated newly identified vaccine candidates and assessed mechanisms of protection in animal models and compared novel formulations of malaria vaccines for protective effectiveness in animal models. ***FY 2014 Plans:*** 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). ***FY 2015 Plans:*** Will identify and characterize mechanism of protective immunity. Will continue to assess immunogenicity (immunity or an immune response) of new vaccine candidates in small-animal models to determine suitability in formulations of multiple antigen vaccines	2.331	2.307	2.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S13 / *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
(an antigen is a substance, usually a protein, on the surface of a cell or bacterium that stimulates the production of an antibody). Will identify and characterize new technologies to deliver candidate vaccine into the human body by using novel formulations.			
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 2013 Accomplishments:*** Undertook discovery of and evaluated new vaccine components needed for vaccine protection for severe bacterial diarrhea based on prior studies; evaluated different components from pathogens causing diarrhea for their ability to induce protection against these organisms; and developed further knowledge of bacterial wound infection pathogens to develop effective treatments. ***FY 2014 Plans:*** Study the mechanism by which diarrheal pathogens stick to the wall of the intestine to develop countermeasures against these pathogens and study novel methods of formulating vaccine candidates to effectively deliver them inside the human body. Study mechanism of bacterial wound infection pathogens to develop effective treatments. ***FY 2015 Plans:*** Will explore common platforms for a combination vaccine against Campylobacter (leading bacterial cause of food borne disease in many developed countries), Shigella (bacteria that causes diarrhea, similar to salmonella), and enterotoxigenic E. coli (leading bacterial cause of diarrhea) (three agents causing diarrhea). Will identify epidemiologic (area of medicine that deals with the study of the causes, distribution, and control of disease in populations) importance of enteric pathogens (gastrointestinal organisms) to develop strategies for preventing diarrhea in deployed US forces. Will define correlates of protection (indicator of effectiveness) in animal models. Will identify new techniques and tools for improved infection control and wound healing. Will identify, and evaluate novel methods for prevention of highly antibiotic-resistant bacteria trauma-associated infection.	1.948	1.537	1.538
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 (a life-threatening form of the dengue fever caused by a virus and transmitted by a mosquito) 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 2013 Accomplishments:***	1.739	1.571	1.600

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S13 / *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Studied and evaluated the basis of dengue disease and how the immune system reacts to it; evaluated factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; 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; determined the contribution of various cells present in human body to provide protection against dengue infection and/or dengue disease; studied and evaluated pathogenesis of hemorrhagic fever caused by hantaviruses (a family of deadly viruses transmitted by rodents); and studied the biology of HIV to understand the impact of human genes on HIV acquisition and progression to inform vaccine development. ***FY 2014 Plans:*** 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; 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 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. ***FY 2015 Plans:*** Will identify and evaluate the role of human cells and antibodies in developing preventive and/or treatment countermeasures for diseases caused by hantaviruses (a deadly virus responsible of hemorrhagic fever with renal syndrome). Will identify host and viral determinants of dengue disease severity. Will explore innovative vaccine designs, adjuvant (agent that enhances the effect of vaccines) systems, and delivery methods for dengue virus vaccine. Will continue epidemiological (area of medicine that deals with the study of the causes, distribution and control of disease in populations) studies with all types of dengue present world-wide to determine the prevalence and incidence of dengue fever (a severe debilitating disease caused by a virus and transmitted by a mosquito) and dengue hemorrhagic fever (a life-threatening form of the dengue fever caused by a virus and transmitted by a mosquito).			
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 2013 Accomplishments:***	1.633	1.471	1.467

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S13 / *Sci BS/Med Rsh Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Identified novel fast-acting, directly targeted, insecticides that rapidly degrade to harmless by-products; investigated next-generation risk assessment tools for evaluating potential infectious disease transmission in insects (beyond modeling); and developed identification keys for medically important insect vectors. ***FY 2014 Plans:*** 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 evaluate new technologies selected as part of the new-generation diagnostic systems for use in the deployed setting for detection of pathogens in humans. ***FY 2015 Plans:*** Will explore innovative technologies (traps, attractants, and devices) for vector (organisms that transmit disease) surveillance in military operations. Will continue to develop user friendly, web-based, geographical identification keys for the medically relevant arthropods and insects (e.g., ticks, mosquitoes, and sandflies). Will identify novel pesticide matrices/application strategies for vector control. Will explore passive arthropod repellent systems/strategies that do not require pesticide applications.			
Accomplishments/Planned Programs Subtotals	11.172	10.696	11.005

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army											Date: March 2014	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) S14 / *Sci BS/Cbt Cas Care Rs*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
S14: *Sci BS/Cbt Cas Care Rs*	-	8.794	9.167	10.553	-	10.553	9.827	9.970	10.141	10.325	-	-

The FY 2015 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 (Medical Technology).

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 (USADTRD) 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.

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.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S14 / *Sci BS/Cbt Cas Care Rs*

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 2013	FY 2014	FY 2015
Title: Damage Control Resuscitation	1.295	1.617	2.700
Description: This effort conducts studies of genetic pathways and metabolic (biochemical activity) mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma. ***FY 2013 Accomplishments:*** Conducted 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:*** Conduct studies of re-engineered blood products to control traumatic bleeding and treat shock and perform studies to better understand the genetic basis of survival from hemorrhage. ***FY 2015 Plans:*** Will conduct studies of cell and tissue protective drugs as potential new candidate alternatives to blood products and fluids when these are not available.			
Title: Combat Trauma Therapies	0.767	0.783	0.800
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 2013 Accomplishments:*** Continued 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:*** Study mechanisms to manipulate the molecules, cells, and structure of the skin to optimize healing, appearance, and function. ***FY 2015 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S14 / *Sci BS/Cbt Cas Care Rs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will begin studies to determine the optimal thicknesses of skin grafts for more rapid closure and improved functional outcomes of face wounds.			
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. ***FY 2013 Accomplishments:*** Continued 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:*** Perform research on decision support algorithms that use non-traditional vital signs to assess patient physiologic status and continue studies of algorithms for early identification of individuals with high- and low-tolerance to blood loss to optimize resuscitation. ***FY 2015 Plans:*** Will continue research on decision support algorithms using non-traditional vital signs to assess patient status and optimize fluid resuscitation. Will conduct studies to identify new physiological (characteristic of or appropriate to an organism's healthy or normal functioning) information that distinguish individuals with high and low tolerances to blood loss.	0.629	0.857	0.803
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 procedures to mitigate the effects of TBI. ***FY 2013 Accomplishments:*** Conducted research to further understand cell death and neuroprotection (protecting degeneration of the nervous system) mechanisms, and identified critical thresholds for secondary injury (i.e., polytrauma) complicating TBI. ***FY 2014 Plans:*** 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; 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 continue research to understand cell death and neuroprotection (protection of the brain) mechanisms and determine critical thresholds for secondary injuries (polytrauma) complicating TBI. ***FY 2015 Plans:***	0.660	0.990	1.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S14 / *Sci BS/Cbt Cas Care Rs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will continue studies applying 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 continue basic research to study the brain and nervous system during the sub-acute (weeks) and chronic (months) periods after head injury to identify predictors of long-term consequences of TBI. Will continue research to understand cell death and neuroprotection (protection of the brain) mechanisms and determine critical thresholds for secondary injuries (polytrauma) complicating TBI. Will conduct studies to determine the time course of neuroplasticity (capacity of the nervous system for adaptation or regeneration after trauma) markers during the post-injury recovery periods.			
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 2013 Accomplishments:*** Explored the mechanisms of eye trauma injury and the epidemiology (studying incidence or prevalence of injury) of eye trauma wounds and explored innovative strategies to regenerate tissues and advance promising approaches to the applied research phase. ***FY 2014 Plans:*** 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 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. ***FY 2015 Plans:*** Will explore the cellular mechanisms and functional challenges of eye trauma injuries and advance promising therapies for eye trauma wounds into the applied research phase; correlate the epidemiology (incidence, prevalence and severity) of eye trauma with clinical outcomes; explore innovative strategies to regenerate and reconstruct tissues to enable promising approaches to advance into the applied research phase through directed experimentation in the lab and in animal models to address injury of the extremities (arms and legs), craniomaxillofacial (head, neck, face and jaw), genital, and abdominal regions.	5.443	4.920	4.750
Accomplishments/Planned Programs Subtotals	8.794	9.167	10.553

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S14 / *Sci BS/Cbt Cas Care Rs*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) S15 / *Sci BS/Army Op Med Rsh*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
S15: *Sci BS/Army Op Med Rsh*	-	5.013	7.366	6.815	-	6.815	6.636	6.720	6.831	6.961	-	-

The FY 2015 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 (Medical Technology).

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 Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; US Army Institute of Surgical Research (USAISR), San Antonio TX; and the U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Injury Prevention and Reduction	1.174	1.185	1.000
Description: This effort identifies biological patterns of change in Soldiers during states of physical exertion, identifies physiological (human physical and biochemical functions) mechanisms of physical injury and exertion that will predict musculoskeletal (muscle, bone, tendons, and ligaments) injury, and establishes laser dose-response for eye tissue.			
FY 2013 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S15 / *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Identified indicators of cellular responses to determine efficacy of intervention strategies related to injury susceptibility in the skeletal muscle; diagnosed and characterized repeated and long-duration exposure from military lasers; and characterized 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:*** Explore musculoskeletal injury and repair mechanisms to identify possible therapeutic targets that regulate skeletal muscle and bone function; 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 establish ocular (eye) injury metrics for blast exposures. ***FY 2015 Plans:*** Will explore inflammatory processes in muscle and surrounding tissues following physical injury and during cellular repair using cell and animal models. Retinal imaging (photographic procedure that details the optic nerve, retinal blood vessels and the light sensing tissues in the back of the eye) will be used to examine and document the presence or absence of visible retinal alterations following blast exposure to rodents and laser exposures to eyes in a non-human primate model.			
Title: Physiological Health ***Description:*** This effort conducts research on the physiological (human physical and biochemical functions) mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being. ***FY 2013 Accomplishments:*** Determined muscle metabolic responses to nutritional deficit; identified the relationship between micronutrient and bone adaptation during military training; and identified 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:*** Determine whether electrical brain stimulation can be used to induce sleep; explore promoting sleep during intervals between missions when sleep is not physiologically required; establish nutritional requirements for optimizing muscle formation and repair; determine the effects of various nutritional interventions on cell function; explore various nutritional interventions that might enhance resistance to cellular injury; and explore nutritional interventions that might promote physiological improvements to training and enhance recovery from physical injury. ***FY 2015 Plans:***	1.789	3.041	2.515

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S15 / *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will investigate the metabolic mechanisms underlying injury recovery and explore the capability of macronutrients and micronutrients to promote metabolic recovery using cell and animal models. Will determine the neurophysiological (branch of physiology that studies how the nervous system functions on a molecular and tissue level) basis of recuperation during sleep and explore the use of pharmacological (drugs/pharmaceuticals) and non-pharmacological approaches for improving the recuperation processes during sleep.			
Title: Environmental Health and Protection ***Description:*** This effort conducts research on the physiological (human physical and biochemical functions) mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. ***FY 2013 Accomplishments:*** Identified how clinical pathways alter progression and extent of organ damage following heat injury/stroke. These studies will determined 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:*** 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 explore treatments to protect against organ damage resulting from heat injuries. ***FY 2015 Plans:*** Will use animal models to identify sensitive biomarkers of organ damage and delineate the molecular pathways of heat injury. This data can be used to identify targets for therapeutic interventions to accelerate recovery from heat injury.	0.453	0.804	0.800
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 2013 Accomplishments:*** Identified 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:***	1.597	2.336	2.500

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** S15 / *Sci BS/Army Op Med Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Determine whether a sleep-related intervention strategy can enhance resilience to concussion/mild TBI effects in a proof-of-concept rodent model and 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; establish cellular mechanisms for regulation of PTSD symptoms associated with increased stress sensitivity and increased anxiety in a rodent model of PTSD. ***FY 2015 Plans:*** Will utilize an animal model for traumatic exposure, traumatic stress symptoms, and recovery to do a preliminary screening of pharmaceuticals that may impact mental health status. The results of these studies will create a methodology for sequential testing of novel pharmaceuticals that will lead ultimately to clinical trials for the treatment of PTSD. Will identify the association of exposure to blast and/or blunt impact on the likelihood of a brain concussion in a rodent model.			
Accomplishments/Planned Programs Subtotals	5.013	7.366	6.815

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) T22 / *Soil & Rock Mech*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T22: *Soil & Rock Mech*	-	3.951	4.577	5.704	-	5.704	4.484	4.548	4.624	4.710	-	-

The FY 2015 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 2013	FY 2014	FY 2015
Title: Military Engineering Basic Research	2.042	2.318	2.404
Description: Funding is provided for this activity			
FY 2013 Accomplishments: Developed basic wave propagation/sensor interaction knowledge, modifications to current and future data analysis, processing, and classification algorithms to account for use of conduit, and produced a modeling framework for future variable manipulation.			
FY 2014 Plans: 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.			
FY 2015 Plans: Will develop improved understanding of interaction between gel chemistry and concrete to reduce explosive spalling under ultra-high temperatures; will investigate multi-temporal radar physics to identify frequency dependencies of roughness scale and grain			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T22 / *Soil & Rock Mech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
size of dielectrically similar soils and snow; will direct tunable bacteriophage morphology to assemble high-ordered nano-scale structures.			
Title: Materials Modeling for Force Protection ***Description:*** 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 2013 Accomplishments:*** Created experimental techniques that provide measurements at the nano- to micro-scale that allowed for validation and verification of simulations of material. These techniques generated a 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:*** 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. ***FY 2015 Plans:*** Will identify and introduce energy dissipation mechanisms in novel multi-layered, heterogeneous structural systems to achieve significant weight reduction; will investigate fundamental nano-scale parameters of biological protective materials on the macro-scale damage variables of a multi-layered protective material, where the macro-scale variables will be incorporated into simulations of multi-layered nano-composite materials.	1.909	2.259	3.300
Accomplishments/Planned Programs Subtotals	3.951	4.577	5.704

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) T23 / *Basic Res Mil Const*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T23: *Basic Res Mil Const*	-	1.618	1.772	2.102	-	2.102	1.733	1.757	1.787	1.820	-	-

The FY 2015 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 2013	FY 2014	FY 2015
Title: Facilities Research	1.618	1.772	2.102
Description: Funding is provided for the following effort.			
FY 2013 Accomplishments: Completed investigations of enhanced heat transfer of hybrid surfaces and switching mechanisms in bioinspired polymers.			
FY 2014 Plans: 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.			
FY 2015 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T23 / *Basic Res Mil Const*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will determine fundamental processes in microbial interactions with surfaces that lead to bio-fouling and corrosion; will re-create plant photosynthesis processes in an artificial cell matrix.			
Accomplishments/Planned Programs Subtotals	1.618	1.772	2.102

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) T24 / *Signature Physics And Terrain State Basic Research*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T24: *Signature Physics And Terrain State Basic Research*	-	1.424	1.600	2.005	-	2.005	1.635	1.655	1.681	1.715	-	-

The FY 2015 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 2013	FY 2014	FY 2015
Title: Analysis for Signal and Signature Phenomenology (Previously titled - Terrain State and Signature Physics)	1.424	1.600	2.005
Description: Funding is provided for the following effort.			
FY 2013 Accomplishments: Formulated 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; formulated a			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T24 / *Signature Physics And Terrain State Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
methodology for assessing motivational intensities (cognitive-based processes) contributing to movement patterns in constrained landscapes. ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will investigate radio frequency propagation signal loss in mountainous terrain shadow zones to determine causes of attenuation variance to model predictions and determine the utility of a low frequency simulation with reduced computational demand to emulate actual high frequency behavior; will enable realistic modeling of high bandwidth impulsive waveforms to improve space/ time localization of high resolution acoustic and electromagnetic receivers by extending wave propagation theory in random media to include decorrelations of signals over separations in space and time resulting from dynamic variability of the atmosphere.			
Accomplishments/Planned Programs Subtotals	1.424	1.600	2.005

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) T25 / *Environmental Science Basic Research*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T25: *Environmental Science Basic Research*	-	5.620	7.171	7.303	-	7.303	7.028	7.129	7.251	7.385	-	-

The FY 2015 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 2013	FY 2014	FY 2015
Title: Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants	2.607	2.794	2.900
Description: Funding is provided for the following effort.			
FY 2013 Accomplishments: Initiated research on amphibian response to various militarily relevant chemicals and materials to develop an understanding of if and how these unique organisms are impacted; developed an understanding of transport of compounds through cellular channels			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T25 / *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
that will allow information for more sensitive nano-sensors; investigated the new insensitive munitions behavior and persistence in environmental condition and media. ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will determine the fundamental biological mechanisms that predict interactions of new insensitive munitions with environmental constituents; will increase understanding of chemical-environmental interactions and ecosystem functions for advanced sensing; will provide underlying mechanisms of biological networks to utilize in man-made systems.			
Title: Fundamental Understanding of Explosives, Energetics and UXO in the Environment ***Description:*** Previously titled:Remediation of Explosives, Energetics, and UXO ***FY 2013 Accomplishments:*** Investigated the mineralization of depleted uranium munitions and effects on solubility, sorption, and mobility; explored novel microbial systems for degrading energetic compounds; and studied the bioavailability implications of interactions between munitions constituents and performance enhancing nano-material in mixtures. ***FY 2014 Plans:*** 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 and characterize novel biocatalysts involved in the direct incorporation of molecular oxygen into amines resulting in a green biosynthesis route to energetic. ***FY 2015 Plans:*** Will determine the potential for use of aquatic biological systems as a basis for trace chemical sensors in water; will determine how understanding of chemical impact on biological systems can be translated across different species through similarities in molecular systems; will identify the mode of toxic interactions of multiple chemical mixtures in the IMX.	1.567	2.296	2.396
Title: Training Land Natural Resources ***Description:*** Funding is provided for the following effort. ***FY 2013 Accomplishments:***	0.491	1.007	1.107

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T25 / *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Investigated how climate induced change affects the adsorption and biotransformation characteristics of northern peat-land ecosystems; conducted 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; analyzed pollination networks and nectar-dwelling yeast communities and discerned 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:*** 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. ***FY 2015 Plans:*** Will study how invasive species impact the affected ecosystem at the molecular level; will investigate potential of novel mechanisms to assess ecosystem components utilizing specialized monitoring of unique sounds.			
Title: Network Science ***Description:*** Funding is provided for the following effort. ***FY 2013 Accomplishments:*** Investigated the molecular architecture that dictates the highly specific ligand preference of insect pheromone receptors based on amino acid networks for intelligent receptor design; investigated genetic and genomic basis of intra-species variance in sensitivity to munitions and reduced uncertainty in risk/toxicity assessment of military sites; explored the trade-offs between adaptability and susceptibility within self-organizing biological networks. ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will investigate how molecular design impacts biological function and how this can be translated to man-made systems like robotics; will investigate biological cell assembly mechanisms for man-made systems and programming.	0.955	1.074	0.900
Accomplishments/Planned Programs Subtotals	5.620	7.171	7.303

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T25 / *Environmental Science Basic Research*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army												Date: March 2014
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*				Project (Number/Name) T63 / *Robotics Autonomy, Manipulation, & Portability Rsh*			
COST ($ in Millions)	**Prior Years**	**FY 2013**	**FY 2014**	**FY 2015 Base**	**FY 2015 OCO #**	**FY 2015 Total**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**Cost To Complete**	**Total Cost**
T63: *Robotics Autonomy, Manipulation, & Portability Rsh*	-	1.760	1.990	7.000	-	7.000	7.286	7.218	7.443	8.140	-	-

The FY 2015 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 expands 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. It enables future systems to support and unburden Soldiers by integrating technologies with an understanding of cognitive and physical needs, and the missions of the humans and (non-human) agents operating on the battlefield. The ability of the Warfighter to command a suite of small unmanned systems (e.g., air, ground, and hybrid vehicles) reduces exposure of the Soldier to harm and improves 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 U.S. Army Research Lab conducts 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.

Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0601104A (University and Industry Research Center)/H54 (Micro-Autonomous Systems Technology Collaborative Technology Alliance) and PE 0602622A (Chemical, Smoke and equipment Defeating Technology)/544 (Smoke/Novel Effect Munition).

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.

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T63 / *Robotics Autonomy, Manipulation, & Portability Rsh*

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Robotics Autonomy and Human Robotic Interface Research	1.760	1.990	2.000
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 2013 Accomplishments:*** Conducted experimental studies to create a fundamental model of flapping wing locomotion to enable future micro-scale unmanned aerial vehicle systems; examined the basic concepts and underpinning mechanics of grasping and manipulating unknown, arbitrarily shaped objects. ***FY 2014 Plans:*** Conduct experimental studies to investigate the fundamental flow behavior of small scale flyers as it impacts range and endurance; investigate cognitive approaches for machine perception; explore concepts from game theory and machine learning to determine adversarial intent from sensor observations; examine mechanics and control related to whole body manipulation; and examine novel locomotion mechanisms focusing upon energy efficiency and mobility. ***FY 2015 Plans:*** Will conduct experimental studies related to fundamental flow behavior of very small scale air vehicles; explore algorithms for semantic labeling and relationship determination between objects in the environment to permit robots to interact with soldiers using more intiuitive and natural means and to enable the robot to infer the purpose of objects and human activity; and examine novel locomotion concepts to enable greater efficiency and application in complex and confined environments.			
Title: Intelligent Systems	-	-	5.000
Description: Pursue in-house research that supports and unburdens Soldiers in a flexible, robust, survivable and comprehensive manner. This work will address the cognitive requirements of humans and (non-human) agents, both hardware and software based, operating individually or in collaboration, on the battlefield. Emphasis will be placed on perception, reasoning, and collaboration techniques that can apply to and transfer between a broad range of systems (such as: adaptive communication and data collection networks; cyber defense, crowd-sourcing and information retrieval software agents; and predictive and explanatory decision support systems). ***FY 2015 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T63 / *Robotics Autonomy, Manipulation, & Portability Rsh*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will explore, and characterize architectures and algorithms for intelligent explanation, facilitating human interpretation of machine outputs; investigate techniques for limited supervised learning to enhance machine recognition of threats and objectives and assess their impact on baseline planning algorithms; and address socially-inspired concepts for collective intelligence in the context of dynamic situation assessment, re-organization and collaboration.			
Accomplishments/Planned Programs Subtotals	1.760	1.990	7.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) T64 / *Sci BS/System Biology And Network Science*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T64: *Sci BS/System Biology And Network Science*	-	2.726	2.958	2.398	-	2.398	2.952	2.996	3.048	3.102	-	-

The FY 2015 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 have potential to provide 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 computational biology processes and knowledge of biological networks to discover medical products that prevent and/or treat diseases or medical conditions.

The cited work provides theoretical underpinnings for PE 0602787A (Medical Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Title: Network Sciences Initiative	2.726	2.958	2.398
Description: This effort supports research using iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies.			
FY 2013 Accomplishments: Expanded 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: 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; develop systems biology algorithms to establish new strategies to identify drug targets and therapeutics for malaria- and trauma-induced coagulopathy (abnormal blood clotting); exploit novel in-silico (performed on computer via simulation) models to identify sensitive biomarkers and determine the time course of wound healing; and develop mathematical models to characterize how viruses escape immune response to support the development of anti-viral drugs.			
FY 2015 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** T64 / *Sci BS/System Biology And Network Science*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
Will use algorithms to investigate the discrimination between biomarkers (key molecular or cellular events, such as the presence of specific proteins, that link a specific environmental exposure to a health outcome) of mild, moderate, and severe TBI; will test and extend computational biology algorithms to identify drug targets and therapeutics for conditions such as infectious disease (e.g., malaria); will develop mathematical models of upper respiratory airflow patterns for the non-invasive diagnosis of pulmonary (lung) diseases; will computationally predict potential drug targets that could induce re-sensitization to current antibiotics in biofilm-producing bacteria (bacteria that can form into a thin layer that adheres to surfaces including tissues of the body, bacterial biofilms are more antibiotic-resistant); will mathematically model standard vital-sign data to enable the non-invasive prediction of heat stress injury and allow for timely counteractive measures.			
Accomplishments/Planned Programs Subtotals	2.726	2.958	2.398

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) VR9 / *Surface Science Research*	

COST ($ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
VR9: *Surface Science Research*	-	1.717	2.009	2.500	-	2.500	2.239	2.273	2.312	2.354	-	-

The FY 2015 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 provides the theoretical underpinnings for PE 0602622A (Chemical, Smoke and Equipment Defeating Technology).

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 2013	FY 2014	FY 2015
Title: Surface Science Research	1.717	2.009	2.500
Description: The activities in this program are related to performing basic 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 2013 Accomplishments: Developed 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; investigated the mechanisms			

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601102A / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** VR9 / *Surface Science Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2013	FY 2014	FY 2015
governing specific binding or adherence of biological molecules to abiotic surfaces; and performed structural determination and in silico modeling of trans-membrane proteins from human induced pluripotent cells ***FY 2014 Plans:*** 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. ***FY 2015 Plans:*** Will investigate chemical and biochemical phenomena occurring at or near solid surfaces and material interfaces, to include the effects of binding energy, reactions, transport and deposition; the interactions between chemical reactions and transport processes on surfaces; theory and modeling of processes at complex surfaces; and experimental work focused on the systematic understanding of surface structure, morphology (the study of form and structure), and surface group properties.			
Accomplishments/Planned Programs Subtotals	1.717	2.009	2.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A