Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: Research, Development, Test & Evaluation, Army BA 1: Basic Research					R-1 ITEM NOMENCLATURE PE 0601102A: DEFENSE RESEARCH SCIENCES					

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
Total Program Element	190.019	213.604	219.180	-	219.180	226.586	227.763	232.331	237.623	Continuing	Continuing
305: ATR RESEARCH	2.332	2.429	2.204	-	2.204	2.281	2.386	2.397	2.621	Continuing	Continuing
31B: INFRARED OPTICS RSCH	2.664	2.783	2.836	-	2.836	2.861	2.893	2.926	2.895	Continuing	Continuing
52C: MAPPING & REMOTE SENS	2.774	2.910	2.233	-	2.233	2.259	2.288	2.312	2.344	Continuing	Continuing
53A: BATTLEFIELD ENV & SIG	3.272	3.430	3.534	-	3.534	3.572	3.621	3.583	3.642	Continuing	Continuing
74A: HUMAN ENGINEERING	6.793	8.006	8.265	-	8.265	8.413	8.642	8.816	8.880	Continuing	Continuing
74F: PERS PERF & TRAINING	5.359	6.755	7.094	-	7.094	7.219	7.338	7.458	7.583	Continuing	Continuing
F20: ADV PROPULSION RSCH	3.348	3.990	4.211	-	4.211	4.256	4.307	4.283	4.357	Continuing	Continuing
F22: RSCH IN VEH MOBILITY	0.561	0.587	0.606	-	0.606	0.612	0.621	0.630	0.642	Continuing	Continuing
H42: MATERIALS & MECHANICS	6.769	8.448	8.644	-	8.644	8.907	8.998	9.053	9.208	Continuing	Continuing
H43: RESEARCH IN BALLISTICS	8.078	9.049	9.103	-	9.103	9.383	9.546	9.607	9.769	Continuing	Continuing
H44: ADV SENSORS RESEARCH	9.405	9.989	10.219	-	10.219	10.347	10.658	10.943	11.127	Continuing	Continuing
H45: AIR MOBILITY	2.328	2.445	2.515	-	2.515	2.552	2.588	2.625	2.671	Continuing	Continuing
H47: APPLIED PHYSICS RSCH	4.861	5.079	5.222	-	5.222	5.270	5.535	5.980	6.001	Continuing	Continuing
H48: BATTLESPACE INFO & COMM RSC	13.309	15.701	21.519	-	21.519	22.557	23.177	23.446	23.752	Continuing	Continuing
H52: EQUIP FOR THE SOLDIER	1.055	1.103	1.135	-	1.135	1.146	1.157	1.172	1.189	Continuing	Continuing
H57: Single Investigator Basic Research	70.691	78.134	78.050	-	78.050	81.385	80.297	82.675	84.357	Continuing	Continuing
H66: ADV STRUCTURES RSCH	1.851	1.939	1.999	-	1.999	2.018	2.046	2.069	2.022	Continuing	Continuing
H67: ENVIRONMENTAL RESEARCH	0.946	0.995	1.020	-	1.020	1.031	1.054	1.065	1.084	Continuing	Continuing
S13: SCI BS/MED RSH INF DIS	10.355	10.883	12.099	-	12.099	12.265	12.389	12.182	12.471	Continuing	Continuing
S14: SCI BS/CBT CAS CARE RS	6.606	9.694	10.197	-	10.197	9.472	9.069	9.375	9.697	Continuing	Continuing
S15: SCI BS/ARMY OP MED RSH	8.602	6.310	5.683	-	5.683	6.692	6.666	6.522	6.590	Continuing	Continuing
T22: SOIL & ROCK MECH	4.243	4.918	4.034	-	4.034	4.579	4.780	4.978	5.056	Continuing	Continuing

Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Army										**DATE:** February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*							
T23: *BASIC RES MIL CONST*	1.779	1.898	1.659	-	1.659	1.773	1.715	1.732	1.964	Continuing	Continuing
T24: *Signature Physics and Terrain State Basic Research*	1.543	1.613	1.495	-	1.495	1.601	1.539	1.547	1.656	Continuing	Continuing
T25: *Environmental Science Basic Research*	7.851	8.221	6.888	-	6.888	7.175	7.170	7.293	8.254	Continuing	Continuing
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.411	1.854	1.956	-	1.956	1.991	2.025	2.059	2.094	Continuing	Continuing
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	1.233	2.195	2.824	-	2.824	2.959	2.930	2.972	3.022	Continuing	Continuing
VR9: *SURFACE SCIENCE RESEARCH*	-	2.246	1.936	-	1.936	2.010	2.328	2.631	2.675	Continuing	Continuing

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

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

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Army				DATE: February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*			**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*		
B. Program Change Summary ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**
Previous President's Budget	195.845	213.942	219.116	-	219.116
Current President's Budget	190.019	213.604	219.180	-	219.180
Total Adjustments	-5.826	-0.338	0.064	-	0.064
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.730	-			
• Adjustments to Budget Years	-	-	0.064	-	0.064
• Other Adjustments 1	-2.096	-0.338	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT 305: *ATR RESEARCH*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
305: *ATR RESEARCH*	2.332	2.429	2.204	-	2.204	2.281	2.386	2.397	2.621	Continuing	Continuing

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, such as land mines. Critical technology issues include low depression angle, relatively short range, and highly competing clutter backgrounds. The resulting research will provide fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at determining the complexity and variability of target and clutter signatures and ultimately utilizing that knowledge to conceptualize and design advanced ATR paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. Research in this project builds knowledge for several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared (FLIR), and advanced multi-function laser radar (LADAR).

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: ATR Algorithms	1.344	1.413	1.300
Description: Investigate new algorithms to improve aided/unaided target detection and identification. *FY 2011 Accomplishments:* Developed restoration techniques for atmospheric turbulence distorted imagery and a new anomaly detection algorithm based on novel computational imaging methods. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 305: *ATR RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Research automatic machine perception algorithms that provide enhanced situational awareness; investigate fast algorithms for feature extraction and scene understanding from hyperspectral and multimodal data. *FY 2013 Plans:* Will investigate methods for object and event detection and classification using multimodal and hyperspectral imaging sensors to support Data-to-Decision capabilities. Will conduct research for optimal sensor fusion and novel feature selection techniques to enhance Automatic Target Recognition (ATR) and biometric capabilities.			
Title: Tagging, Tracking and Locating (TTL) *Description:* Conduct basic research to support advances in state-of-the-art clandestine TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are in accordance with the Hostile Forces TTL Capabilities Development Document and the TTL Science and Technology Roadmap. This effort will directly support ARL's efforts in applied research and the Communications-Electronics Research, Development, and Engineering Center's advanced research in clandestine TTL. *FY 2011 Accomplishments:* Investigated and validated an enhanced capability in hyperspectral imaging and target detection for tracking and locating. Fabricated an RF tag sample and validated an enhanced capability in hyperspectral target detection for tracking & locating. Completed investigations for the MEMS and flexible ultrasonic tags. *FY 2012 Plans:* Research efforts in the areas of imaging and tagging for TTL enhancements and applications. *FY 2013 Plans:* Will investigate and design advanced algorithms, components, sensors, and techniques applicable to TTL. Will assess the use of inherent target signatures including hyperspectral signatures to provide enhanced TTL standoff capabilities. Will further investigate the application of nanotechnology and MEMS to TTL technologies. Will examine the development of advanced taggant technologies across the electromagnetic spectrum including ultraviolet, infrared, and radio frequency for enhanced range performance and covertness. Will advance flexible electronics and non-cooperative biometric identification for TTL applications.	0.988	1.016	0.904
Accomplishments/Planned Programs Subtotals	2.332	2.429	2.204

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 305: *ATR RESEARCH*

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*			R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*			PROJECT 31B: *INFRARED OPTICS RSCH*				

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
31B: *INFRARED OPTICS RSCH*	2.664	2.783	2.836	-	2.836	2.861	2.893	2.926	2.895	Continuing	Continuing

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 Midwave IR lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semi-conductor materials to enhance the performance of lasers and IR FPAs. In the area of RF Photonics, near-IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. This research also is intended to lay the foundation for the development of integrated optoelectronic circuits using active and passive devices and components such as lasers, waveguides, and detectors in conjunction with fiber optic interconnects for the generation, distribution, processing, and control of microwaves and study the fundamental physics of signal processing and noise generation as well as the conversion between the time and frequency domains and the optical and electrical domains in these opto-electronic (OE) circuits/systems. The technical goals are to manage and control defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation over time and thermal management, particularly as it applies to interband cascade lasers. This work is coordinated with the Communications-Electronics Research, Development, and Engineering Center (CERDEC).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: IR Focal Plane Arrays, RF Photonics, and Infrared Countermeasures	2.664	2.783	2.836
Description: Conduct research into IR Focal Plane Arrays, RF Photonics, and IR countermeasures to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance missile threat IR countermeasure (IRCM) protection.			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 31B: *INFRARED OPTICS RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
FY 2011 Accomplishments: Applied fiber-optic RF-photonic techniques to the advancement of opto-electronic processing of military signals; developed nano-fabrication techniques in order to create a novel photonic waveguide structure that could be a substitute for a fiber optic cable ; investigated large area dual color Long Wave/Midwave Infrared detector arrays; investigated methods for the improvement of minority carrier lifetimes in the type II strained layer superlattice materials that resulting in improved FPA performance. *FY 2012 Plans:* Conduct laser research for IR countermeasures including detailed studies on the thermal characteristics of Midwave Infrared (MWIR) lasers for IRCM; investigate environmental effects of RF-photonic devices and reduce their vibration and temperature sensitivity for improved reliability; continue development of nano-fabrication techniques to achieve chip-scale RF photonic devices; and investigate methodologies for quantum well infrared detector arrays to be fabricated up to 2K x 2K focal plane arrays. *FY 2013 Plans:* Will advance investigations of environmental effects on RF photonic devices and reduce their vibration and temperature sensitivity for improved reliability; will experimentally validate the RF-Photonic time domain signal auto-correlation processor for signals intelligence applications; develop nano-photonic devices and nano-fabrication techniques for chip-scale opto-electronic integrated circuit devices with reduced size, weight and power, Will investigate plasmonic materials, metamaterials, photonic crystals and resonating materials on the quantum efficiency of Quantum Well Infrared Photodetectors (QWIPS); will extend the operating wavelength of III-V semiconductor devices, will explore materials properties for the Type II Strained Layer Superlattice and investigate novel growth approaches and novel growth structures that will result in cheaper IR focal plane arrays. Will investigate possible methods of improving power output of quantum cascade lasers with potential transition to infrared countermeasures applications.			
Accomplishments/Planned Programs Subtotals	2.664	2.783	2.836

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army	DATE: February 2012

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 52C: *MAPPING & REMOTE SENS*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
52C: *MAPPING & REMOTE SENS*	2.774	2.910	2.233	-	2.233	2.259	2.288	2.312	2.344	Continuing	Continuing

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 2011	FY 2012	FY 2013
Title: Sensor Phenomenology and Spatial-Temporal Pattern Discovery	2.774	2.910	2.233
Description: Funding provided for the following research.			
FY 2011 Accomplishments: Explored the relationship of magnetic core nanomaterials and the stand-off recovery of these materials as sensors using Surface-Enhanced Raman Scattering (SERS); also, investigated social network concepts to better assess important interaction within and between our adversaries, directly relating objects, events, actions, and trajectories within a spatial-temporal domain.			
FY 2012 Plans: Investigate the effects of underground anomalies on the spectral properties of surface vegetation; create a specific mathematical boundary for determining if a trajectory is an outlier.			
FY 2013 Plans:			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 52C: *MAPPING & REMOTE SENS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Will investigate a multi-parameter soil metabolic index to understand environmental impacts on emerging biological sensing. Will construct primitives to aid in efficiently solving concurrent complex queries in hierarchically represented spatial-temporal data. Will validate new infrasound signal propagation models against collected data applicable to remote assessment of hostile activity.			
Accomplishments/Planned Programs Subtotals	2.774	2.910	2.233

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 53A: *BATTLEFIELD ENV & SIG*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
53A: *BATTLEFIELD ENV & SIG*	3.272	3.430	3.534	-	3.534	3.572	3.621	3.583	3.642	Continuing	Continuing

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 understanding, characterizing, and depicting 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 abilities to provide predictable, actionable, accurate and timely tactical environmental intelligence to battlefield commanders. 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 for soldier health, 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-optic spectrum, and formulation of objective analysis tools that can assimilate on-scene all-source weather observations and fuse this information with forecasts to provide immediate Nowcast products. These capabilities will have a direct impact on ensuring Soldier survivability, weapon system lethality, effective surveillance and reconnaissance, and the mobility required for future warfighter mission planning and execution operations.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Research in optical and acoustical propagation in the atmosphere	1.936	2.032	2.090
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 2011 Accomplishments:* Developed acoustic propagation algorithms for complex urban domains accounting for multiple building structure effects; exploited broader frequency acoustic propagation including ultrasound; investigated and employed the capabilities of Two-dimensional			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 53A: *BATTLEFIELD ENV & SIG*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Angular Optical Scattering and Ultra Violet-Laser Induced Fluorescence technologies for the characterization of hazardous particles in the atmosphere. *FY 2012 Plans:* Characterize atmospheric propagation effects on emerging technologies including Terahertz spectroscopy and imaging systems; Perform investigations and analyses of environmental impacts on thermal and infrared polarimetric images; Investigate the use of high resolution, multi-spectra, Light Detection And Ranging techniques for the detection of atmospheric aerosols and trace gases; Investigate the effects of ozone and other atmospheric constituents on the fluorescence spectra and other properties of bioaerosols; Measure fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents using laser-induced fluorescence and photoacoustic spectroscopy; Investigate the use of active wind screens for infrasound sensors to reduce sensor footprint on the ground; Investigate whether the influence of acoustic waves on the ionosphere can be used for the detection of anomalous events. *FY 2013 Plans:* Will investigate how bioaerosol properties change with different atmospheric conditions (sunlight, humidity, oxidizing agents, etc.) so that bioaerosol viability and detectability can be added to transport and dispersion models for force protection and mission planning; will measure spectrally resolved fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents to enable more accurate assessments of the capabilities of biowarfare agent detectors; will investigate Raman spectra of individual airborne bioparticles to provide increased capability for characterizing atmospheric particles, especially harmful particles, which are too small to detect with other techniques; will perform multidisciplinary theoretical investigations for the remote sensing of precursors to atmospheric events affecting Army Operations to enhance force protection; will establish functional relationships between mid-infrared (MidIR) and long-wave infrared (LWIR) polarimetric signatures as a function of atmospheric and meteorological conditions for improved target detection, classification, and identification. Will extend terahertz (THz) propagation modeling to include path radiance and water vapor background noise to add these performance effects and improve the design of emerging passive THz imaging technology; Will improve the fundamental theory for optical turbulence effects on short-exposure passive electro-optics and infrared imaging for new optimal designs for passive adaptive optics correction.			
Title: Predictive Modeling of the Boundary Layer *Description:* Increase survivability and improve situational awareness for a variety of sensors optics and flying objects (projectiles, UAVs, etc&) through research to enhance accuracy of predictive modeling of the atmospheric boundary layer and improve the ability to function effectively in adverse conditions. *FY 2011 Accomplishments:* Investigated ensemble modeling techniques leading to fine-scale battlefield probabilistic weather and effects forecasting; produced improved theory and characterization of atmospheric turbulence using sonic anemometer arrays for more realistic	1.336	1.398	1.444

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 53A: *BATTLEFIELD ENV & SIG*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
mechanical and optical turbulence models, developed biologically inspired approaches to improved environmental awareness and reactions for autonomous systems; and extended the Atmospheric Boundary Layer Environment (ABLE) microscale wind model from 2D to 3D using advances in high-performance modeling to improve wind flow predictions in complex and urban terrain .			
FY 2012 Plans: Verify and validate the 3D ABLE model against well established measured and modeled data from complex and urban domain; Investigate modeling techniques deriving probabilistic weather impacts forecasts for future decision support tools; and develop new approaches to adverse weather route optimization algorithms for air and ground applications.			
FY 2013 Plans: Will enhance the 3D ABLE models 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; Will improve characterization and simulation of urban turbulence effects and bio-inspired control corrections that will improve Nano and Micro Air Vehicle control, hover stability and wind gust rejection; Will investigate the improvements in using sub-km Weather Research & Forecasting-based Weather Running Estimate-Nowcast (WRE-N) forecast/local now-cast model output as initial conditions to improve the fidelity and accuracy of predictions from the boundary layer 3D ABLE model for high resolution meteorology in complex terrain.			
Accomplishments/Planned Programs Subtotals	3.272	3.430	3.534

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY
2040: *Research, Development, Test & Evaluation, Army*
BA 1: *Basic Research*

R-1 ITEM NOMENCLATURE
PE 0601102A: *DEFENSE RESEARCH SCIENCES*

PROJECT
74A: *HUMAN ENGINEERING*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
74A: *HUMAN ENGINEERING*	6.793	8.006	8.265	-	8.265	8.413	8.642	8.816	8.880	Continuing	Continuing

Note
  Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Research to characterize and enhance Soldier performance	2.065	1.951	2.022
Description: Characterize and enhance human auditory performance of the dismounted warrior in complex environments while protecting the hearing of the Soldier.			
FY 2011 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Conducted initial experiments to quantify the contributions of visual, auditory, tactile, kinesthetic and narrative factors to an individual Soldier's immersive experiences; developed measures to capture how individuals perceive the effectiveness/ contribution of immersion in simulation environments. *FY 2012 Plans:* Determine the effects of ear coverage, from wearing infantry helmets, on auditory localization for modeling of Soldier mission performance. *FY 2013 Plans:* Will investigate the sound characteristics of weapon firing signatures to enable Soldiers' future ability to identify the specific weapons being fired and location of attack.			
Title: Soldier performance *Description:* Characterize key issues underlying Soldier decision making such as computer modeling and social network analyses to investigate the quality of information flow in a defined command and control structure, investigations into situational understanding and prediction in uncertain environments, and identifying usability deficiencies and mismatches between battle command processes and technology enhancements. *FY 2011 Accomplishments:* Began development of cognitive models predictive of team decision making; worked on determining effects of information quality and presentation on Soldier system performance. *FY 2012 Plans:* Transfer lessons learned from the development of a cognitive model-based architecture for robotics control to the Robotics Collaborative Technology Alliance; continue studies which correlate electroencephalograph data with response times to perceptual stimulus events that will further the validation of the perceptual component of the cognitive model Adaptive Control of Thought-Rational (ACT-R). *FY 2013 Plans:* Will continue to transition cognitive model-based architecture knowledge for robotics control to the Robotics Collaborative Technology Alliance and the Army Research Laboratory Robotics Enterprise allowing enhancement of recon capability to the level of	2.180	2.205	2.570
Title: Translational Neuroscience *Description:* Integrating neuroscience with traditional approaches to understanding Soldier behavior to enable systems designs that maximize Soldier performance. Formerly titled Research in Neuroergonomics.	1.510	3.050	2.412

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
FY 2011 Accomplishments: Advanced state-of-the-art in data analytic capabilities to extract brain-relevant information from multi-dimensional data arrays obtained in operationally-relevant contexts; validated models of neural mechanisms underlying visual scanning and explored the neural processes underlying human interaction with autonomous systems. *FY 2012 Plans:* Investigate closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/ fatigue state of the user; develop normative models that account for the variability in individual differences on performance; explore functional connectivity of multivariate datasets for assessment of performance measures; investigate predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals. *FY 2013 Plans:* Will investigate sensory and motor neural processes with respect to affect on Soldier-systems within dynamic environments; will examine validation techniques for measures of task performance in operational environments to develop future Soldier metrics; will evaluate efficacy of predictive metrics for neural processing and/or cognitive performance among individuals for quantifying cognitive loads.			
Title: Cognition and Neuroergonomics *Description:* Devise and show fundamental translational principles for neuroscience-based research and theory to complex operations settings in three focus areas: Soldier-system information transfer, commander-level decision making, and individualized analysis and assessment of cognitive performance in operational environments. *FY 2011 Accomplishments:* Explored models of information presentation, including multi-modal and adaptive displays; examined the effects of information systems on physical and cognitive performance; examined how the nervous system filters large-scale, multi-dimensional data sets for decision making; identified individual differences in neural processing underlying successful and unsuccessful decision making; identified key individual differences and stressors and investigated their impact on neural processing and cognitive performance; explored the appropriate neuro-sensing approaches for assessment in operational environments; explored methods for state detection and signal processing techniques for signal integration; developed static algorithms that account for the variability in individual differences and/or environmental stressors on performance. *FY 2012 Plans:* Investigate closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/ fatigue state of the user; Develop normative models that account for the variability in individual differences on performance;	1.038	0.800	1.261

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
explore functional connectivity of multivariate datasets for assessment of performance measures; and investigate predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals. ***FY 2013 Plans:*** Will explore neural representations and develop novel measures for assessing individual differences in decision making, cognitive performance, and/or anatomical structure; will explore network connectivity measures and patterns in both model simulations and empirical datasets.			
Accomplishments/Planned Programs Subtotals	6.793	8.006	8.265

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army									**DATE:** February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*					**PROJECT** 74F: *PERS PERF & TRAINING*	
COST ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**Cost To Complete**	**Total Cost**
74F: *PERS PERF & TRAINING*	5.359	6.755	7.094	-	7.094	7.219	7.338	7.458	7.583	Continuing	Continuing

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Title: Human Behavior	3.644	4.765	5.024
Description: Funding is provided to better select, classify, train, and/or develop Soldiers and leaders.			
FY 2011 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *PERS PERF & TRAINING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Conducted basic research in the areas of psychological measures of individual abilities, implicit and explicit learning, cognition, and social influence. *FY 2012 Plans:* Conduct research in the areas of the leadership and team performance in complex environments; analyze the impact of training methods on learner performance; investigate how a neurophysiologic state (i.e., affect) influences perception; identify cognitive strategies of experts that can be used to develop efficient training protocols. *FY 2013 Plans:* Will develop data-driven models to assess the impact of training methods on task performance; will identify approaches to enhance experiential learning for guided self-development; and will investigate tacit acquisition of cultural knowledge.			
Title: Network-Human Science *Description:* Funding is provided for better understanding individual, unit, and organizational behavior within the context of complex networked environments. *FY 2011 Accomplishments:* Continued basic research on variables that influence the interaction of individuals and teams within distributed environments. *FY 2012 Plans:* Conduct research to understand organizational dynamics and unit cohesion; conduct research on how language usage influences social dynamics; and analyze the influences of human performance in complex networked environments. *FY 2013 Plans:* Will investigate organizational leadership as transmitted through social network links; will develop models of unit cohesion within multi-level organizational units.	1.715	1.990	2.070
Accomplishments/Planned Programs Subtotals	5.359	6.755	7.094

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army								DATE: February 2012		

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT F20: *ADV PROPULSION RSCH*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
F20: *ADV PROPULSION RSCH*	3.348	3.990	4.211	-	4.211	4.256	4.307	4.283	4.357	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

Work in this project is performed by the Army Research Laboratory (ARL) at Aberdeen Proving Grounds and the NASA Glenn Research Center, Cleveland, OH.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Thermal Materials	2.332	2.443	2.495
Description: Investigates new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluates 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 2011 Accomplishments:* Completed computational assessment of gear windage for various gear rotational conditions and compared with validation results to identify and mitigate power losses. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** F20: *ADV PROPULSION RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Investigate a modeling and simulation capability that will be used to predict and compare the automotive, thermal, and electromechanical performance of next-generation Army wheeled tactical and combat vehicle power train concepts; and investigate the design of more fuel efficient propulsion systems . *FY 2013 Plans:* Will determine loading and durability properties associated with hybrid ceramic bearings and hybrid composite gears for next generation Army wheeled tactical and combat vehicle power-train concepts.			
Title: Reliable Small Engines for Unmanned Systems *Description:* Develops 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 2011 Accomplishments:* Evaluated potential for improving fuel consumption and reliability of heavy fuel engine concepts for small (<100 HP) system applications. *FY 2012 Plans:* Evaluate the performance of a representative Army unmanned vehicle engines at simulated altitude conditions . *FY 2013 Plans:* Will establish the capability to experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions to optimize combustion performance in future engine concepts.	1.016	1.547	1.716
Accomplishments/Planned Programs Subtotals	3.348	3.990	4.211

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** F22: *RSCH IN VEH MOBILITY*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
F22: *RSCH IN VEH MOBILITY*	0.561	0.587	0.606	-	0.606	0.612	0.621	0.630	0.642	Continuing	Continuing

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, and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced adiabatic diesel 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 high-output military engines. 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 instantaneous diesel engine optimizations, using advanced analytical and experimental procedures.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Advanced Mathematical Algorithms for Improved Vehicle Efficiency	0.561	0.587	0.606
Description: Funding is provided for the following effort: *FY 2011 Accomplishments:* Continued developing JP-8 engineering models for combustion and ignition as a function of fuel ignition quality; continued exploring vehicle-human interaction dynamics; and studied better modeling techniques for vehicle-terrain interaction dynamics. *FY 2012 Plans:* Expand JP-8 ignition models to include wide varying ignition quality fuels; explore and develop robust multidisciplinary design optimization techniques with advanced materials for reducing ground vehicle weight while improving or maintaining ground vehicle mobility, reliability and survivability. *FY 2013 Plans:* Will research ignition under high pressure injection conditions, and analyze heat release data for synthetic JP-8 fuel; will research importance sampling techniques for accelerated testing for reliability quantification under stochastic input conditions; will explore			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** F22: *RSCH IN VEH MOBILITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
quantification of model uncertainty with enhanced identifiability; and research mobility models for small robot terramechanics, i.e. the interaction of wheeled or tracked vehicles on various surfaces.			
Accomplishments/Planned Programs Subtotals	0.561	0.587	0.606

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H42: *MATERIALS & MECHANICS*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H42: *MATERIALS & MECHANICS*	6.769	8.448	8.644	-	8.644	8.907	8.998	9.053	9.208	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Microscopic/Nanostructural Materials	2.363	2.448	2.571

Description: Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the future force.

FY 2011 Accomplishments:
Researched novel processing method concepts for improved armor ceramics; and characterized multifunctional materials systems seeking performance at minimum weight.

FY 2012 Plans:
Provide a theoretical basis for the selection of kinetically stabilizing alloying elements in nanocrystalline materials; and prove grain size stabilization in nanocrystalline metallic systems by experimental methods for better performing ceramic armor materials.

FY 2013 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army			DATE: February 2012		
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*		**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*		**PROJECT** H42: *MATERIALS & MECHANICS*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will research novel composite materials that demonstrate self-healing capability using bio-engineered concepts emerging basic research; and will advance the principles of inverse materials design and apply to emerging material models for future armor designs			
Title: High Deformation Rate Materials *Description:* Develop fundamental understanding necessary to design, process and characterize materials specifically intended for high loading rate applications. *FY 2011 Accomplishments:* Performed research relating high rate properties and microstructures to ballistic property observations; and used model results of static and transient electric/magnetic/flow fields to identify new materials and mechanisms. *FY 2012 Plans:* Model and experimentally determine property relationships in piezoelectric materials; and describe the chemical state of emerging high rate materials with a view toward optimizing materials properties for ballistic environments. *FY 2013 Plans:* Will develop models to describe specific strengthening mechanisms for novel aluminum alloys and use to cast coupon-scale ingots for experimental validation; and develop synthesis, processing and characterization methods specifically designed for materials in extreme dynamic environments.	2.203	2.475	3.009
Title: Materials Research and Processing at Small Scale *Description:* Elucidate and exploit unique structure, processing, and property relationships that occur in materials at small length scales and develop methods to tailor the physical, chemical and mechanical response of these materials to enable unprecedented performance improvements in materials properties. *FY 2011 Accomplishments:* Determined the relationship between textile properties and fabrication methods; and characterized novel protective materials using state of the art microscopy tools. *FY 2012 Plans:* Develop tools for the characterization of hierarchically structured materials for an understanding of the synthesis and mechanics of bio-inspired materials; and determine quantum effects on materials design to enable unprecedented performance improvements in materials properties. *FY 2013 Plans:*	2.203	3.525	3.064

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H42: *MATERIALS & MECHANICS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will develop novel polymeric materials which are thermally and chemically stable under extreme operating conditions; will investigate and develop modeling and simulation methods specifically designed for materials used in extreme dynamic environments.			
Accomplishments/Planned Programs Subtotals	6.769	8.448	8.644

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H43: *RESEARCH IN BALLISTICS*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H43: *RESEARCH IN BALLISTICS*	8.078	9.049	9.103	-	9.103	9.383	9.546	9.607	9.769	Continuing	Continuing

Note
  Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: National Advanced Energetics Initiative	2.575	2.949	2.913
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 2011 Accomplishments:* Linked atomistic descriptions of disruptive energy storage and release mechanisms to new mesoscale models to describe space-time fluctuating microstructure behavior critical to understanding reactive behavior at the continuum modeling level. *FY 2012 Plans:* Investigate rapid energy release from new classes of materials subjected to extreme physical constraints and characterize through high performance computer models and experiments. *FY 2013 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will extend quantum-mechanical-based models to enable prediction of key performance and vulnerability properties; will determine feasibility of non-traditional energetic materials containing stored structural energy (e.g. extended solids), and identify factors influencing stabilization for designing future disruptive energetic 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 2011 Accomplishments:* Established a validation technique that directly probes and quantifies the fundamental mechanism responsible for brittle material ballistic performance; developed suitable post-ignition thermal and equation of state models for reactive material ignition products; and quantified the terminal ballistic effects of a variety of urban construction materials impacting the human body through extensive modeling and sub-scale experiments. *FY 2012 Plans:* Explore non-linear aerodynamics of complex shapes to advance next generation extended range precision munitions; Investigate non-traditional modeling techniques for using on-board projectile flight information to enable affordable non-GPS guidance; and perform first generation mapping of the shock and blunt impact effects on the mechanical state of human bone and tissues and the effects on specified connective centers in the human brain. *FY 2013 Plans:* Will develop and validate coupled computational fluid dynamics, flight dynamics, and rigid body dynamics techniques in a single computational model to predict non-linear aerodynamic behavior of maneuvering precision munitions; will characterize theoretically and experimentally coupled GPS and navigation concepts for the next generation of highly dynamic, spinning projectiles; will investigate the fundamental mechanical interaction of human brain tissue with shock waves that occur during ballistic events.	2.612	2.479	1.732
Title: Extramural research in non-lethal (NL) control methods *Description:* Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. *FY 2011 Accomplishments:*	0.925	0.996	1.262

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Developed fast hierarchical Bayesian inference algorithms and fusion techniques to combine results obtained from analyzing hyper-spectral imagery with information obtained from other sources such as biological validation or knowledge base for increased battlefield awareness. *FY 2012 Plans:* Focus on the development of new models for automated image analysis and understanding, with emphasis on crowd behavior analysis through examining the spatio-temporal pattern of crowd behavior as well as abnormal event detection in crowds for situation awareness and crowd control; study relationships between molecular structure, decomposition pathways, and potential energy surfaces for ground and excited electronic states of energetic compounds using laboratory-based spectroscopic and advanced electronic structure methods to enable more accurate predictions of the performance properties of speculative energetic compounds. *FY 2013 Plans:* Will study the decomposition pathways of energetic materials to elucidate the molecular decomposition behavior at the, individual molecule scale; will create new approaches and methods to reduce effects of complex noise and missing data for exploiting sparse hyperspectral and multimodal data ; establish novel approaches for scalable indexing and retrieval of large image datasets that are necessary for effective analysis and exploitation of knowledge databases.			
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 2011 Accomplishments:* Formulated and validated explosive-free plate acceleration models and equation of state models into continuum mechanics codes; and used the mesoscale modeling approach to identify ceramic material microstructures that resulted in improved ballistic resistance. *FY 2012 Plans:* Evaluate novel reactive armor and electromagnetic armor mechanisms to include inferring real-time geometry of penetration into thick armor sections induced with electromechnical stresses. *FY 2013 Plans:* Will develop the capability to measure electromechanical stress in very small samples deforming at very high strain rates and explore the effects of high magnetic field on the stress response within these deforming solids; will develop fundamental underpinnings of the electrical conductivity within the shock cone that forms around hypervelocity penetrators.	1.966	2.625	3.196
Accomplishments/Planned Programs Subtotals	8.078	9.049	9.103

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H44: *ADV SENSORS RESEARCH*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H44: *ADV SENSORS RESEARCH*	9.405	9.989	10.219	-	10.219	10.347	10.658	10.943	11.127	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Adaptive, Active, and Intelligent Optical Systems	1.697	1.752	1.833

Exhibit **R-2A**, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Description: Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. *FY 2011 Accomplishments:* Devised target-in-loop (TIL) laser beam control techniques for Army long range and tactical scenario engagements. *FY 2012 Plans:* Develop image processing software that includes super resolution, fusion, and adaptive optics for application to enhance laser communication technologies and validate image processing software in realistic battlefield conditions to improve real-time situational awareness through greater fidelity of battlefield imagery. *FY 2013 Plans:* Will investigate and develop advanced Army battle-space tactical and long-range atmospheric laser communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization, and allow utilization of advanced command and control techniques. Will develop novel processing techniques to extend the use of quantum imaging to tactical environments in order to improve battlefield communications.			
Title: Improving Sensor and Display Capabilities *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 2011 Accomplishments:* Optimized conducting organic materials for flexible display and electronics, investigate 3-D Synthetic Aperture Radar imaging using wide-angle simulation data of complex buildings for through-the-wall sensing research, developed conductive organic materials and thin film transistors and integrated into flexible electronic devices. Researched networked fusion concepts across distributed multimodal sensor nodes and developed novel magnetic sensors with enhanced performance. Fabricated and evaluated metamaterial inspired antennas based on theoretical simulations. *FY 2012 Plans:* Fabricate and investigate metamaterial inspired antennas based on theoretical simulations; develop, apply and validate advanced computational models of 3-dimensional realistic ground surfaces to aid in defining theoretical performance limits of low frequency wideband radar technology for the detection of landmines and IEDs; research phenomenology of features associated with sensing human motion and concepts for fusion of new features to reduce false alarms; optimize conductive organic materials and high	2.571	2.685	2.775

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
stability Organic Light Emitting Diodes (OLEDs) for transition into OLED displays to include development of thin-film transistors and transparent electrodes for flexible electronics applications. *FY 2013 Plans:* Will develop sensor fusion algorithms to enable the aggregation of data features into information within the context of D2D. Will develop theoretical understanding of metaferrites (using analytical and computer simulations) as an enabling technology for low-profile and embedded antenna enhancements. Will analyze and develop algorithms to exploit co-registered video and radar imagery to enhance detection of landmines and IEDs with reduced false alarms. Will enhance acoustic sensor and array performance through wind mitigation and adaptive algorithms for improved event classification. Will evaluate conductive organic materials and high stability OLEDs for transition into OLED displays and emerging sensor applications. Will develop 1/f noise resistant magnetic sensors to improve signal-to-noise ratio (SNR) and detection range for counter IED technologies.			
Title: Biologically-Inspired Sensing and Power Generation *Description:* Investigate biological systems to develop biologically-inspired materials for use as sensors as well as for power generation and storage. *FY 2011 Accomplishments:* Manipulated bacteria for improved remediation of energetic materials and generation of organic fuels, investigated electric properties of bio-assembled materials for battery applications, investigated mechanical properties of bio-inspired structural materials, and investigated the electronic properties of bio-assembled electronic structures. *FY 2012 Plans:* Investigate methods to redesign cellular proteins to converge the signaling from different cellular receptors to a common output signal suitable for electronic device detection; manipulate bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterize the resulting complexes; complete characterization of 2-D assembly of nucleic acid templates in non-aqueous solvents for patterning of semiconductor seed particles for IR and photovoltaic devices; continue iterative modeling and experimental evaluation of models for remediation of energetics and generation of organic fuels to reflect new information collected from systems biology approaches. *FY 2013 Plans:* Will evaluate biofilm contaminate-sensing genetic constructs against actual logistics fluid specimens for both JP-8 and potable water; will manipulate bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterize the resulting complexes; will transition to larger 2-D assemblies appropriate for traditional electronic manufacturing; and will analyze engineered strains against models for generation of organic fuels to evaluate information collected from systems biology approaches. Will investigate the improvement of advanced modeling techniques through the use of an iterative approach	2.227	3.052	3.068

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
of multi-scale modeling and increased biological characterization. Will examine genotype to phenotype relationship of laboratory bacterial cultures to determine a means for identification.			
Title: Multi-Scale Modeling for Novel Materials *Description:* Explore and develop modeling techniques to support fundamental studies of materials to identify physics and atomic properties that define electronic properties and characteristics. *FY 2011 Accomplishments:* Performed fundamental studies of materials to identify and model physics and atomic interactions that define the electronic properties and characteristics, such as bandgap structure and control material deformation, progressive / catastrophic failure, and phase response across length scales; evolved interface physics between nano- and meso-scales up to the continuum; created new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects at interfaces, and response under extreme conditions. Developed scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems. *FY 2012 Plans:* Perform fundamental studies of materials to identify and model physics and atomic interactions that define the electronic, optical properties and characteristics, such as bandgap structure, carrier transport, diffusion rates, defects, control material deformation, progressive / catastrophic failure, and phase response across length scales. Develop interface physics between nano- and meso-scales up to the continuum; expand upon and create new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions; Develop web-based security scheme for external and internal project users; develop multi-scale computational science environment to facilitate coupling of different software; establish methods to support high performance computing users and software developers. *FY 2013 Plans:* Will conduct fundamental studies of materials to identify and model physics and atomic interactions that define their electronic and optical properties and characteristics. Will evolve interface physics between nano- and meso-scales up to the continuum; will expand upon and create new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions. Will evolve web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; will examine multi-scale computational science environment to facilitate coupling of different software programs/algorithms; will advance methods to support high performance computing users and software developers.	2.910	2.500	2.543
Accomplishments/Planned Programs Subtotals	9.405	9.989	10.219

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*					PROJECT H45: *AIR MOBILITY*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H45: *AIR MOBILITY*	2.328	2.445	2.515	-	2.515	2.552	2.588	2.625	2.671	Continuing	Continuing

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 the logistics footprint, and increase survivability for rotary wing aircraft.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Rotary Wing Aerodynamics	2.328	2.445	2.515
Description: Funding is provided for the following effort			
FY 2011 Accomplishments: Developed improved and validated hover performance methods, investigated the ability of pressure sensitive paint to acquire unsteady pressure measurements for both fuselage and rotor blades.			
FY 2012 Plans: Assess facility effects on existing highest-quality single-rotor hover data; investigate natural laminar flow wings for improved rotorcraft performance; and explore high performance computing methodology for difficult rotorcraft phenomenon.			
FY 2013 Plans:			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H45: *AIR MOBILITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will experimentally investigate detailed helicopter wake structure for the existence of worm-like fluid phenomena seen in computational fluid dynamics (CFD) calculations; will analytically/numerically investigate the oscillation encountered in CFD prediction for hover performance; and will assess the importance of the fuselage impedance on rotor blade structural loads and helicopter vibration.			
Accomplishments/Planned Programs Subtotals	2.328	2.445	2.515

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H47: *APPLIED PHYSICS RSCH*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H47: *APPLIED PHYSICS RSCH*	4.861	5.079	5.222	-	5.222	5.270	5.535	5.980	6.001	Continuing	Continuing

Note
Not applicable for this item

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Nanoelectronic Devices and Sensors	2.917	3.069	3.188
Description: Materials for advanced batteries; fuel cells and reformers for Soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band-gap semiconductors for high-power electronic applications; materials for 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 2011 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H47: *APPLIED PHYSICS RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Split a cold atom cloud in an atom chip waveguide. Integrated nanoporous energetic silicon with MEMS microthruster devices and developed nanoelectronic devices. Developed new battery electrode by bio-inspired processes from Institute for Collaborative Biotechnologies, PE 0601104A/project H05. ***FY 2012 Plans:*** Study the coherence properties of a split cold atom cloud in an atom chip waveguide; investigate energetic energy conversion methods for on-chip pulsed power; examine existing models for graphene materials growth for potential use in nanoelectronic devices; investigate next generation wide band gap power device materials such as Aluminum Nitride (AlN) and diamond, conduct modeling of electron transport in alkaline membrane electrode assemblies, and model physical properties of Silicon (Si) anodes for Lithium ion batteries and the structure property relationships of Si anodes. ***FY 2013 Plans:*** Will experimentally validate multiscale models for electrochemical transport and charge transfer in electrochemical devices to optimize performance. Investigate novel nanostructures for battery and fuel cell electrodes for increased efficiency. Will examine large area growth, material transfer, and substrate interactions of carbon based nanoelectronics for increased capabilities and reduced power consumption of battlefield electronics ; will investigate 3-dimensional growth and patterning of piezoelectric materials for low power large displacement MEMS actuators; will investigate methods and formulations for detonation using on-chip energetic materials; will investigate, emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications. Will characterize interference fringes using cold atoms on an atom chip; Will investigate GaN/AlGaN and other wide-bandgap materials and device structure characteristics under high power conditions for improved electrical efficiency and associated thermal management .			
Title: Advanced Energy Science Research ***Description:*** Conduct materials research and multi-scale modeling that will lead to advances in energy storage, harvesting, and conversion for a wide range of Army applications such as Soldiers, platforms, and microgrids. ***FY 2011 Accomplishments:*** Conducted research to advance novel materials by design using modeling and theoretical computations to predict characteristics and performance a priori for energy storage and conversion materials; investigated multidisciplinary approaches for novel energy harvesting (light, heat, vibration, isotope, and biological energy sources); investigated emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, thin films, and energy conversion applications. ***FY 2012 Plans:*** Conduct research to design, fabricate and characterize materials properties in coordination with planned modeling and theoretical computations for energy storage and conversion materials; conduct research in developing computational tools in multi-scale modeling supporting electrochemical energy materials development; design and experiment with novel energy harvesting (light,	1.944	2.010	2.034

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H47: *APPLIED PHYSICS RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
heat, vibration, isotope, biological energy, sources) methods; investigate, emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, thin films, and energy conversion applications. *FY 2013 Plans:* Will conduct research on the design, fabrication and characterization of material properties in coordination with modeling and theoretical computations for energy storage and conversion materials; will investigate methods for developing multi scale computational and simulation tools supporting the development of materials for electrochemical energy conversion and generation; will design and experiment with novel energy harvesting (light, heat, vibration, isotope, biological energy, sources) methods; investigate emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, and energy conversion applications. Will investigate advanced device architectures for thermoelectric and photovoltaic devices for increased energy conversion efficiency .			
Accomplishments/Planned Programs Subtotals	4.861	5.079	5.222

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army	DATE: February 2012

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *BATTLESPACE INFO & COMM RSC*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H48: *BATTLESPACE INFO & COMM RSC*	13.309	15.701	21.519	-	21.519	22.557	23.177	23.446	23.752	Continuing	Continuing

Note
Not applicable to this item

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Communication for Tactical Networks	1.688	1.750	1.810
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 2011 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Used network behavior models and scaling laws to develop cognitive networking protocols to enhance the performance of tactical mobile networks. *FY 2012 Plans:* Develop techniques to characterize the quality of information and develop an understanding and potential metrics for impact on network behavior. *FY 2013 Plans:* Will develop techniques to enhance overall operational capacity and military effectiveness of networks by adaptive management of quality of information and user trust in composite networks. The results will contribute to novel capabilities in tactical mobile communication networks that enhance effective communications of Warfighters in the networks by maximizing delivery of information of highest quality as well as managing trust in the information and the network.			
Title: Data to Knowledge to Support Decision Making *Description:* Design and implement a laboratory-scale common information-processing infrastructure, inclusive of service oriented architecture for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. *FY 2011 Accomplishments:* Conducted validations in a laboratory environment to assess the impact of scene recognition algorithms on Situation Understanding. *FY 2012 Plans:* Extend scene recognition to scene understanding algorithms, assessing them and their associated machine learning approaches on collaborating mobile platforms. *FY 2013 Plans:* Will investigate techniques for more closely coupling decision algorithms with image processing techniques to enhance and accelerate current data collection and information retrieval algorithms to improve exploitation of tactical intelligence.	1.485	1.513	2.632
Title: Information Protection for Mobile Ad-Hoc Networks (MANET)s *Description:* Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. *FY 2011 Accomplishments:*	1.704	1.767	4.953

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Investigated techniques for incorporating security constraints in networking protocols. *FY 2012 Plans:* Investigate and develop techniques for securing information flows in mobile wireless tactical environments. *FY 2013 Plans:* Will develop new security protocols suitable for use in hybrid networks by leveraging and integrating techniques of both wireless and wired environments. The new protocols will contribute to novel capabilities that will enable the Warfighters to detect and defeat malicious activities of adversaries on tactical networks and hosts in MANETs, with a special focus in mobility effects.			
Title: Multi-Lingual Computing Research *Description:* Establishes formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing. *FY 2011 Accomplishments:* Conducted laboratory validations to assess multi-engine machine translation concepts, addressing scalability and robustness in noisy environments. *FY 2012 Plans:* Formalize techniques for adapting data flows to increase the effectiveness of multi-engine translation techniques; and develop methods to support decision making from machine translated segments. *FY 2013 Plans:* Will develop novel techniques for quantifying language similarity across military domains and assess the effectiveness of those techniques in extending existing translation engines to new military decision constraints in order to improve Soldier effectiveness in foreign-language tactical environments.	1.083	1.125	1.163
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 Biotechnology at the University of California - Santa Barbara. *FY 2011 Accomplishments:* Developed algorithms, techniques and metrics for robust local/global network optimization using cognitive and communication network metrics. *FY 2012 Plans:*	0.986	1.011	1.022

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Develop algorithms for the analysis of complicated large-scale network structures. *FY 2013 Plans:* Will develop techniques and algorithms for assessing and optimizing the impact of social, cognitive and information structures on the behavior and performance of Army networks. The resulting techniques and algorithms will support future network technologies to enable Warfighters to anticipate and manage information, social and communication effects in network-enabled Mission Command.			
Title: Advanced Computing *Description:* Investigate computing and networking architectures, algorithms, as well as visualization for advanced battle command applications of C4I system. *FY 2011 Accomplishments:* Implemented large-scale battlefield network modeling; develop real-time algorithms to assist network emulations; developed models and analysis techniques; established information fusion of different data types for battle command applications that exploit emerging mobile hybrid computing architectures. *FY 2012 Plans:* Validate battle command applications developed on mobile hybrid computing architectures, namely, large-scale network electromagnetic propagation; develop real time algorithms for network emulations, and network simulators; develop new methods for battle command information visualization; investigate scalable programming models and battle command applications for the next generation Intel high performance computing architectures, namely, cloud on a chip, and secure enclaves. *FY 2013 Plans:* Will implement new scalable programming models for cloud-computing and will perform benchmarking for Mobile Network Modeling Institute battle scenario of C4ISR-on the move. The advanced computing approaches will assist in taking supercomputing as a deployable asset to the battlefield enhancing real-time Situational Awareness in tactical environments.	2.509	3.695	3.563
Title: Network Science Technology Experimental Center *Description:* Supports in-house Network Science studies in conjunction with the Network Sciences CTA (0601104A/Project H50). *FY 2011 Accomplishments:* Extended the wireless emulation and simulation tools to support the modeling of networks of 1000s of nodes with high-fidelity propagation models and realistic traffic models. The simulation and emulation tools are linked to field validations to extend the	3.854	4.840	6.376

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
scale of the network evaluated. These efforts significantly improved the understanding of network behaviors under a full range of operational conditions, significantly improving the design of Network Centric Warfare NCW technologies. *FY 2012 Plans:* Expand capabilities toward extensive integration of wireless communications emulation with academic and industrial experimental facilities developed under the Network Sciences CTA; instigate a comprehensive program of multi-disciplinary experiments with wireless emulation utilized as hardware in the loop; document experimental and theoretical results describing and predicting impact of mobility and adversarial attacks on the dynamics of information quality delivered through mobile communication networks to include observed phenomena of the characteristics of network reliability perceptions and trust on battle command decision making; research social network analysis metrics and techniques for integrating these with traditional communications and information network analysis methods. *FY 2013 Plans:* Will develop and validate approaches and techniques to characterize, assess, model, and predict the performance of a notional composite network. will examine the interaction of social, informational and communication processes as they adapt to changes in mission, adversarial attacks and changes in tactics, and structure. The results will contribute to the development of tools to equip Warfighters with the capability to anticipate and manage the effects of information, social and communication dynamics on tactical networks for mission command.			
Accomplishments/Planned Programs Subtotals	13.309	15.701	21.519

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012

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COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H52: *EQUIP FOR THE SOLDIER*	1.055	1.103	1.135	-	1.135	1.146	1.157	1.172	1.189	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Equipment for the Soldier	1.055	1.103	1.135
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 2011 Accomplishments:* Continued fundamental work in supporting the goals of understanding cognition while performing multiple tasks; explored novel approaches to representing body geometry in biomechanical applications to address fundamental errors in measurement and analysis techniques of earlier human limb mass property studies; and conducted experiments to improve the understanding of the basic phenomena of the biomimetic approach to metal oxide formation for the production of novel multifunctional materials. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Investigate the aerodynamics and structural behavior of permeable structures under dynamic loads; explore the cognitive behavior of non-spatial influences on navigation through complex environments; and perform fundamental biomechanical research on exoskeleton design and human sciences towards optimization of user performance. ***FY 2013 Plans:*** As a means to explore different methods to extract a concise feature vector to describe the shape of the human body: will implement computational algorithms to extract the shape- vectors of three-dimensional (3D) scans from the US Army and Marine Corps 3D scan database; will make modifications to available models to reflect the material dependencies on vapor concentration and solubility to understand experimental transport data for constituent membranes and laminates and linear permeation models.			
Accomplishments/Planned Programs Subtotals	1.055	1.103	1.135

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H57: *Single Investigator Basic Research*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H57: *Single Investigator Basic Research*	70.691	78.134	78.050	-	78.050	81.385	80.297	82.675	84.357	Continuing	Continuing

Note
Not applicable

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Basic Research in Life Sciences (formerly titled Basic research in molecular, physiological, and systems biology)	6.351	6.899	8.343
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 investigates the physiology underlying perception, neuro-motor output, and potential methods of monitoring cognitive states during activity, iii) biochemistry research focuses on studies in structural and cell biology, metabolic processes, and biophysics; iv) research in microbiology pursues studies in microbial physiology, ecology, and evolution, and v) social science research aims to elucidate the social,			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
cultural, and other influences to human actions. In FY13 this section includes some research activities and funding previously described under research in brain-electronic interfaces. *FY 2011 Accomplishments:* These research efforts continued to further advance their applicability and have ultimately enabled and facilitated development of new biotechnologies and bio-nano engineering applications for new Army capabilities and material. Research continued to compare the potential for various non-invasive methods to reproducibly interpret brain signals. *FY 2012 Plans:* Efforts continue to improve Soldier protection; investigation of potential mechanisms to improve Soldier cognitive and physical performance is ongoing; and methods to harness biological mechanisms for energy and fuel production are being explored.. *FY 2013 Plans:* Efforts will study fundamental genetic and physiological properties that impact human cognitive and physical performance under normal and stressed conditions; explore mechanisms that control the nanoscale organization of biomolecules and novel approaches to support biological activity outside of the cellular environment; elucidate mechanisms of microbial adaptation and antimicrobial resistance; study the fundamental physiology underlying cognition and novel non-invasive methods to monitor cognitive processes; and explore the basic theoretical foundations of human behavior across various temporal and spatial scales			
Title: Basic Research in Environmental Sciences *Description:* Basic research in environmental science possesses three areas: atmospheric science research which enables the Army to use to operational advantage weather effects on combat operations, to include unmanned aerial vehicle employment, from the surface to the boundary layer (~14,000 feet) by possessing a fundamental understanding of the lower atmosphere; terrestrial science research to enable the Army to operate effectively in all military operating environments by understanding fundamental terrain and land-based phenomena; and military habitation science, basic research to allow military power projection that meets operational needs in a sustainable manner. *FY 2011 Accomplishments:* Examined small-scale processes of the diurnal continental atmospheric boundary layer, investigated the overlapping topics of network science and geographic information science research as related to social networks, and improved operational sustainment through basic research in military habitation science. *FY 2012 Plans:* Environmental sciences is addressing the knowledge and capability gap between current operational weather prediction models and local atmospheric conditions affecting soldiers and systems through basic research in atmospheric dynamics and observational capability; research is further examining the evolution of the nocturnal boundary layer structure using up to three	2.474	3.679	3.807

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Tethered Lift Systems with multiple, redesigned, sensor packages trailing from each; the focus is on quantifying the turbulent processes as a function of separation scales; both experimental and modeling work continue to be performed that investigates the effects of both soil heterogeneity plus water and heat flux conditions at the soil surface on subsurface moisture distribution at different spatial scales in the unsaturated zone. *FY 2013 Plans:* Environmental sciences will develop new approaches to improve the resolution and tradeoffs in high fidelity modeling of atmospheric and terrestrial physical processes; develop new approaches to spatially revise both theoretical and observational problems associated with the Monin-Obukhov theory such that scale-dependent intermittency statistics will be explicitly taken into account; optimize and enhance the performance of the sensor modalities used in UXO, landmine, and explosive device detection as well as develop constitutive models for near-surface processes.			
Title: Basic Research in Chemical Sciences *Description:* Focuses on the ultimate goals of achieving advanced energy control, improved threat detection, and novel responsive materials for Soldier protection. Research efforts in advanced energy control involve the study of electrochemistry and electrocatalysis, and physical and theoretical chemistry, which will lead to light-weight, reliable, compact power sources for the Soldier and more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage. Research in protective materials involves discoveries in polymer, inorganic, and organic chemistry, which will provide new approaches for shielding the Soldier and Army platforms from ballistic, chemical, and biological threats, and reducing signatures for identification by the enemy. Threat detection research involves studies in the fields of physical, theoretical, and inorganic chemistry, which will lead to advances that provide advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals. *FY 2011 Accomplishments:* Research efforts continued to functionalize morphology, novel reactive monomers, environmentally stable self-assembled materials, and reactions in extreme media; mechanophores (mechanically active molecules) were discovered and designed: never-before-created molecules that provide automatic conversions between mechanical, thermal and chemical energy, and synthesized and incorporated these compounds into polymers and polymeric materials. *FY 2012 Plans:* Investigating how material and morphology can effect electron transfer and electrocatalysis; investigating novel approaches and designs for functionalized morphology, novel reactive monomers, and environmentally stable self-assembled materials; novel mechanophores previously integrated into composites are being evaluated for responses to mechanical damage; and initiating modeling and experimental studies to begin to uncover the physical properties that control chemical reactivity. *FY 2013 Plans:*	8.373	9.970	9.545

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will conduct research on ionic liquids in order to obtain an in-depth understanding of how their structure effects physical properties, such as transport, viscosity, and conductivity; will explore series of switchable catalysts that are capable of altering their activities in response to changes in their oxidation states in an effort to produce precisely controlled microstructures; will explore covalently immobilized peptides and proteins on non-biological surfaces to understand how the bio/abio interface can be manipulated to promote desired biological structure and function.			
Title: Basic Research in Physics *Description:* Focuses on superior optics, signature management properties, ultra-sensitive sensors, precision guidance, quantum computing, and secure communications. Research efforts in superior optics, signature management properties, and ultra-sensitive sensors are made possible through discoveries in many subfields of physics, including optical physics and imaging science, and atomic and molecular physics. Research efforts in precision guidance involve the study of atomic and molecular physics, while the pursuit of the quantum computing and secure communications research topics is made possible from specific studies in the fields of quantum information sciences and condensed matter physics. *FY 2011 Accomplishments:* Efforts continued on transformation optics for cloaking and omni-directional light collection; devised models and guided materials development for next generation electronics using optical lattices; engineered artificially layered oxides to enable disruptive electronic technology; studied quantum entanglement-enhanced metrology and stealth imaging; studied techniques to exploit quantum entanglement and controllable quantum physics effects for imaging; researched new spin-based electronics technology (spintronics) and 'cold atom' spintronics. *FY 2012 Plans:* Research continues advancing transformation optics toward eventual uses in cloaking applications and omni-directional light collection; developing new ultra-cold chemistry concepts heralding novel chemical synthesis routes; exploring cross-platform qubit entanglement and evaluate potential applications in quantum entanglement-enhanced metrology and stealth imaging; assessing and improving theories to better understand and control defects in complex oxides, especially at interfaces. *FY 2013 Plans:* Quantum optics of metamaterials will be the focus to include exploration of fundamentally new quantum effects including the photon spin and the interaction with negative index materials; will explore the control of light filaments and long distance propagation; will continue attempts to demonstrate a 25 atto-second laser pulse; will begin studies of high intensity laser light; will design and test alternative cooling techniques for use on molecules not amenable to traditional laser-cooling approaches; will investigate protected states of matter in condensed matter as well as atomic and molecular systems; will investigate non-equilibrium states in ultra-cold atomic optical lattices; will implement and characterize multi-qubit states. Will seek methodology for the rational design of novel quantum many-body states in complex oxide heterostructures; will identify the defect tolerance in	12.457	10.788	12.290

UNCLASSIFIED

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
a series of complex oxides; will perform in-situ chemical analysis of complex oxides; will identify and characterize new candidate materials for topological insulators with strong electronic interactions.			
Title: Basic Research in Electronics and Photonics	14.474	11.554	11.218
Description: Focuses on electronic sensing, optoelectronics, solid state and high frequency science, electromagnetics, microwaves, and power electronics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency.			
FY 2011 Accomplishments: Demonstrated the first MOCVD grown superlattice infrared detector with interfacial layers. Performed epitaxial growth of Zinc Oxide on Zinc Oxide substrates for subsequent characterization and laser design. Developed tunable composition nano-wires that show optically pumped lasing across the visible spectrum in a small area. Determined the effects of polarization field upon ferromagnetic and optical properties of magnetically doped GaN. Developed near and far field RF-terahertz probes and antennas used for studies of biological cells and genetic based constructs.			
FY 2012 Plans: Determining the effect of antidote lattices (a novel material structure) on the bandgap in graphene; Evaluating vertical lasing based on photonic crystal Fano resonances using nanomembrane broadband reflectors. Designing and fabricating photonic bandgap structures for use in multifunctional radio, radar, and sensor systems; Using novel probes to investigate biological cells and large scale nano-materials.			
FY 2013 Plans: Will synthesize mercury cadmium selenide on gallium antimonide substrates and investigate its optical and structural characteristics for infrared detection. Will develop novel vertical cavity transistor lasers with high modulation rates. Will develop biologically-inspired RF direction finding antenna arrays and associated signal processing techniques based on the operation of the human auditory system. Will investigate nanoscale constructs within cells and engineered nano-structures.			
Title: Basic Research in Materials Sciences (formerly titled Basic research in mechanical and material sciences)	11.324	14.131	7.097
Description: Focuses on providing innovations in materials design and processing to enable unprecedented materials through the elucidation of fundamental relationships linking composition, microstructure, defect structure, processing and properties of materials. Revolutionary materials provide support for the Army in firepower, mobility, communications, personnel protection, infrastructure and installations, and will directly affect virtually all mission areas. In FY13, the Mechanical Sciences research description and associated funding is moved to the Mechanical Sciences section within this Project.			
FY 2011 Accomplishments:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Devised a comprehensive understanding of the propagation of intense stress-waves in adaptive media with random, locally varying, and discontinuous properties for unprecedented armor material designs. Investigated novel/emerging composite materials system that mimics biological adaptive and self-healing characteristics for novel structural materials. *FY 2012 Plans:* Developing an understanding at the microscopic level (single layer) for reaction processes and kinetics of reactive materials undergoing high speed impact; develop materials with stress-activated molecules that enhance macroscopic properties of interest when elastic force is applied; investigating a predictive theoretical framework to identify promising 2D free -standing crystalline oxides/ nitrides and nanocomposites; characterizing how the instantaneous 3-D structure of a turbulent boundary changes in the presence of an adverse pressure gradient for the understanding of dynamic stall processes. *FY 2013 Plans:* Will demonstrate novel materials with large electro-caloric effects for thermal management; will achieve rapid fabrication and densification of nanostructured materials with unique combinations of high-pressure and electrical field; will establish theory to guide the design and fabrication of multifunctional materials incorporating programmable responses and hierarchical constructs; will fabricate novel 3D topological insulators with unsurpassed bulk resistivity and surface electron mobility; will demonstrate the ability to translate biochemical activity onto inorganic surfaces. In FY13, the Mechanical Sciences research description and associated funding is moved to the Mechanical Sciences section within this Project.			
Title: Basic Research in Computing Sciences (formerly titled basic research in mathematical sciences and 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 moves to the Mathematical Sciences section within this Project. *FY 2011 Accomplishments:* Used the results of the evaluation and validation efforts from FY10 to refine and improve tools and an enhance theory. Improved tools and enhanced theory developed in FY10 on cyber situation awareness were investigated leveraging advances in cognitive science, adversarial reasoning, and decision sciences to establish new capabilities in effectively predicting, preventing, and detecting cyber intrusions, in sustaining mission critical functions and services, and in rapid recovering from damage. Studies created then assessed efficient (optimal and nearly optimal) change point detection procedures and spatiotemporal image processing techniques for clutter rejection, and nonlinear filtering methods for tracking dim targets in IR/video data. *FY 2012 Plans:*	10.273	11.298	6.054

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Investigating trusted computing that is adaptive to both social and culture influences, and developing new capabilities for warfighters deployed in areas of different social and culture interactions; investigating adaptive change detection procedures for composite hypotheses in cyber security for comparison of several change point detection methods; developing computer network security and surveillance, clutter rejection and nonlinear filtering algorithms. *FY 2013 Plans:* Will continue to explore and investigate new effective computing architectures, computational methods and software tools, and to develop new methods for data sensing and fusion over large volumes of social data. Long term efforts in developing methods for the tomography of social networks, for predicting individual and collective human behaviors in the war against terrorism, and begin development of structural methods for automatic machine translation. In FY13, the Mathematical Sciences research description and associated funding moves to the Mathematical Sciences section within this Project.			
Title: Basic Research In Network Sciences *Description:* Focuses on gaining an understanding of the fundamental aspects of how networks develop, function, and adapt to the environmental and the rate of information flow in manmade and naturally occurring networks. This understanding will have a direct impact on net-centric force operations, such as better communication system design and operations, and more efficient logistics or communications support. *FY 2011 Accomplishments:* Developed the theory to understand the non-stationary, non-ergodic statistics of complex biological, social and cognitive networks observed in the experiments of FY10; understood the limitations of traditional statistical theory on which predictions have been historically based and how it impacts the capabilities of the net-centric force; specifically, the influence of intermittent uncertainty on situation awareness and decision-making in a networked environment was determined. *FY 2012 Plans:* Emphasis is on the understanding of human networks and, in particular, how information mathematically spreads through a network; the impact of the proposed work is providing a better understanding of how decisions are made in groups, and network effects of hard-line members of a group; commonalities between communication and human networks are being investigated, and how they can be analyzed in tandem. *FY 2013 Plans:* Experimental evaluation of mathematical models of how information spreads through groups/ networks is planned using Behavioral Game Theory framework; Mathematical model of decision making will be developed using neuroscience experiments, in collaboration with Life Sciences with attention being paid to errors in human judgment. Development of Game theory derived	3.514	3.224	6.663

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
from observational data is also planned for FY13 to understand microbe adaptations and micro-scale locomotion and control for micro-bio-robots.			
Title: Basic Research in Bioforensics - in FY13 this effort moves to Life Sciences and Chemical Sciences *Description:* Focuses on understanding how microbes adapt to complex and changing environments. The long term goal of this research is to discover and characterize the genetic, proteomic, and metabolic changes in response to a given environment, enabling the ability to determine where microbes originated, how closely related they are, and their recent growth environment. This research could ultimately reveal the identity and feasibility of bacterial signatures that could be used to trace the history of an organism to provide a means of tracking the cause, potential danger, and source of a biological event, whether naturally occurring or nefarious. In FY13 research activities and associated funding moves to Life Sciences and Chemical Sciences sections. *FY 2011 Accomplishments:* Efforts identified the detection limits of bacterial poles (i.e., cell structures acting as 'age markers' within bacteria); compared sequences of virulence genes and fast-evolving microbial genes from temporally, spatially, and clinically diverse Salmonella isolates to determine whether this class of genes is useful for identifying subpopulations that associate with specific environmental niches and those that have increased capacity to cause human disease. *FY 2012 Plans:* Efforts are determining the locations and compositions of palindromic repeats (i.e., structures acting as bacterial 'gene memory'); investigating methods to control of individual bacteria with external stimuli (chemical, optical or electrical) with appropriate spatial and temporal resolution; transferring bacteria from natural environments to the laboratory and identifying mutations that arise after transfer to laboratory culture environment; mapping gene expression patterns of bacterial outer membrane proteins in multiple combinations of environmental factors, including temperature, pH, and iron limitation.	1.451	1.997	-
Title: Basic Research in Oxide Electronics and Brain-electronic Interfaces - in FY13 this effort moves to Life Sciences *Description:* Focuses on advancing the theory, materials growth, and characterization of artificially-layered complex oxides with the ultimate goal of discovering emergent phenomena in this material system that may ultimately provide far-reaching opportunities for new technological capabilities, and deciphering the coding of neural systems with the long-term goal of discovering and developing methods for the non-invasive decoding and modulation of neural systems, the sensing and decoding the complex brain signals responsible for specific muscle movements, and ultimately the bridging of the living/nonliving interface in peripheral nerves that may lead to future applications in silent communication and mental control of equipment such as the natural and full control of prosthetic limbs. *FY 2012 Plans:*	-	1.997	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Research is expanding predictive theories to accurately model materials and then verify accuracy; continuing to expand heteroepitaxial capabilities; exploring solutions to eliminate or mitigate dominant defects; pursuing luminescence diagnostic studies of material defects; developing and examining experimental methods for potential to 'decode' brain signals to determine how particular thoughts can be used as control inputs for engineered systems; and investigating potential methods for interfacing electronics with the brain.			
Title: Basic Research in Quantum Imaging and Defect State Enabled Spintronics - in FY13 this effort moves to Physics. *Description:* Focuses on advancing the theory, materials growth, and characterization of artificially designed and fabricated materials with the ultimate goal of discovering emergent phenomena that may ultimately provide far-reaching opportunities for new technological capabilities. Material systems of interest include for example, artificially structured complex oxides, topological insulators, nanoscale electronic systems that provide a fundamentally-new paradigm beyond semiconductor-based electronics because these systems have properties that depart from the characteristics of the building blocks. *FY 2012 Plans:* Research is expanding predictive theories to accurately model materials and then verify accuracy; continuing to expand heteroepitaxial capabilities with molecular beam epitaxy and pulsed laser deposition; exploring solutions to eliminating or mitigating dominant defects; pursuing luminescence diagnostic studies of material defects; exploring topological insulator material quality improvements to uncover unique physical phenomena; investigating the application of new optical spectroscopic techniques to topological insulators.	-	2.597	-
Title: Basic Research in Mechanical Sciences *Description:* Focuses on improved understanding of propulsion and combustion for improved efficiency and fuel flexibility, energetics initiation for insensitive munitions, fluid dynamics for rotorcraft, complex dynamic systems for novel sensors, energy generation and multi-dimensional systems, and solid mechanics especially at high strain rates in composite materials for novel armor and protection systems. In FY13, this section includes research plans in Mechanical Sciences moved from the Materials and Mechanics section. *FY 2013 Plans:* Will establish the differential geometry (geometric mechanics) of multi-body/granular media interactions; will develop understanding to enable JP-8 surrogate fuels for diesel engine cycle studies; will investigate novel nano-thermodynamic corrections for prediction of hot spots in energetic material; will investigate the flow mechanisms associated with transitory aerodynamic loading effected by flow control on the boundaries of stationary and moving platforms.	-	-	6.498
Title: Basic Research in Mathematical Sciences	-	-	6.535

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Description: Pursue the creation of new mathematical tools, methods for performing complex, multi-system analysis and modeling to enhance soldier and overall weapon system performance. More specifically, the focus will be on creating mathematical principles and practical algorithms for modeling complex systems, analysis and control of biological systems, geometric analysis and topological modeling for complex systems, stochastic analysis and control, and numerical computation of infinite dimensional systems. Research in this section was previously described under Computational and Mathematical Sciences. *FY 2013 Plans:* New numerical methods and algorithms that facilitate improved aerodynamic performance of helicopters in adverse conditions as well as enabling optimal design of supersonic projectiles will be created. Efforts to develop a multivariate heavy-tail statistical theory and develop algorithms to improve modeling capability for complex systems will begin. New mathematical tools, computational algorithms, and capabilities that deepen understanding of protein-ligand docking will be created.			
Accomplishments/Planned Programs Subtotals	70.691	78.134	78.050

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

| APPROPRIATION/BUDGET ACTIVITY
2040: *Research, Development, Test & Evaluation, Army*
BA 1: *Basic Research* | | | | R-1 ITEM NOMENCLATURE
PE 0601102A: *DEFENSE RESEARCH SCIENCES* | | | | | PROJECT
H66: *ADV STRUCTURES RSCH* | |

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H66: *ADV STRUCTURES RSCH*	1.851	1.939	1.999	-	1.999	2.018	2.046	2.069	2.022	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Structural Analysis and Vibration Methods	1.851	1.939	1.999

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H66: *ADV STRUCTURES RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
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 2011 Accomplishments:* Investigated predictive tools for residual strength after impact for thin-skin structural concepts; studied damage resistant and damage tolerant core and skin concepts; and validated residual strength prediction tools for stiffened skin components. *FY 2012 Plans:* Use enhanced and selected Fatigue Crack Growth algorithms to validate damage tolerance (DT) methods through analytical redesign of a full-scaled rotorcraft component to meet DT requirements for Joint Future Theater Lift; investigate Prognostics & Diagnostics (P&D) frameworks for remaining useful life computations using flight evaluation data; validate emerging P&D methods to establish probability of damage/flaw detection, analyze usage credits, and establish fracture mechanics-based P&D technology. *FY 2013 Plans:* Will validate progressive failure analysis methods and fatigue damage model of composites under various loadings and composite configurations to address failures in Army vehicle composite structures. Will assess sensor technologies embedded in composite materials to enable multifunctional structures and to improve the capability to predict the remaining useful life of Army vehicle structures. Will investigate an advanced sensing method used for prognostics and diagnostics to reduce maintenance man-hours and to increase the availability of Army weapon systems.			
Accomplishments/Planned Programs Subtotals	1.851	1.939	1.999

C. Other Program Funding Summary ($ in Millions)
 N/A

D. Acquisition Strategy
 N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	

| APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research* | | | R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES* | | | | PROJECT H67: *ENVIRONMENTAL RESEARCH* | | | |

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
H67: *ENVIRONMENTAL RESEARCH*	0.946	0.995	1.020	-	1.020	1.031	1.054	1.065	1.084	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Industrial Pollution Prevention	0.946	0.995	1.020
Description: This effort conducts research on innovative environmentally- friendly technologies that support the warfighter (focusing on pollution prevention technologies). *FY 2011 Accomplishments:* Continued research efforts in FY10 that were reviewed by the Peer Panel during the Gate Reviews in September 2010.. *FY 2012 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H67: *ENVIRONMENTAL RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Begin a new three year cycle of projects with a full call for proposals sent to the RDECOM laboratories. ***FY 2013 Plans:*** Will continue research efforts in FY12 that were reviewed by the Peer Panel during the Gate Reviews in September 2012; will conduct research on mechanics of antibiotic and disinfectant resistance from wastewater treatment and research into synthesis of biofuels.			
Accomplishments/Planned Programs Subtotals	0.946	0.995	1.020

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army									DATE: February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*					PROJECT S13: *SCI BS/MED RSH INF DIS*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
S13: *SCI BS/MED RSH INF DIS*	10.355	10.883	12.099	-	12.099	12.265	12.389	12.182	12.471	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project fosters basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research for this project provides an understanding of the mechanisms that make organisms infectious, and mechanisms that render the human body response effective to prevent diseases caused by infectious agents. Understanding the biological characteristics of infectious organisms also enables the development of point-of-care and laboratory-based diagnostic tools. Understanding of disease transmission by insects and other organisms helps in developing new interventions to prevent transmission of such diseases. Infectious disease threats from malaria, diarrhea, and dengue (a severe debilitating disease transmitted by mosquitoes), which are common in Africa, Central, European, Southern, and/or Pacific Commands, are the highest priorities for basic research. Research conducted in this project focuses on the following four areas: (1) Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases; (2) Bacterial Threats; (3) Viral Threats; and (4) Diagnostics and Disease Transmission Control. Work is managed by the U.S. Army Medical Research and Materiel Command (MRMC) in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all DoD naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases *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. Since 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 2011 Accomplishments:*	5.729	3.709	4.203

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Continued iterative approaches for the discovery, design and synthesis of promising new antimalarial drug compounds and potential vaccine components. *FY 2012 Plans:* Identify compounds to down-select for advance screening studies and evaluate their potential for future development as anti-parasitic drugs. *FY 2013 Plans:* Will modify candidate compounds active against malaria and leishmania parasites to improve their anti-parasitic activity with a goal to transition these compounds to pre-clinical studies in an animal model.			
Title: Vaccines for Prevention of Malaria *Description:* This effort conducts basic research to better understand and identify new proteins in the design of candidate vaccines for various types of malaria including the severe form of malaria (Plasmodium falciparum) and the less severe but relapsing form (Plasmodium vivax). A highly effective vaccine could reduce/eliminate the use of antimalarial drugs and also reduce the development of drug resistance to current/future drugs. *FY 2012 Plans:* Identify new protein molecules as vaccine candidates against malaria to down-select for advance screening studies and evaluate their potential for future development; study the mechanism of developing antibodies against these new molecules in animal models; conduct research to develop methods of formulating new vaccine candidates for effective delivery inside the human body by using cutting-edge technologies. *FY 2013 Plans:* Will formulate and evaluate newly identified vaccine candidates and assess mechanisms of protection in animal models. Will compare novel formulations of malaria vaccines for protective effectiveness in animal models.	-	2.227	2.440
Title: Bacterial 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 2011 Accomplishments:* Developed further knowledge of the epidemiology (study of factors affecting the health and illness of populations) of diarrhea and wound infections in military personnel; assessed basic wound management measures (concentrated oxygen, nutritional	1.624	1.476	1.432

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
supplements and wound cleansing) to minimize the need for antimicrobials (a substance that kills or inhibits the growth of microbes such as bacteria, fungi, or viruses) and reduced antimicrobial resistance. *FY 2012 Plans:* Assess results of epidemiologic studies (studies of factors affecting the health and illness of populations) of bacterial diarrhea and wound infections to ensure formulation of the best vaccine candidates for diarrhea and the best prevention practices to mitigate wound infections; transition best basic wound management measures to preclinical (animal model) testing. *FY 2013 Plans:* Will undertake discovery of and evaluate new vaccine components needed for vaccine protection for severe bacterial diarrhea based on prior studies. Will evaluate different components from pathogens causing diarrhea for their ability to induce protection against these organisms. Will develop further knowledge of bacterial wound infection pathogens to develop effective treatments.			
Title: Viral Threats Research *Description:* This effort conducts research to better understand Human Immunodeficiency Virus (HIV) and other highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (severe viral infection that causes internal bleeding), such as dengue hemorrhagic fever and hantaviruses (severe viral infection that causes internal bleeding and is contracted from close contact with rodents). Basic research includes understanding risk of disease prevalence to the Warfighter, viral biology (including structure, function, lifecycle, and interactions with the environment), the disease process, and disease interaction with the human body. *FY 2011 Accomplishments:* Continued to study and evaluated the basis of disease and how the immune system reacts to diseases of interest. *FY 2012 Plans:* Continue to study and evaluate the basis of the dengue disease and how the immune system reacts to it; conduct research on defining factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; also develop methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection. *FY 2013 Plans:* Will study and evaluate the basis of dengue disease and how the immune system reacts to it; will evaluate factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; will develop methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection; will determine the contribution of various cells present in human body to provide protection against dengue infection and/or dengue disease. Will study and evaluate pathogenesis of hemorrhagic fever caused by hantaviruses (a	1.667	1.736	2.109

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
family of deadly viruses transmitted by rodents). Will study the biology of HIV to understand the impact of human genes on HIV acquisition and progression to inform vaccine development.			
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 2011 Accomplishments:* Conducted mosquito identification within U.S. Northern Command region using DNA markers to identify specimens. Conducted research leading to a new generation of detection assays for diagnosis of Rickettsial disease (carried by ticks, fleas, and lice) and lethal virus infectious agents within insect vectors (carriers of disease). *FY 2012 Plans:* Develop new trapping methods to improve sand fly surveillance; develop tools to identify mosquito species that transmit malaria parasites; develop a detection method for scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics) in the Pacific Commands area of operation. *FY 2013 Plans:* Will identify novel fast-acting, directly targeted, insecticides that rapidly degrade to harmless bi-products; will investigate next generation risk assessment tools for evaluating potential infectious disease transmission in insects (beyond modeling); will identify identification keys for medically important insect vectors.	1.335	1.735	1.915
Accomplishments/Planned Programs Subtotals	10.355	10.883	12.099

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army										**DATE:** February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*					**PROJECT** S14: *SCI BS/CBT CAS CARE RS*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
S14: *SCI BS/CBT CAS CARE RS*	6.606	9.694	10.197	-	10.197	9.472	9.069	9.375	9.697	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research to understand the fundamental mechanisms of severe trauma in order 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) Clinical and Rehabilitative Medicine
(5) Traumatic Brain Injury (TBI)

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

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

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the U.S. Army Dental Trauma Research Detachment; 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 2011	FY 2012	FY 2013
Title: Damage Control Resuscitation	0.962	1.340	1.433
Description: This effort conducts studies of genetic pathways and metabolic mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma.			
FY 2011 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Investigated genetic components of the response to hemorrhage (bleeding) in specific strains of rats. *FY 2012 Plans:* Conduct studies of immune system interaction with the coagulation (blood clotting) system and the effect of trauma on fibrinogen (a blood clot component) formation. *FY 2013 Plans:* Will conduct studies aimed at reducing effects on cells caused by hemorrhage (bleeding) in an animal model during resuscitation to determine the role of an enzyme in protecting cells.			
Title: Combat Trauma Therapies *Description:* This effort conducts studies of trauma to tissues and organs, and ways to mitigate and/or repair this damage. Research addresses cellular repair/growth mechanisms to treat TBI, dental injuries, extremity wounds and fractures, and burns. *FY 2011 Accomplishments:* Continued gene regulation and neuroprotection mechanism studies including studies to understand cellular mechanisms of cell death; characterization of a poly-trauma (multiple injuries) model; discovery of novel pharmaceuticals to mitigate TBI brain hypothermia (drop in temperature); investigated new therapies based upon dentally-derived stem cells for traumatic dental wound healing and repair; explored causes of low vision from head trauma. *FY 2012 Plans:* Realign neuroprotection research to the TBI program area, and regenerative efforts in craniomaxillofacial trauma (soft tissue and skeletal injuries to the face, head and neck) to the Clinical and Rehabilitative Medicine Research Program; research potential bone defect models to find one that is clinically relevant to combat trauma. *FY 2013 Plans:* Will continue to study the relevant model of bone defect to create a model for use in evaluating new therapies. Will identify factors capable of minimizing the development of chronic inflammation.	1.963	0.956	0.836
Title: Combat Critical Care Engineering *Description:* This effort conducts basic science studies of vital sign responses to trauma as predictors of medical outcomes and as a basis for developing life-saving interventions. This research area starts in FY 2012. *FY 2012 Plans:*	-	0.769	0.699

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Begin basic research studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss. ***FY 2013 Plans:*** Will continue studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss as a path to tailoring resuscitation to individuals.			
Title: Traumatic Brain Injury ***Description:*** This effort conducts basic research in poly-trauma (multiple injuries)/TBI model, cellular mechanisms of cell death, and the discovery of novel drugs to mitigate TBI. ***FY 2012 Plans:*** Realign neuroprotection research from the Combat Trauma Therapies task area to the TBI task area; continue basic research in poly-trauma (multiple injuries)/TBI model, cellular mechanisms of cell death and discovery of novel drugs to mitigate TBI. ***FY 2013 Plans:*** Will conduct research to further understand cell death and neuroprotection (protecting degeneration of the nervous system) mechanisms, and identify critical thresholds for secondary injury (i.e. polytrauma) complicating TBI.	-	0.986	0.660
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, and face (including eye), as well as burns. ***FY 2011 Accomplishments:*** Continued the iterative process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase. ***FY 2012 Plans:*** Continue research in eye trauma to understand the cellular and neuronal mechanisms of eye injury; continue the process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase. ***FY 2013 Plans:***	3.681	5.643	6.569

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Will continue to explore the mechanisms of eye trauma injury and the epidemiology (studying incidence or prevalence of injury) of eye trauma wounds. Will continue exploring innovative strategies to regenerate tissues and advance promising approaches to the applied research phase.			
Accomplishments/Planned Programs Subtotals	6.606	9.694	10.197

C. Other Program Funding Summary ($ in Millions)
    N/A

D. Acquisition Strategy
    N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012									

APPROPRIATION/BUDGET ACTIVITY
2040: *Research, Development, Test & Evaluation, Army*
BA 1: *Basic Research*

R-1 ITEM NOMENCLATURE
PE 0601102A: *DEFENSE RESEARCH SCIENCES*

PROJECT
S15: *SCI BS/ARMY OP MED RSH*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
S15: *SCI BS/ARMY OP MED RSH*	8.602	6.310	5.683	-	5.683	6.692	6.666	6.522	6.590	Continuing	Continuing

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 includes research on the neurobehavioral aspects of post-traumatic stress and suicide, and developing 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 six areas:

(1) Injury Prevention and Reduction
(2) Physiological Health
(3) Environmental Health and Protection
(4) Computational Biology
(5) Psychological Health and Resilience

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

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

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the U.S. 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 2011	FY 2012	FY 2013
Title: Injury Prevention and Reduction	1.396	1.094	0.970
Description: This effort conducts research on the body's effects from non-ionizing radiation and directed energy (laser), as well as the physiological mechanisms of musculoskeletal injury. *FY 2011 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S15: *SCI BS/ARMY OP MED RSH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Identified specificity of hormonal fatigue markers in Soldiers during states of physical exertion and energy status; investigated responses to physical fatigue to prevent musculoskeletal injury; examined dose-response relationships to blood and tissue changes, and modeled results for visible and infrared wavelengths as a risk assessment tool for laser eye injury. ***FY 2012 Plans:*** Examine effectiveness of topical applications of drugs to prevent further nerve degeneration from eye trauma and high-risk military environmental exposures. For example, an intervention could be applied through an eye dropper as a treatment against laser eye injury. ***FY 2013 Plans:*** Will identify indicators of cellular responses to determine efficacy of intervention strategies related to injury susceptibility in the skeletal muscle; will diagnose and characterize repeated and long duration exposure from military lasers. Will characterize ocular injury as a function of shock wave (IED) impulse in a large-eye animal model to establish advanced triage, treatment, and prevention methodologies. This data will lead to our understanding of multiple ocular injuries from a single blast or laser exposure; this data will also anchor predictive biophysical models to prevent or mitigate Soldier eye injury from blast.			
Title: Physiological Health ***Description:*** This effort conducts research on the physiological mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being. ***FY 2011 Accomplishments:*** Investigated the extent to which the recuperative value of recovery sleep and the rate of recuperation can be enhanced through use of medication; identified the nutritional strategies required to sustain health in the modern training environment; explored the impact of micronutrient (nutrients essential in small quantities to orchestrate a whole range of physiological functions) status on performance and immune function during military training. ***FY 2012 Plans:*** Identify menus, food service practices, labeling and educational materials to promote healthy eating behavior in military dining facilities; identify the hormonal and metabolic responses of human fat tissue during periods of underfeeding, followed by overfeeding. ***FY 2013 Plans:*** Will determine muscle metabolic responses to nutritional deficit; will identify the relationship between micronutrient and bone adaptation during military training; will identify the effects of energy deficits on human brain function and cognitive performance. These results will lead to an increased understanding of the benefits of adequate nutrition for the Warfighter.	2.065	2.776	3.068
Title: Environmental Health and Protection	1.227	1.199	0.245

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S15: *SCI BS/ARMY OP MED RSH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Description: This effort conducts research on the physiological mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. *FY 2011 Accomplishments:* Explored molecular mediators of tissue, organ and skeletal muscle injury associated with exertional heat injury and/or heat stroke in the rodent model; expanded the investigation of dose-response of medication countermeasures for the effectiveness of preventing altitude illness at moderate altitude (3,000 meters). *FY 2012 Plans:* Identify clinical measures (blood and molecular changes within tissue) of heat stroke. *FY 2013 Plans:* Will identify how clinical pathways alter progression and extent of organ damage following heat injury/ stroke. These studies will determine the role of inflammation in multi-organ failure. These results will be used to develop protective treatments against damage to internal organs resulting from heat exposure.			
Title: Computational Biology *Description:* This effort conducts research using tools that combine biology, computer sciences, and mathematics to solve biological problems that would be difficult or impossible to solve solely through testing in traditional laboratory experiments, animal models, or human trials. Research in this area began in FY 2011 and transfers to PE 61102, Project T64 in FY 2012. *FY 2011 Accomplishments:* Conducted computational biology modeling to advance the development of protein-protein interaction models for the prediction of host-pathogen interaction networks.	0.893	-	-
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. Studies also include determination of suicide risk and understanding underlying mechanisms driving suicide behavior, as well as underlying neurobiological mechanisms related to post-traumatic stress disorder (PTSD) and depression. *FY 2011 Accomplishments:* Induced and evaluated PTSD-like symptoms in rodents for potential drug and behavioral intervention to treat combat-related PTSD; further explored associations of completed and attempted suicides with the use of anti-depression medication; investigated	3.021	1.241	1.400

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
the predictive value of neuropsychological and neurological measures for prediction of likelihood and/or severity of subsequent post-concussion symptoms.			
FY 2012 Plans: Identify deployment-related measures to assess intervention effectiveness (e.g., mitigating functional impairment, transition, risky behaviors) for the treatment of PTSD. Examine and validate underlying psychosocial and biological theories of suicidal behavior. Examine underlying neural systems? response to depression treatment.			
FY 2013 Plans: Will identify markers to indicate the effectiveness of candidate medications for post-traumatic stress disorder (PTSD) treatments. Through exploration with an animal model, existing candidate compounds will be evaluated for efficacy in the treatment of PTSD. Neural systems response to depression treatment will be used to inform development of optimized treatment regimen for depression.			
Accomplishments/Planned Programs Subtotals	8.602	6.310	5.683

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army								DATE: February 2012		
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** T22: *SOIL & ROCK MECH*		

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
T22: *SOIL & ROCK MECH*	4.243	4.918	4.034	-	4.034	4.579	4.780	4.978	5.056	Continuing	Continuing

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 2011	FY 2012	FY 2013
Title: Military Engineering Basic Research	2.307	2.434	2.209
Description: Funding is provided for this activity			
FY 2011 Accomplishments: Developed a mathematical technique to create continuum models for engineering-level analysis at coarser scales using discrete variables from nanoscale models.			
FY 2012 Plans: Complete a particle scale model to study the effects of two naturally occurring bonding agents on the suspension of particulates from naturally occurring soils.			
FY 2013 Plans: Will develop basic wave propagation/sensor interaction knowledge, modifications to current and future data analysis, processing, and classification algorithms to account for use of conduit, and produce a modeling framework for future variable manipulation.			
Title: Materials Modeling for Force Protection	1.936	2.484	1.825
Description: This effort moved from PE 0601102 Project T23 in FY 11 to this Project T22 in FY 12. The long-term goal of this task is to develop a structural ceramic composite that could replace steel and aluminum for most applications at one third the			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
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 2011 Accomplishments:*** Conducted basic research to explore characteristics of natural materials with exceptional mechanical properties in order to develop the foundational understanding that will lead to advances in blast and ballistic protection, base sustainment, and readiness through engineered material models. ***FY 2012 Plans:*** Perform fundamental research to explore characteristics of natural materials with exceptional mechanical properties in order to develop the foundational understanding that will lead to advances in blast and ballistic protection through engineered material models. This work moves from PE0601102A-T23 Facilities Research in FY12. ***FY 2013 Plans:*** Will create experimental techniques that provide measurements at the nano- to micro-scale to allow for validation and verification of simulations of material. These techniques will allow for better understanding of how bio-lamina are created and how or if those processes can be exploited for synthesis and self-healing.			
Accomplishments/Planned Programs Subtotals	4.243	4.918	4.034

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army									**DATE:** February 2012	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*					**PROJECT** T23: *BASIC RES MIL CONST*	

COST ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**Cost To Complete**	**Total Cost**
T23: *BASIC RES MIL CONST*	1.779	1.898	1.659	-	1.659	1.773	1.715	1.732	1.964	Continuing	Continuing

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 2011**	**FY 2012**	**FY 2013**
Title: Facilities Research	1.779	1.898	1.659
Description: Funding is provided for the following effort.			
FY 2011 Accomplishments: Continued to establish a basic understanding of physical, chemical, and biological phenomena specific to the next generation nanotechnology research initiatives of military interest. Also, completed investigation of electric field effects on chemical reactions in confined nanoporous geometries.			
FY 2012 Plans:			

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T23: *BASIC RES MIL CONST*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
Explore the controlled dissociation of either methane or ammonia in order to produce pure hydrogen gas; determine the effects of temperature on the quantum dot output spectrum in order to increase understanding for improved sensor development. ***FY 2013 Plans:*** Will complete investigations of enhanced heat transfer of hybrid surfaces and switching mechanisms in bioinspired polymers.			
Accomplishments/Planned Programs Subtotals	1.779	1.898	1.659

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army								DATE: February 2012			

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T24: *Signature Physics and Terrain State Basic Research*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
T24: *Signature Physics and Terrain State Basic Research*	1.543	1.613	1.495	-	1.495	1.601	1.539	1.547	1.656	Continuing	Continuing

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 2011	FY 2012	FY 2013
Title: Terrain State and Signature Physics	1.543	1.613	1.495
Description: Funding is provided for the following effort. *FY 2011 Accomplishments:* Investigated the topography and morphology of a high relief mountain basin as a major factor driving the spatial distribution of snow melt onset as measured by passive microwave sensors. Devised a calculation method for sound wave propagation and coherence over random spatial variations in terrain surface elevation and ground properties (such as permeability, porosity, grain size, and water content) and identified the characteristics and significance of random terrain effects on wave scattering. *FY 2012 Plans:*			

PE 0601102A: *DEFENSE RESEARCH SCIENCES*
Army

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T24: *Signature Physics and Terrain State Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Determine if radars can better detect subsurface disturbances through improved coherent waveform detection, and understanding of volume scatter loss rates; formulate methods for near real-time calculation of sound fields in complex environments; construct a 3D numerical model of gas transport in soil that incorporates convection and diffusion and will determine the role of soil microstructure in gas movement through porous media in the near-surface ground, which will support emerging methods of subsurface target detection; investigate a novel approach to represent terrain state spatial and temporal patterns and relationships to significantly reduce computational complexity and intensity required to model soil moisture and surface temperature. ***FY 2013 Plans:*** Will formulate new statistical approaches for improved sensing and communication systems operating in complex terrestrial environments with new quantitative measures for heterogeneity and intermittency of random terrestrial media; will formulate a methodology for assessing motivational intensities (cognitive-based processes) contributing to movement patterns in constrained landscapes.			
Accomplishments/Planned Programs Subtotals	1.543	1.613	1.495

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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

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APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
T25: *Environmental Science Basic Research*	7.851	8.221	6.888	-	6.888	7.175	7.170	7.293	8.254	Continuing	Continuing

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 2011	FY 2012	FY 2013
Title: Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants	3.292	3.979	3.272
Description: Funding is provided for the following effort. *FY 2011 Accomplishments:* Established a basic understanding of physical, chemical, and biological phenomena specific to the environmental and ecological fate of contaminants of military interest. Continued investigations of degradation and transformation mechanisms of insensitive munitions and emerging contaminants. *FY 2012 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Investigate bioassay response to climate and contaminant stress on a standard laboratory organism (Daphnia) to elucidate impacts on other species of concern to Military installations; characterize metals-rich granules (MRG) produced by lead (Pb) exposed soil invertebrates to determine bioavailability and potential for bacteria to release the Pb back into the environment in a biologically available form; construct a neuro-endocrine feedback mechanism ex vivo to replicate the neuroendocrine system in environmental monitoring species (fish) for advancement of high throughput screening and analyses, and computation modeling of contaminates; also, investigate the linkage of oxidative stress to behavior and animal survival impacts using real time-time imaging of gene expression and behavioral tracking. *FY 2013 Plans:* Will initiate research on amphibian response to various militarily relevant chemicals and materials to develop an understanding of if and how these unique organisms are impacted. Will develop an understanding of transport of compounds through cellular channels that will allow information for more sensitive nano-sensors. Will investigate the new insensitive munitions behavior and persistence in environmental condition and media.			
Title: Remediation of Explosives, Energetics, and UXO *Description:* Funding is provided for the following effort. *FY 2011 Accomplishments:* Continued to establish a base of understanding of the physical, chemical, and biological phenomena specific to the remediation of explosives and energetics on training ranges. *FY 2012 Plans:* Determine the potential for abiotic and biotic degradation of insensitive explosives, NTO and FOX-7, potential insensitive replacements for RDX; investigate non-traditional concentration response relationships for prediction of environmental risks supporting development of novel energetics. *FY 2013 Plans:* Will investigate the mineralization of depleted uranium munitions and effects on solubility, sorption, and mobility; will explore novel microbial systems for degrading energetic compounds; and will study the bioavailability implications of interactions between munitions constituents and performance enhancing nano-material in mixtures.	2.229	2.391	1.967
Title: Training Land Natural Resources *Description:* Funding is provided for the following effort. *FY 2011 Accomplishments:*	0.862	0.749	0.616

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Continued to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigations, and rehabilitation. Investigated the mechanisms of accumulated oxidative stress affects on altered animal behavior and survival to provide a model of linking animal responses across large spatial and temporal scales for landscape, river, coastal and climate management. *FY 2012 Plans:* Define multiple-stressor assessment techniques to identify and evaluate the relative contribution of interacting stressors that impact military lands and critical natural resources; investigate how geographical fragmentation affects the pollination dynamics and gene flow within species populations to advance the fundamental knowledge for management of rare and endemic plant and pollinator species on Army ranges; also, through dermal and dietary exposure in plant and animal tissue determine the magnitude of tungsten bioavailability impacting firing range sustainability as well as to advance ecological assessment capabilities. *FY 2013 Plans:* Will investigate how climate induced change affects the adsorption and biotransformation characteristics of northern peat-land ecosystems; will conduct mechanistic investigations of Lead (Pb) chemical separation by plant exudates to advance understanding on the potential for plant exudates to mobilize Pb in the presence of environmentally relevant completing interactions; will analyze pollination networks and nectar-dwelling yeast communities and discern shared dynamics and structural interactions between two systems to continue to advance the fundamental knowledge for management of rate and endemic plant and pollinator species on Army ranges.			
Title: Network Science	1.468	1.102	1.033
Description: Funding is provided for the following effort. *FY 2011 Accomplishments:* Established a basic understanding of physical, chemical, and biological phenomena specific to network science applications. Evaluated alternative compositions of heterogeneity in population vigilance affording resilient/adaptive behavior at reduced cost. Developed cognitive elements to dynamically elicit the emergence of desired composition in heterogeneity. Defined the network structure involving steroidogenesis genes using time series analysis. Developed approaches using genetic tools to perturb network dynamics by gene silencing or over-expression. *FY 2012 Plans:* Investigate first principle phenomenology describing spontaneous formation of highly regular biological networks by bacteria to determine spatial pattern relationships in bacteria colonies; determine cognitive elements associated with attention and memory			

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
allowing heterogeneity in vigilance across a population to emerge naturally in a form conducive to social network resilience and adaptive behavior under predatory threat. ***FY 2013 Plans:*** Will investigate the molecular architecture that dictates the highly specific ligand preference of insect pheronmone receptors based on amino acid networks for intelligent receptor design; will investigate genetic and genomic basis of intra-species variance in sensitivity to munitions and reduced uncertainty in risk/toxicity assessment of military sites; will explore the trade-offs between adaptability and susceptibility within self-organizing biological networks.			
Accomplishments/Planned Programs Subtotals	7.851	8.221	6.888

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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

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APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.411	1.854	1.956	-	1.956	1.991	2.025	2.059	2.094	Continuing	Continuing

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Robotics autonomy and human robotic interface research	1.411	1.854	1.956

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
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 2011 Accomplishments:* New combinations of advanced sensor data were fused in real time to provide enhanced dynamic situation awareness for small robotic systems, increasing the speed and agility of operation. *FY 2012 Plans:* Evaluate novel modes of air and ground mobility for micro-mechanical systems. *FY 2013 Plans:* Will conduct experimental studies to create a fundamental model of flapping wing locomotion to enable future micro-scale unmanned aerial vehicle systems. Will examine basic concepts and underpinning mechanics of grasping and manipulating unknown and arbitrarily shaped objects.			
Accomplishments/Planned Programs Subtotals	1.411	1.854	1.956

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army								DATE: February 2012			
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*			

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	1.233	2.195	2.824	-	2.824	2.959	2.930	2.972	3.022	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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

Work in this project is performed by the U.S. Army Medical Research and Material Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Network Sciences Initiative	1.233	2.195	2.824
Description: This effort supports research to conduct studies through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. *FY 2011 Accomplishments:* Validated these mathematical models developed in FY 2010 that predict host/pathogen networks *FY 2012 Plans:* Validate the accuracy of the models and apply the models to identify markers for traumatic brain injury. *FY 2013 Plans:* Will expand the identification of traumatic brain injury biomarkers to include key biological pathways. This will lead to the development of diagnostic assays and identification of potential drug targets.			
Accomplishments/Planned Programs Subtotals	1.233	2.195	2.824

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Army		DATE: February 2012

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT VR9: *SURFACE SCIENCE RESEARCH*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
VR9: *SURFACE SCIENCE RESEARCH*	-	2.246	1.936	-	1.936	2.010	2.328	2.631	2.675	Continuing	Continuing

Note
Not applicable for this item.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Surface Science Research *Description:* The activities in this program are related to performing basic and early applied research in chemistry, biology and physics on fundamental problems related to surfaces, interfacial dynamics, thin film materials, chemical-biological catalysis and opto-electronic/sensory technologies. *FY 2012 Plans:* Investigate the complex behavior of mass transport in microporous systems; will design rational molecular and nano-system functional abiotic structures; will conduct fundamental studies and modeling of the interfacial phenomena of particulate matter	-	2.246	1.936

Exhibit R-2A, **RDT&E Project Justification:** PB 2013 Army		**DATE:** February 2012
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** VR9: *SURFACE SCIENCE RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013**
(solid/liquid) with surfaces and the interaction of matter and mechanisms of transfer of energy at the nanoscale and at biological interfaces.			
FY 2013 Plans: Will develop a robust set of surface science tools, both experimentally and theoretically, that can be used to further our understanding of surface properties and interfacial dynamics of complex materials; investigate rational design approaches to metal-metal oxide nano-architectures; systematically model engineered functional systems; investigate the mechanisms governing specific binding or adherence of biological molecules to abiotic surfaces; and perform structural determination and in silico modeling of trans-membrane proteins from human induced pluripotent cells.			
Accomplishments/Planned Programs Subtotals	-	2.246	1.936

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

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