Exhibit R-2, PB 2011 Army RDT&E Budget Item Justification											DATE: February 2010
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 2009 Actual**	**FY 2010 Estimate**	**Base FY 2011 Estimate**	**OCO FY 2011 Estimate**	**Total FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	193.968	197.471	195.845	0.000	195.845	188.160	207.424	216.332	227.412	0	1,622.457
305: *ATR RESEARCH*	2.272	2.366	2.401	0.000	2.401	2.433	2.462	2.508	2.554	Continuing	Continuing
31B: *INFRARED OPTICS RSCH*	2.543	2.662	2.721	0.000	2.721	2.787	2.831	2.887	2.946	Continuing	Continuing
52C: *MAPPING & REMOTE SENS*	2.674	2.773	2.841	0.000	2.841	2.915	2.979	3.038	3.097	Continuing	Continuing
53A: *BATTLEFIELD ENV & SIG*	3.003	3.200	3.341	0.000	3.341	3.435	3.530	3.611	3.697	Continuing	Continuing
74A: *HUMAN ENGINEERING*	4.973	5.673	6.971	0.000	6.971	6.711	7.710	7.836	8.068	Continuing	Continuing
74F: *PERS PERF & TRAINING*	5.588	5.829	5.549	0.000	5.549	5.766	7.023	7.148	7.266	Continuing	Continuing
F20: *ADV PROPULSION RSCH*	3.299	3.331	3.429	0.000	3.429	3.496	4.193	4.272	4.355	Continuing	Continuing
F22: *RSCH IN VEH MOBILITY*	0.547	0.564	0.576	0.000	0.576	0.588	0.601	0.612	0.624	Continuing	Continuing
H42: *MATERIALS & MECHANICS*	5.722	6.009	6.975	0.000	6.975	7.461	8.676	8.835	8.990	Continuing	Continuing
H43: *RESEARCH IN BALLISTICS*	7.995	8.208	8.318	0.000	8.318	8.463	9.224	9.395	9.563	Continuing	Continuing
H44: *ADV SENSORS RESEARCH*	6.112	6.343	9.695	0.000	9.695	7.005	7.623	7.769	7.912	Continuing	Continuing
H45: *AIR MOBILITY*	2.298	2.361	2.399	0.000	2.399	2.449	2.497	2.543	2.588	Continuing	Continuing
H47: *APPLIED PHYSICS RSCH*	2.841	2.940	5.009	0.000	5.009	3.077	3.167	3.228	3.290	Continuing	Continuing
H48: *BATTLESPACE INFO & COMM RSC*	8.814	11.374	13.685	0.000	13.685	14.726	17.816	18.285	18.890	Continuing	Continuing
H52: *EQUIP FOR THE SOLDIER*	0.978	1.030	1.078	0.000	1.078	1.105	1.134	1.158	1.181	Continuing	Continuing
H57: *Single Investigator Basic Research*	63.397	64.649	73.075	0.000	73.075	68.663	75.881	82.178	90.434	Continuing	Continuing
H66: *ADV STRUCTURES RSCH*	1.711	1.808	1.889	0.000	1.889	1.942	1.996	2.040	2.089	Continuing	Continuing
H67: *ENVIRONMENTAL RESEARCH*	0.906	0.941	0.967	0.000	0.967	0.997	1.018	1.039	1.072	Continuing	Continuing

Exhibit R-2, PB 2011 Army **RDT&E Budget Item Justification**									**DATE:** February 2010		
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*							
H68: *PROC POLLUT ABMT TECH*	0.420	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
S04: *MIL POLLUTANT/HLTH HAZ*	0.701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
S13: *SCI BS/MED RSH INF DIS*	10.747	10.481	10.652	0.000	10.652	10.900	11.121	11.348	11.544	Continuing	Continuing
S14: *SCI BS/CBT CAS CARE RS*	6.067	6.505	6.818	0.000	6.818	7.049	7.725	7.860	7.990	Continuing	Continuing
S15: *SCI BS/ARMY OP MED RSH*	9.374	7.083	8.839	0.000	8.839	9.381	10.338	10.531	10.723	Continuing	Continuing
S19: *T-MED/SOLDIER STATUS*	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*	25.085	20.573	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
T22: *SOIL & ROCK MECH*	2.208	2.299	2.358	0.000	2.358	2.426	2.481	2.531	2.581	Continuing	Continuing
T23: *BASIC RES MIL CONST*	1.688	1.761	3.839	0.000	3.839	1.901	1.970	2.005	2.042	Continuing	Continuing
T24: *Signature Physics and Terrain State Basic Research*	1.451	1.513	1.573	0.000	1.573	1.616	1.660	1.693	1.727	Continuing	Continuing
T25: *Environmental Science Basic Research*	5.980	7.917	8.106	0.000	8.106	8.234	8.562	8.719	8.870	Continuing	Continuing
T61: *Basic Research Initiatives - MRMC (CA)*	2.392	4.775	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.453	1.224	1.463	0.000	1.463	1.457	1.935	1.969	2.001	Continuing	Continuing
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	0.000	1.279	1.278	0.000	1.278	1.177	1.271	1.294	1.318	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element (PE) fosters fundamental scientific knowledge and contributes to the sustainment of US Army scientific and technological superiority in land warfighting capability and military problems related to long-term national security needs, provides new concepts and technologies for the Army's future force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. The PE fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) 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 Army areas of interest, such as

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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 the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry. The work in this PE is coordinated and integrated between four primary contributors: 1) the Army Research, Development, and Engineering Command (RDECOM); 2) the US Army Engineer Research and Development Center (ERDC); 3) the Army Medical Research and Materiel Command (MRMC) laboratories; and 4) the Army Research Institute for Behavioral and Social Sciences (ARI). The basic research program is coordinated with the other Services via Defense Basic Research Advisory Group and other inter-Service working groups.The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this PE is primarily managed by: the US Army Research Laboratory (ARL), Adelphi, MD and 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.

B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	198.103	173.024	183.403	0.000	183.403
Current President's Budget	193.968	197.471	195.845	0.000	195.845
Total Adjustments	-4.135	24.447	12.442	0.000	12.442
• Congressional General Reductions		-1.033			
• Congressional Directed Reductions					
• Congressional Rescissions		0.000			
• Congressional Adds		25.480			
• Congressional Directed Transfers					
• Reprogrammings	-0.425	0.000			
• SBIR/STTR Transfer	-3.710	0.000			
• Adjustments to Budget Years	0.000	0.000	12.442	0.000	12.442

Change Summary Explanation

FY10 Congressionally directed increases.

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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
305: *ATR RESEARCH*	2.272	2.366	2.401	0.000	2.401	2.433	2.462	2.508	2.554	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides automatic target recognition (ATR) research 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 evaluating 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. This research supports several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared (FLIR), and advanced multi-function laser radar (LADAR). The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.286	1.320	1.387	0.000	1.387
ATR Algorithms: Investigate new algorithms to improve aided/unaided target detection and identification. In FY09, researched novel behavior characterization algorithms for color and FLIR video; researched methods to develop ATR algorithms that exploit the fusion of disparate spatial views of a target for unattended ground sensor (UGS) network applications; and designed advanced nonlinear band selection methods and implemented new hyperspectral algorithms based on the selected bands. In FY10, enhance hyperspectral anomaly detections and validate rapid reconstruction of hyperspectral images by using 3D compressed sensing techniques; and develop novel fusion detection and classification algorithms based on kernel learning theory. In FY11, will develop					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
restoration techniques for atmospheric turbulence distorted imagery and new anomaly detection algorithms based on novel computational imaging methods. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 TTL: 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 In FY09, began to prove technologies selected for further exploration. This includes both device and algorithm development. In FY10, explore RF techniques and technologies for TTL, investigate advances in RF Integrated Circuits for an RF Tag and model an enhanced IR Tag. In FY11, will fabricate a RF tag sample and validate an enhanced capability in hyperspectral target detection for tracking & locating. *FY 2009 Accomplishments:* FY 2009	0.986	1.010	1.014	0.000	1.014

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.036	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	2.272	2.366	2.401	0.000	2.401

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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 31B: *INFRARED OPTICS RSCH*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
31B: *INFRARED OPTICS RSCH*	2.543	2.662	2.721	0.000	2.721	2.787	2.831	2.887	2.946	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems and radio frequency (RF) photonics. 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 interband cascade lasers (ICLs) 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 interband cascade 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. Micro Electro Mechanical System (MEMS) configurations are incorporated into the photonic-crystal waveguide structures to enable reconfigurable IR waveguide properties. Customized IR photonic materials and components in conjunction with fiber optic interconnects are applied to the control of microwaves. 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. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.543	2.651	2.721	0.000	2.721
Increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance IR countermeasure (IRCM) protection against missile threats. In FY09, researched frequency modulated IR lasers for covert communication applications, fabricated high operating temperature Long Wave Infrared (LWIR) Type detector arrays. Investigated dilute Nitride materials. Designed and researched chip-scale integrated IR-photonic circuit based on the reconfigurable photonic crystal-MEMS waveguide devices; and assembled innovative fiber optic circuits with a patented new concept in photonic crystals for microwave					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
true-time-delay applications. In FY10, utilize fiber optic integrated circuits to improve mode control of ultra-low-noise microwave oscillator. Improve LWIR superlattice quantum efficiency and lifetime at higher operation temperature. In FY11, fiber-optic RF-photonic techniques will be applied to the advancement of opto-electronic processing of military signals. Will validate large area dual color LWIR/Midwave Infrared detector arrays. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base	0.000	0.011	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	2.543	2.662	2.721	0.000	2.721

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 52C: *MAPPING & REMOTE SENS*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
52C: *MAPPING & REMOTE SENS*	2.674	2.773	2.841	0.000	2.841	2.915	2.979	3.038	3.097	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project increases knowledge of the 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 exploits terrain and environmental data to improve situational awareness and enhance information dominance, leading to increased survivability, lethality, and mobility. The research provides the theoretical underpinnings for PE 0602784A (Military Engineering Technology), project 855 (Mapping and Remote Sensing). The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.674	2.748	2.841	0.000	2.841
Sensor Phenomenology and Spatial-Temporal Pattern Discovery: In FY09, created recoverable semiconductor particles based on paramagnetic properties for distributed robotic sensing, and examining the quantum confined Stark Effect exhibited in nanoscale wires as a new chemical, biological, radiological, nuclear, and explosive (CBRNE) detection scheme. Also, creating a new taxonomy for multi-scale spatial-temporal cascade patterns. In FY10, examine the synthesis of high quantum yield optical reporters for remote sensing. Also, will create new interest measures for multi-scale spatial-temporal cascade patterns. In FY11, will explore the relationship of magnetic core nanomaterials and the stand-off recovery of these materials as sensors using Surface-Enhanced Raman Scattering (SERS). Also, will investigate social network concepts to better assess important interaction within and between our adversaries, directly relating objects, events, actions, and trajectories to spatial-temporal dimensions.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.025	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	2.674	2.773	2.841	0.000	2.841

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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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
53A: *BATTLEFIELD ENV & SIG*	3.003	3.200	3.341	0.000	3.341	3.435	3.530	3.611	3.697	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides 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 force will operate in very complex environments (e.g. urban and mountainous terrain) requiring new approaches to understanding, characterizing, and depicting microscale atmospheric phenomena. 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 accurate and timely tactical weather intelligence to battlefield commanders. This project focuses on boundary layer meteorology especially over open, complex and urban terrain. It supports the future Army through formulation of novel capabilities and techniques in such areas as characterization of urban turbulence for its effects on platforms and payloads, high resolution urban wind modeling, the characterization of aerosols for force protection and soldier health, the characterization and identification of bio-warfare agents, atmospheric effects on acoustic wave propagation in urban domains, electro-optic propagation modeling techniques for improved target detection and acquisition, and formulation of objective analysis tools that can assimilate on-scene 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 operations. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.896	1.995	1.976	0.000	1.976
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. In FY09, devised and employed a model for illumination effects of clouds on night vision devices to improve prediction of range limits, analyzed the measurements of heated aerosol particle laser induced fluorescence spectra to enhance identification, investigated techniques for classification of non-spherical aerosol particles for improved chem/bio aerosol identification, and investigated effects of multiple urban structures on sound fields to enhance detection and targeting. Developed building effects parameterizations for acoustic models. In FY10, design algorithms for					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
atmospheric propagation of acoustic signatures in urban and complex terrain. Develop processing techniques for enhancing target contrast and minimizing background clutter for infrared polarimetric imagery. Measure Raman spectra of individual particles. In FY11, will develop acoustic propagation algorithms for complex urban domains accounting for multiple building structure effects. Exploit broader frequency acoustic propagation including ultrasound. Investigate and employ the capabilities of Two-dimensional Angular Optical Scattering (TAOS) and Ultra Violet-Laser Induced Fluorescence (UV-LIF) technologies for the characterization of hazardous particles in the atmosphere. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Increase survivability and improve situational awareness through research to enhance accuracy of predictive modeling of the boundary layer and improve the ability to function effectively "anyplace and anytime". In FY09 investigated methods to solve problems encountered in computing wind flows for steep terrain and across large elevation differences by introducing immersed boundary methods and vertical coordinate stretching; investigated spectral analysis of measured urban meteorological profiles to produce new wake parameterizations to improve the high resolution urban wind model. Investigated water vapor fluctuation spectra influenced by urban boundary layer for propagation effects on sensor performance and imaging capabilities. Measured and characterized the	1.107	1.201	1.365	0.000	1.365

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
length scale transitions from 3D isotropic to 2D non-isotropic turbulence in the atmospheric surface layer for their effects on propagation and micro air vehicles. In FY10, investigate methods for optimizing aircraft routes in adverse weather conditions; extend physics-based version of the 3 dimensional wind field (3DWF) microscale wind model to improve fidelity for simulation and prediction of wind fields in urban and complex terrain. In FY11, will devise ensemble modeling techniques leading to fine-scale battlefield probabilistic weather and effects forecasting; will produce improved theory and approach to modeling turbulence based on sonic anemometer array field evaluations for more accurate and realistic effects in propagation and turbulence models; and improve microscale wind modeling in complex terrain using advances in high-performance computing technology and computational acceleration using general-purpose graphical processing units. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Small Business Innovative Research/Small Business Technology Transfer Programs. *FY 2009 Accomplishments:* FY 2009	0.000	0.004	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	3.003	3.200	3.341	0.000	3.341

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
74A: *HUMAN ENGINEERING*	4.973	5.673	6.971	0.000	6.971	6.711	7.710	7.836	8.068	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on improving Soldier-system performance in future force environments. Research is on key underlying Soldier performance phenomena such as judgment under uncertainty; echo-location and distance-estimation under degraded conditions; extending and protecting auditory and cognitive performance; human performance in automated, mixed-initiative (human control-machine control) environments; associated neurological dynamics; communications in hearing-degraded conditions; 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. 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 neuroergonomics, the study of the brain at work, research is carried out to examine leading edge methodologies and technologies to improve cognitive and behavioral performance, particularly under high stress conditions and to assess how neural pathways implicated in functional processing can be enhanced to improve the training of Soldiers in an operational context. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.438	1.308	1.991	0.000	1.991
Research to characterize and enhance Soldier performance: In FY09, investigated synergy between bone conduction (BC) and tactile communication for military applications. Formulated an algorithm for predicting localization error due to headgear. In FY10, investigate and determine optimum ear coverage by infantry helmets. Devise binaural criterion of speech intelligibility. In FY11, will determine neurological pathways of BC sounds. Will conduct initial experiments to quantify the contributions of visual, auditory, tactile, olfactory, kinesthetic					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
and narrative factors to an individual Soldier's immersive experiences; will develop measures to capture how individuals perceive the effectiveness/contribution of immersion in simulation environments. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Soldier performance. In FY09, used computer modeling/social network analyses to study Soldier decision-making to examine quality of information flow in defined command & control structures; conducted follow-on study to explore valid robot lexicon for human-robot communication; began research to determine important variables for human-robot teams control; investigated effect of information quality on low-level decision making. In FY10, conduct investigations of situational understanding & prediction in uncertain environments; identify usability deficiencies & mismatches between battle command processes & technology enhancements; further investigate the effects of information presentation on the Soldier's ability to perceive information. In FY11, will begin development of cognitive models predictive of team decision making; will continue work on determining effects of information quality and presentation on Soldier system performance. *FY 2009 Accomplishments:* FY 2009	2.048	2.181	2.294	0.000	2.294

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Research in Neuroergonomics: Enable systems designs that are consistent with human brain function, taking into account its limitations and exploiting its potentials, to maximize Soldier performance. In FY09, investigated novel approaches to capture brain activity and Soldier behavior in complex, dynamic operationally-relevant environments, examined differences in neural processes between individuals, and explored the neural processes underlying visual scanning. In FY10, explore the feasibility of using dry, wireless neurophysiological sensors suitable for high-density arrays in operationally-relevant environments; identify and model specific neural processes underlying visual scanning and target identification. In FY11, will advance the state-of-the-art in data analytic capabilities to extract brain-relevant information from multi-dimensional data arrays obtained in operationally-relevant contexts; will validate models of neural mechanisms underlying visual scanning and explore the neural processes underlying human interaction with autonomous systems. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.487	1.078	1.551	0.000	1.551

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4	0.000	1.069	1.135	0.000	1.135
Cognition and Neuroergonomics: 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. In FY10, investigate perceptual-motor interactions, including those between sensory-perceptual channels and motor systems; explore the complex effects of information quality and quantity on physical and cognitive performance; explore the neural representations of command-level decision making through identification of information representation; examine factors leading to successful or faulty decisions, including biases, heuristics, implicit versus explicit knowledge, context and stressor; identify key individual differences and stressors and investigate their impact on neural processing and cognitive performance; explore the appropriate neuro-sensing approaches for assessment in operational environments.In FY11, will explore models of information presentation, including multi-modal and adaptive displays; will examine the effects of information systems on physical and cognitive performance; will examine how the nervous system filters large-scale, multi-dimensional data sets for decision making; will identify individual differences in neural processing underlying successful and unsuccessful decision making; will identify key individual differences and stressors and investigate their impact on neural processing and cognitive performance; will explore the appropriate neuro-sensing approaches for assessment in operational environments; will explore methods for state detection and signal processing techniques for signal integration; will develop static algorithms that account for the variability in individual differences and/or environmental stressors on performance. *FY 2009 Accomplishments:* FY 2009					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.037	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	4.973	5.673	6.971	0.000	6.971

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
74F: *PERS PERF & TRAINING*	5.588	5.829	5.549	0.000	5.549	5.766	7.023	7.148	7.266	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds behavioral and social science basic research 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; identifying principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; identifying potential methods for faster learning, improved skill retention, and adaptable transfer of training to new tasks; identifying likely methods for developing leader adaptability and flexibility and for speeding the maturation process; discovering and testing the basic cognitive principles that underlie effective leader-team performance; understanding the role of emotions in regulating behavior; extending social network theory to assist in training effectiveness for counter insurgency operations; and improving 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) support the Army's new Network Science initiative by focusing 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. Research in this project is related to and fully coordinated with efforts funded in PE 0602785A, project 790 (Personnel Performance and Training Technology).The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work in this project is performed by the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	3.633	3.768	3.764	0.000	3.764
Human Behavior: In FY09: identified and measured individual attributes and learning principles that foster adaptive performance and promote rapid adaptability skill acquisition and retention; developed a new, culture free measure of self-control that will allow prediction of achievement above and beyond cognitive ability; and matured theoretical framework for addressing the human dimension for training and enhanced performance, Soldier					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
retention, productivity, and organizational citizenship. In FY10: achieve a better understanding of the interplay between cognition and emotion in training, performance, and socio-cultural interactions; link training methods and learning principles to performance such that they can be incorporated into models that predict job performance and could be used to improve immersive training environments that are tailorable to the individual needs of learners; systematically examine how nonverbal behaviors are encoded and decoded in human communications in a variety of settings (in particular, we will be concerned with training, leadership, and negotiation types of settings); and determine whether and how nonverbal behaviors affect outcomes in these environments. In FY11, will continue basic research in the areas of psychological measures of individual abilities, implicit and explicit learning, cognition, and social influence. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Network-Human Science: In FY09, conducted research on modeling and simulation of the human use of networks, communication, and command and control technologies to create semantic networks of common sense knowledge in tactical military settings; created new technologies to integrate the human, biological, mathematical, and engineered domains of network science, to extract higher level principles that illuminate each domain in new ways; and explored the regularities of networked social behavior within massively multi-	1.955	1.908	1.785	0.000	1.785

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
user online environments as simulations of real behavior. In FY10, create new computational measures of leadership and organizational expertise in on-line networks and distinguish novices from experts in order to rate the reliability of the contributed information; and match those needing information to those who are able to share it to investigate the dynamics that foster a thriving online community. In FY11, will continue basic research on variables that influence the interaction of individuals and teams within distributed environments. In all years, research will be done in collaboration with the Army Research Laboratory and Army Research, Development, and Engineering Centers and with researchers at the Army's University Affiliated Research Centers, i.e., the Institute for Creative Technologies at the University of Southern California, the Institute for Collaborative Biotechnology at the University of California, Santa Barbara, the Massachusetts Institute of Technology, and Carnegie Mellon University. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Small Business Innovation Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009	0.000	0.153	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	5.588	5.829	5.549	0.000	5.549

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
F20: *ADV PROPULSION RSCH*	3.299	3.331	3.429	0.000	3.429	3.496	4.193	4.272	4.355	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds research to increase the performance of small air-breathing engines and power trains to support improved system mobility, reliability, and survivability, and ultimately serve to reduce the logistics cost burden for the future. 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 (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and 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. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.303	2.301	2.389	0.000	2.389
Thermal Materials: 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 In FY09, investigated synchronized speed control shifting algorithms that could enable variable speed helicopter transmissions and formulate diagnostic fault detection methods to improve the safety and reliability of helicopter transmissions. In FY10, investigate optimum fiber architecture needed to fabricate uncooled turbine components for increased fuel efficiency and develop improved sand trajectory modeling methodology to improve the safety, durability, and reliability of turbine engines. In FY11, will complete computational assessment of gear windage for various gear rotational conditions and compare with validation results to identify and mitigate power losses.					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Reliable Small Engines for Unmanned Systems: 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. In FY09, investigated high priority engine technology shortfalls associated with small unmanned aerial systems (UAS) that can also benefit emerging robotic platforms and energy generation platforms with similar power requirements. Conducted research to establish a small engine-class analytical database and tools. In FY10, utilize validated suite of system simulation tools to identify and improve component and system operation of current and potential Army small engine applications. In FY11, will evaluate potential for improving fuel consumption and reliability of heavy fuel engine concepts for small (<100 HP) system applications. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	0.996	1.008	1.040	0.000	1.040

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.022	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	3.299	3.331	3.429	0.000	3.429

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
F22: *RSCH IN VEH MOBILITY*	0.547	0.564	0.576	0.000	0.576	0.588	0.601	0.612	0.624	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: 1) non-linear ground vehicle control algorithms, using off-road terrain characteristics; and 2) instantaneous diesel engine optimizations, using advanced analytical and experimental procedures. This work is performed at the Tank and Automotive Research, Development and Engineering Center.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.547	0.556	0.576	0.000	0.576
Advanced mathematical algorithms for improved vehicle efficiency: In FY09, investigated JP-8 versus DF-2 combustion differences, expanded physics based human modeling effort for vehicle-human interaction dynamics, and explored improved vehicle-terrain methodologies. In FY10, develop engineering models for JP-8 ignition and combustion profiles, explore reduced chemical kinetics JP-8 ignition models, and further investigate vehicle-human interaction dynamics. In FY11, will continue to develop JP-8 engineering models for combustion and ignition as a function of fuel ignition quality, will continue exploring vehicle-human interaction dynamics, and will study better modeling techniques for vehicle-terrain interaction dynamics.					
FY 2009 Accomplishments: FY 2009					
FY 2010 Plans: FY 2010					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Program *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.008	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	0.547	0.564	0.576	0.000	0.576

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H42: *MATERIALS & MECHANICS*	5.722	6.009	6.975	0.000	6.975	7.461	8.676	8.835	8.990	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds the Army's 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 approach 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. This research supports materials technology applied research in PE 0602105A, project H84. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.121	2.258	2.759	0.000	2.759
Microscopic/Nanostructural Materials: Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the future force. In FY09, performed comprehensive materials characterization for damage-tolerant sub-micron Silicon Carbide (SiC) ceramic materials, and developed 1st-generation phenomenological constitutive and failure model for Silicon Carbide Nitride (SiC-N) ceramic materials for armor. In FY10, research grain boundary engineering of ceramics to improve fracture tolerance at low and high rates; and characterize materials using a combination of electron microscopy and crystallographic orientation tools to identify optimum microstructures for ballistic protection. In FY11, will research novel processing method concepts for improved armor ceramics; and characterize multifunctional materials systems seeking performance at minimum weight.					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 High deformation rate materials: In FY09, investigated engineered scalable materials for armor applications using nanoscale building blocks; characterized their properties and fed ballistic modeling efforts to rapidly screen for performance. Created underpinning understanding to enable the engineering of expedient materials. In FY10, investigate the relationships existing between high rate properties and prior processing; and characterize nanoscale materials using high resolution microscopic analytical methods for feedback to processing and modeling research for protection materials. In FY11, will perform research relating high rate properties and microstructures to ballistic property observations; and will use model results of static and transient electric/magnetic/flow fields to identify new materials and mechanisms. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	2.021	1.838	2.124	0.000	2.124

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Materials research and processing at small scale: In FY09, researched concept of materials by design which enables conduct of material modeling studies to enable bottom-up armor materials design. Researched methods relating processing to materials microstructure that feeds ballistic property models with focus of the effort largely on ceramics. In FY10, perform materials research to relate properties observed at small scale to microstructure; and perform research relating ballistic model output to processing, properties and microstructure.In FY11, will determine the relationship between textile properties and fabrication methods; and will characterize novel protective materials using state of the art microscopy tools. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.580	1.816	2.092	0.000	2.092
Program #4	0.000	0.097	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	5.722	6.009	6.975	0.000	6.975

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H43: *RESEARCH IN BALLISTICS*	7.995	8.208	8.318	0.000	8.318	8.463	9.224	9.395	9.563	Continuing	Continuing

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/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. This research supports survivability and lethality technology applied research in PE 0602618A, project H80.The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Aberdeen Proving GroundAdelphi, MD, and Research Triangle Park, NC.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.580	2.547	2.672	0.000	2.672
National Advanced Energetics Initiative: 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 In FY09, designed smart, molecularly engineered energetics; designed insensitive, nano-reactive energetic materials/structural energetic composites; differentiated initiation reactions caused by conductive versus shear stimuli; explored turbulent mixing and combustion in late-time energy release; and characterized sensitivity and performance of insensitive warhead explosive fills and validated refined propellant models. In FY10, provide new theoretical descriptions, quantum mechanical models, and real-time, in-situ validation measurements of energy storage and release mechanisms in non-traditional condensed phase materials such as structural nano-reactives, metastable polymerics, strained crystals, and diamond-like explosives. In FY11, will link 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.					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Launch and flight of gun launched projectiles and missiles: 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 In FY09, devised 1st-generation physically consistent phenomenological constitutive and failure model for select damage-tolerant ceramics; implemented both controlled fragmentation and reactive material ignition models into a continuum mechanics code; and modeled effects of secondary debris on humans and compared model results with actual human injury data obtained from the medical community. In FY10, identify the controlling mechanisms through modeling and validation that are responsible for the ballistic effectiveness of ceramic materials; expand the reactive material ignition model to include a variety of reactive materials with different terminal effects; and adjust the urban material failure model to account for numerous urban construction materials. In FY11, will establish a validation technique that directly probes and quantifies the fundamental mechanism responsible for ceramic material ballistic performance; will develop suitable post-ignition thermal and equation of state models for reactive material ignition products; and will quantify the terminal ballistic effects of a variety of urban construction materials impacting the human body through extensive modeling and sub-scale experiments.	2.564	2.580	2.686	0.000	2.686

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities In FY09, focused research efforts on bridging gaps that link these governing mechanisms and laid the groundwork for the prediction of overall response, including human functions such as cognitive and physical performance. Attempted to validate man-portable microwave sources operating at 94 GHz for active denial and crowd control, intending to leverage the development of the micro-machined sources. In FY10, conduct research on high rate response of biological materials, cause of injury, and injury mechanisms for development of novel protection concepts. Research energy flow processes at interfaces to develop precise control of explosive effects. Focus on the analysis and understanding of hyper-spectral image data and the development of rigorous mathematical models and hierarchical statistical techniques to characterize impacts. In FY11, will develop 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 2009 Accomplishments:* FY 2009	0.883	0.927	0.932	0.000	0.932

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Armor research: In FY09, investigated modeling and simulation of ballistic impact events to include modeling materials response with enhanced failure models that capture realistic behavior with minimum parameterization; created fundamental ceramic/glass model and developed mesoscale approaches. For electromagnetic armor technology created physics based models to address coupling ballistic and electrodynamics models for solid mechanics, computational fluid dynamics, and material failure models; and validated model predictions. In FY10, develop models for armor plate acceleration that do not utilize explosive materials; obtain laboratory derived mesoscale modeling parameters for ceramic materials to enable modeling of ceramic armor materials at the micro-structural level; and begin the study of a thermodynamically-consistent equation of state theory. In FY11, will formulate and validate explosive-free plate acceleration models and equation of state models into continuum mechanics codes; and will use the mesoscale modeling approach to identify ceramic material microstructures that will result in their improved ballistic resistance. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.968	2.017	2.028	0.000	2.028

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.137	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	7.995	8.208	8.318	0.000	8.318

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H44: *ADV SENSORS RESEARCH*	6.112	6.343	9.695	0.000	9.695	7.005	7.623	7.769	7.912	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds 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 fusion, and battlefield acoustic signal processing algorithms. Research performed under this project supports survivable sensor systems, organic thin film transistor (OTFT) technology and organic light emitting diode (OLED) technology for affordable rugged flexible displays, and hazardous material monitoring, both point and remote. Payoffs include 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 (UWB) 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, and hazardous material and event sensing. This project also funds research in the development of biologically inspired materials for use as sensors as well as for power generation and storage. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.662	1.708	1.761	0.000	1.761
Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications: In FY09, researched parameters and defined the operational envelope for the use of ultra short (femtosecond) laser illumination for the Army's active imaging and directed energy applications. In FY10, explore long range atmospheric laser beam propagation paths for military reconnaissance, laser communications, and directed energy applications. In FY11, will devise target-in-loop (TIL) laser beam control techniques for Army long range and tactical scenario engagements.					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Improving sensor capabilities: create more survivable/secure systems and displays, improve hazardous material monitoring, and investigate new magnetic sensor technologies for personnel and IED detection. In FY09, researched target & clutter scattering to support radar detection of concealed targets; evaluated signal processing algorithms for networks of heterogeneous sensor nodes; assessed, and continued to improve high conducting films to integrate with OLED and OTFT development. In FY10, integrate conductive organic materials and high stability OLED with flexible backplanes and demonstrate a Micro Electric Mechanical System (MEMS) low-noise magnetic sensor. Model metamaterial antennas and explore their theoretical limits. In FY11, will optimize conducting organic materials for flexible display and electronics, will investigate 3-D Synthetic Aperture Radar (SAR) imaging using wide-angle simulation data of complex buildings for through-the-wall sensing research, will develop conductive organic materials and thin film transistors and integrate into flexible electronic devices. In FY11, will also research networked fusion concepts across distributed multimodal sensor nodes and develop novel magnetic sensors with enhanced performance. Will fabricate and test metamaterial inspired antennas based on theoretical simulations.	2.471	2.518	2.644	0.000	2.644

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Biologically-inspired sensing and power generation: In FY09, conducted research to advance novel biologically inspired sensor methodologies for biological hazards detection and bio-inspired routes to assembly of electronic structures. Researched bio-inspired materials for lightweight, portable energy generation and storage. In FY10, investigate bacteria that remediate energetic materials and produce small organic molecules useful as fuels, bio-inspired structural materials for energy absorption, bio-inspired batteries, and biologically directed assembly of electronic structures. In FY11, will manipulate bacteria for improved remediation of energetic materials and generation of organic fuels, investigate electric properties of bio-assembled materials for battery applications, will investigate mechanical properties of bio-inspired structural materials, and will investigate the electronic properties of bio-assembled electronic structures. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.979	2.033	2.290	0.000	2.290

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Multi-scale Modeling for Novel Materials: In FY11, will perform fundamental studies to identify and model physics and atomic interactions that control material deformation, progressive / catastrophic failure, and phase response across length scales; will evolve interface physics between nano- and meso-scales; will create new multi-scale experimental techniques and characterization methods to probe materials microstructure and response under extreme conditions. Supporting computational research will investigate and develop scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.000	3.000	0.000	3.000
Program #5	0.000	0.084	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	6.112	6.343	9.695	0.000	9.695

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H45: *AIR MOBILITY*	2.298	2.361	2.399	0.000	2.399	2.449	2.497	2.543	2.588	Continuing	Continuing

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 test 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. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. 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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.298	2.317	2.399	0.000	2.399
Rotary Wing Aerodynamics: In FY09, developed computational fluid dynamics and computational structural dynamics methods for active rotors, assessed capability of state-of-the-art turbulence models for capturing rotorcraft flow physics such as intersecting and vortical flows, and developed improved dynamic stall models for comprehensive analysis. In FY10, investigate interacting vortex wakes for rotors in close proximity, and identify the high speed aeromechanics boundaries of compound helicopter configurations. In FY11, will develop improved and validated hover performance methods, will investigate the ability of pressure sensitive paint to acquire unsteady pressure measurements for both fuselage and rotor blades.					
FY 2009 Accomplishments: FY 2009					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.044	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	2.298	2.361	2.399	0.000	2.399

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H47: *APPLIED PHYSICS RSCH*	2.841	2.940	5.009	0.000	5.009	3.077	3.167	3.228	3.290	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project performs basic research on electronic materials and structures as well as energetic 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 electrode, and electronic materials; thin heterostructure systems where quantum confinement effects are important; advanced batteries and 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 and advanced radar systems. Applications of cold atom chips include gyroscopes and accelerometers for inertial navigation units, gravitational sensors for detecting underground facilities, very-low-phase noise precision oscillators for low-velocity Doppler radar, and atomic clocks denied global positioning system (GPS) environments for possible space applications. Technical barriers affecting performance, weight, cost, and power consumption will be addressed. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.841	2.902	3.002	0.000	3.002
Research focuses on nanoelectronic devices and sensors; 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; cold-atom chip devices for advanced sensors and ultra-stable atomic clocks; and integration of nanoenergetics and micro electro mechanical system (MEMS) for fuzing and microrobotic applications. In FY09, investigated system insertion for nanoelectronic devices and sensors and failure mechanisms for wide-bandgap electronic devices; attempted measurements of a cloud of cold atoms on an atom chip; and developed capability for creation of bio-inspired materials for batteries and fuel cells. Formulated electrode/electrolyte systems based on fundamental understanding of their interface. In FY10, attempt to load and launch cold atoms into an atom waveguide. Integrate nanoporous energetic silicon with MEMS acceleration switch; investigate carbon based materials for application to nanoelectronic devices. Use computer					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
modeling and simulation to guide design of reformer components, which involves developing gas and liquid phase sulfur sorbents to strip sulfur from the JP8 to avoid poison fuel cell catalysts after reformation. In FY11, will attempt to split a guided atomic beam on an atom chip. Will integrate nanoporous energetic silicon with MEMS microthruster devices and demonstrate nanoelectronic devices. Will develop new battery electrode prospects by bio-inspired processes from Institute for Collaborative Biotechnologies, PE 0601104A/project H05. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Advanced Energy Science Research: In FY11, will conduct research to advance novel materials by design approach of modeling and theoretical computations to predict characteristics and performance a priori for energy storage and conversion materials; will investigate multidisciplinary approaches for novel energy harvesting (light, heat, vibration, isotope, biological energy, sources); will investigate emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications. *FY 2009 Accomplishments:* FY 2009	0.000	0.000	2.007	0.000	2.007

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.038	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	2.841	2.940	5.009	0.000	5.009

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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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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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H48: *BATTLESPACE INFO & COMM RSC*	8.814	11.374	13.685	0.000	13.685	14.726	17.816	18.285	18.890	Continuing	Continuing

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 becomes smaller 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 new 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 Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.651	1.678	1.568	0.000	1.568
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. In FY09, performed laboratory analysis to incorporate technologies in mobile radio units. Developed scaling laws for mobile ad hoc and sensor networks under military constraints. In FY10, perform validation analysis to extract tractable models of network behavior to enhance military network design tools. In FY11, will use network behavior models and scaling laws to develop cognitive networking protocols to enhance the performance of tactical mobile networks.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 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. In FY09, evaluated 3-D scene reconstruction and pose recognition for enhanced situational awareness, along with information mediation improvements to the military operational and tactical decision and planning process. In FY10, extend scene recognition algorithms to mobile platforms to support biologically inspired collaborative behaviors. Investigate local and global policy aware information exchange and information exploitation algorithms in collaboration with the Network Science CTA initiative. In FY11, will conduct validations in a laboratory environment to assess the impact of policy aware algorithms on Situation Understanding. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.453	1.480	1.636	0.000	1.636

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 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. In FY09, designed and evaluated analytically and via simulation/emulation, robust classes of algorithms that provided a dynamic architecture to support detection of attackers under conditions of mobility. In FY10, refine and evaluate the dynamic security services architecture for mobile tactical networks for assured Soldier communications. In FY11, will investigate and develop techniques for securing information flows in highly mobile wireless tactical environments. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.668	1.710	1.765	0.000	1.765
Program #4	1.061	1.082	1.222	0.000	1.222

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Establish formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing. In FY09, explored multi-engine machine translation architectures for processing and exploiting multi-media, multi-language (e.g. Arabic, Farsi, and Swahili) sources. In FY10, develop and assess novel metrics for evaluating new multi-engine machine translation architectures. In FY11, will conduct laboratory validations to assess multi-engine machine translation concepts, addressing scalability and robustness in noisy environments. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5 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. In FY09, conducted component-based performance modeling and analysis of routing protocols and design networking protocols that adapt to varying operating environments in order to optimize performance. In FY10, develop and compare component based analytical models with executable models to enable the design of robust tactical networks. In FY11, will develop algorithms, techniques and metrics for robust local/global network optimization using cognitive and communication network metrics.	0.994	1.001	1.036	0.000	1.036

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #6 Advanced Computing. In FY09, researched advanced computing algorithms and techniques to addresses implementation issues for mobile networking, machine based language translation, and information processing infrastructure. Researched computer based modeling, simulation and data analysis techniques for the study of scientific phenomena and engineering designs. In FY10, investigate algorithms, approaches, and methodologies for battle command applications that exploit emerging mobile hybrid computing architectures. Battle command applications will include large-scale battlefield network modeling; real-time algorithms to assist network emulations; comprehensive data representation, models and analysis techniques; information fusion of different data types; engineering design based approaches. In FY11, will implement large-scale battlefield network modeling; real-time algorithms to assist network emulations; models and analysis techniques; information fusion of different data types for battle command applications that exploit emerging mobile hybrid computing architectures. *FY 2009 Accomplishments:* FY 2009	1.987	2.524	2.599	0.000	2.599

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #7 Network Science Technology Experimental Center. Supports in-house Network Science studies in conjunction with the Network Science and Technology Research Center (PE 0601104A/project J22) and is coordinated through the Network Sciences CTA (0601104A/project H50). Investigate fundamental network behaviors utilizing high performance computing software that enables the design and analysis of mobile ad hoc networks at sufficient levels of fidelity and with sufficient speed to understand network centric warfare (NCW) technologies in the full range of conditions in which they will be employed. Investigate and devise scalable software tools that significantly extend the capabilities to perform simulation, emulation and validation of mobile ad hoc networks. Devise a software environment that will enable the eventual integration and linking of the simulation-emulation-validation cycle. In FY10, devise advanced computing based tools to accelerate scenario/model development, coupling of different models, verification and validation (V&V), and enhanced multi-disciplinary collaboration through common user interfaces, scalable library routines, pre-processing, scalable optimization routines, and post-processing analysis tools. In FY11, will extend 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 will be linked to field validations to extend the scale of the network tested These efforts will significantly improve the understanding of network behaviors under a full range of operational conditions, significantly improving the design of NCW technologies.	0.000	1.756	3.859	0.000	3.859

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #8 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.143	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	8.814	11.374	13.685	0.000	13.685

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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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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H52: *EQUIP FOR THE SOLDIER*	0.978	1.030	1.078	0.000	1.078	1.105	1.134	1.158	1.181	Continuing	Continuing

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. 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 Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.978	1.027	1.078	0.000	1.078
Equipment for the Soldier: 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. In FY09, screened multiple isolates for advancement to biofilm formation for rapid screening of foods for pathogenic bacteria; and addressed selected behavioral principles most likely to impact long term acceptance and use results. In FY10, use novel computational methodologies to understand techniques necessary to simulate dynamics/interactions of fluid structure systems undergoing topology change as would be found in parachutes, parafoils and flexible structures. In FY11, will continue fundamental work in supporting the goals of understanding cognition while performing multiple tasks; will explore 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 will conduct experiments to improve the understanding of the basic phenomena of the biomimetic approach to metal oxide formation for the production of novel multifunctional materials.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.003	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	0.978	1.030	1.078	0.000	1.078

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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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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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H57: *Single Investigator Basic Research*	63.397	64.649	73.075	0.000	73.075	68.663	75.881	82.178	90.434	Continuing	Continuing

A. Mission Description and Budget Item Justification

This extramural research project discovers and exploits new scientific opportunities and technology breakthroughs, primarily at universities, to 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 biology), the engineering sciences (mechanical sciences, electronics, materials science and environmental science (atmospheric and terrestrial sciences)), and mathematical and information sciences (mathematics, computer, and information sciences) and network science. Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature 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 Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed extramurally by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	5.820	5.729	6.351	0.000	6.351
Basic research in molecular, physiological, and systems biology:In FY09, focused on exploiting multidisciplinary interface of bionanoengineering to engineer bioinspired nanodevices with novel capabilities, using biomimetics to create new protective materials, and to understand and engineer countermeasures to molecular and physiological factors that impair Soldier cognitive and physical performance. Undertook systems biology approach to bioremediation focused on the few microbial species capable of degrading toxic halogenated pollutants, investigated modulating effects of oxidative stress on Soldier health and performance, investigated biophysics and modeling of spore germination and inactivation for effective biowarfare countermeasures, and explored other					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
species sense and computing capabilities for novel algorithms usable in automated and remote military systems. Studied use of synthetic materials and molecular circuits capable of promoting tissue regeneration, developed tools in synthetic biology to construct genetic programmable circuits that could serve as the basis for chemical and biological sensing, used noninvasive human state sensors, correlated physiological signals with behavioral functions and human performance, and model and engineered relevant microbial species for the optimal synthesis of energy for military specific needs. In FY10, basic research in all of these areas is being continued with a concurrent transition and focus towards field use. New initiatives in non-invasive modulation of neural systems, bridging the living/nonliving interface in peripheral nerves, and sensing of brain signals will commence. Biofuel development studies will expand; improved methods to convert operating base biological waste to energy, and development of methodologies to convert sunlight "directly" to biofuels are being initiated.In FY11, this research will mature and enable new biotechnologies and bionanoengineering for new Army capabilities and materiel. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Basic research in environmental science possesses three areas: (i) atmospheric science research to measure, model, and theoretically understand the nighttime atmospheric boundary layer; (ii) terrestrial science research to enable the Army to operate effectively in all military operating environments by understanding fundamental	1.989	2.030	2.474	0.000	2.474

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
terrain and land-based phenomena; and (iii) military habitation science, basic research to allow military power projection that meets operational needs in a sustainable manner. In FY09, investigated environmental effects on geophysical techniques used remotely to sense both the surface and shallow subsurface and understanding relationships between surface and subsurface characteristics of the soil system, with a focus on soil moisture through a multi-agency R&D initiative. Military habitation science focused on basic research to support resource reuse and transformation, energy recovery, and energy conversion at base camps. In FY10, address Army-unique atmospheric operational needs and investigate automated terrain navigation by autonomous vehicles and use geographic information systems (GIS)-based approaches for cognitive understanding and utilization of geospatial information, analysis, representation, and modeling of multiple types of geospatial data. In FY11, environmental sciences will examine small-scale processes of the diurnal continental atmospheric boundary layer, will investigate the overlapping topics of network science and geographic information science research as related to social networks, and will improve operational sustainment through basic research in military habitation science. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Basic research in chemical sciences for advanced energy control, protective materials, and threat detection. Advanced energy control will provide light-weight, reliable, compact power sources for the soldier and more	6.894	6.920	8.373	0.000	8.373

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage. Protective materials will shield soldiers and their platforms from ballistic, chemical, and biological threats; and reduce signatures for identification by the enemy while providing clear identification by friendly forces. Threat detection will provide advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals. In FY09, research focused on nano-particle material repair, optical limiting, fuel cell catalysts and membranes, structure/function for protective membrane transport, and reactive surfaces for decontamination. In FY10 research focuses on functionalized morphology, novel reactive monomers, environmentally stable self-assembled materials and reactions in extreme media. In FY11, will continue research of functionalized morphology, novel reactive monomers, environmentally stable self-assembled materials, and reactions in extreme media. Will research mechanophores, never-before-created molecules that provide automatic conversions between mechanical, thermal and chemical energy, will synthesize and incorporate these into polymers and polymeric materials. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Basic research in physics for precision guidance, superior optics, signature management properties, ultra-sensitive sensors, quantum computing, and secure communications. In FY09, devised flat lenses and sub-	9.353	9.325	12.457	0.000	12.457

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
wavelength imaging for ultra light optical components and detection of pathogens; explored physics of attosecond light pulses for remote spectroscopy, armor fatigue analysis and "seeing through the wall"; conducted optical lattice simulation of magnetism and high temperature superconductivity; studied artificially layered oxides for remote passive sensors and ultra-low power electronics; devised multi-modal plasmon enhanced environmental sensors, elucidated decoherence in quantum computation platforms and extended ion trap qubit fidelity to solve "unsolvable" problems. In FY10, demonstrate ultra-light negative-index optical components; simulate intractable condensed matter theories with optical lattices; devise ultra cold chemistry concepts heralding novel chemical synthesis routes; engineer artificial oxides to stimulate a second electronics revolution; and explore cross-platform qubit entanglement. In FY11, will advance transformation optics for cloaking and omni-directional light collection; will devise models guiding materials development for next generation electronics using optical lattices; will engineer artificially layered oxides to enable disruptive electronic technology; and will study quantum entanglement-enhanced metrology and stealth imaging. Will study techniques to exploit quantum entanglement and controllable quantum physics effects for imaging. Will research new spin-based electronics technology (spintronics) and 'cold atom' spintronics. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5	12.463	12.342	14.474	0.000	14.474

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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 H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Basic research in electronics and photonics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency. In FY09, devised small tactical antennas operating across high frequency bands; determined feasibility of quartz oscillator infrared detectors; created methods to control magnetization dynamics in nanostructures for high speed electronics; improved mid-IR lasers based on antimonide type-I quantum well lasers in 2-3 micron range; and determined the optical/magnetic properties of doped Gallium Nitride (GaN) semiconductors for magnetic semiconductor applications. In FY10, generate small avalanche photodiode arrays of the (Ga,In)(As,Sb) family providing low noise/high gain for night vision applications in mid infrared spectral region; show feasibility of electrically-injected room temperature continuous-wave mid-infrared semiconductor lasers based on group IV-VI lead salt materials for optical communications; validate optical subwavelength sensing on biomolecules for Chem/Bio analysis; and show proof of concept for a single-chip 2.4GHz transceiver on silicon with integrated antenna for improved radio communications. In FY11 will determine feasibility of quantum cascade superlattice IR detector; will create wide-bandgap ZincOxide(ZnO)/ GaN based semiconductor lasers; tunable composition nanowire visible lasers with improved efficiencies/scalable power for low cost applications; and will determine effects of polarization field upon ferromagnetic and optical properties of magnetically doped GaN for sensing/information processing. Will study theory, materials growth and characterization of complex oxides that exhibit strong electron correlations leading to emergent phenomena not possible with semiconductors. Will research non-invasive techniques to interface electronics with the brain. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Program #6 Basic research in mechanical and material sciences for survivable armor, more lethal anti-armor, improved mobility, and flexible displays for Soldier systems.In FY09, validated chemical kinetic mechanisms for alternative hydrocarbon-based fuels at high temperature and pressure in diesel and turbine engine applications. Researched new materials for armor and Soldier protection, and improved techniques to predict material failures. In FY10, investigate topological optimization strategies to devise tools to optimize structures based on damage tolerance. Validate new vorticity-based computational methods for rotorcraft flows capable of convecting the wake without the deleterious effects of numerical diffusion for improved model accuracy. Research implementation of reduced hydrocarbon combustion kinetics codes into engine models for future fuel flexible engines and devise physical understanding of hypergolic ignition to enable gel-propellant rocket propulsion. In FY11, will devise 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. Will investigate novel/emerging composite materials system that mimics biological adaptive and self-healing characteristics for novel structural materials. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base	12.491	12.387	12.385	0.000	12.385

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Program #7	11.982	12.301	11.273	0.000	11.273
Basic research in mathematical and computer sciences is the backbone for performing complex, multi-system analysis, modeling and understanding simulation, and information systems. Advancements in mathematical and 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 FY09, devised tools for design of heterogeneous swarms for desired emergent behavior, which led to better system design or control design for military systems such as UAVs, UGAs, or robotics. In FY10, experimentally validate the effectiveness of the devised products and tools on swarming and sensor fusion in laboratory test-beds. These results help to identify computer techniques designed to identify attacks against information systems, protecting information systems from attacks, and on devising techniques for inherently hardened software. New understanding and knowledge gained from these efforts contribute to the development of robust and resilient information systems that address the processing and delivery of authentic, secure, reliable, and timely information to the warfighters, regardless of threat conditions. In FY11, will use the results of the testing and validation efforts from FY10 to refine and improve tools and an enhance theory.					
FY 2009 Accomplishments: FY 2009					
FY 2010 Plans: FY 2010					
Base FY 2011 Plans: FY 2011 Base					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Program #8 Basic research to gain 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, or more efficient logistics or communications support.. In FY09, examined mechanisms by which different layers interact with one another. In particular, a universal representation of information (information theory, metrics, topology, etc.) within physical, biological, and social networks was constructed to enable network interfacing and control across multiple scaled networks. Moreover, the barriers to network control across multiple scales was addressed in this general information context. The goal was to gain a deep understanding of network systems that provides a basis for their properties. In FY10, define and conduct first order laboratory experiments and simulations to refine network representations. In FY11, developing the theory to understand the non-stationary, non-ergodic statistics of complex biological, social and cognitive networks observed in the experiments of FY10 will be addressed. Understanding the limitations of traditional statistical theory on which predictions have been historically based will strongly impact the capabilities of the net-centric force. Specifically, the influence of intermittent uncertainty on situation awareness and decision-making in a networked environment will be determined. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base	2.405	2.158	3.623	0.000	3.623

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Program #9 Bioforensics and Microscale Manipulation with Bacteria:In FY11 will conduct research leading to an understanding of adaptation in microbes enabling the ability to determine where microbes originated, how closely related they are, and how they were most recently grown. Taken together, this will provide a means of attribution of a biological event, whether naturally occurring or nefarious. Will study micro-scale locomotion and manipulation using flagellated bacteria for actuation, which lends itself to bacteria propelled micro-structures for engineering of micro-manipulators and micro-robotics. Research will include extending theory to address the use of attractants for controlling the trajectory of bacteria-propelled barge. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.000	1.665	0.000	1.665
Program #10 Small Business Innovative Research/Small Business Technology Transfer Programs	0.000	1.457	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	63.397	64.649	73.075	0.000	73.075

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H66: *ADV STRUCTURES RSCH*	1.711	1.808	1.889	0.000	1.889	1.942	1.996	2.040	2.089	Continuing	Continuing

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 structures 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. As agreed under Project Reliance, this is the only project for rotorcraft and ground vehicle structures basic research within DoD. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. 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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.711	1.806	1.889	0.000	1.889
Structural Analysis and Vibration Methods: This research devises new structural analysis and validation methods to more accurately predict durability and damage tolerance of composite and metallic rotorcraft structures, and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
system components of future aircraft.In FY09, evaluated multibody-compatible thin-walled elastic finite element methods to enable aeroelastic predictions for small-scale air vehicle systems. In FY10, complete characterization testing for materials used in finite element models for delamination fatigue life prediction, and validates life prediction tools for dynamic rotorcraft sub-components. In FY11, will develop predictive tools for residual strength after impact for thin-skin structural concepts; will develop damage resistant and damage tolerant core and skin concepts; and will validate residual strength prediction tools for stiffened skin components. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	0.000	0.002	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	1.711	1.808	1.889	0.000	1.889

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H67: *ENVIRONMENTAL RESEARCH*	0.906	0.941	0.967	0.000	0.967	0.997	1.018	1.039	1.072	Continuing	Continuing

A. Mission Description and Budget Item Justification

The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army production base and weapon systems as well as non-stockpile chemical warfare (CW) site remediation. The pollution prevention work 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. The goal is to reduce 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. This project is linked to 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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and the defense Technology Area Plan (DTAP). Work is under the direction of the U.S. Army Armament, Research, Development and Engineering Center.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.906	0.938	0.967	0.000	0.967
Industrial pollution prevention: This effort conducts research on innovative environmentally- friendly technologies that support the warfighter (focusing on pollution prevention technologies). In FY09, developed environmentally benign approaches to nitration reaction in microreactors (ARDEC), conducted modeling, processing, and characterization of highly layered polymer films (NSRDEC), investigated new physical vapor deposition technologies for new ordnance coatings (Benet Labs), developed polysiloxane nanocomposites for environmental and human safe flame-retardant materials (NSRDEC), conducted research on anaerobic hydrogen					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
production from a variant of clostridium phytofermentans (ECBC), investigated bio-based gel coats with zero hazardous air pollutant contents for composites applications (ARL), and researched ammonium perchlorate replacements (AMRDEC). In FY10, continue efforts in FY09 that were selected by the Peer Panel during the Gate Reviews in September 2009 and conduct research on additional new yet undetermined projects. In FY11will continue the ongoing programs based on the Peer Panel review and any new starts selected by the Panel. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	0.000	0.003	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	0.906	0.941	0.967	0.000	0.967

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H68: *PROC POLLUT ABMT TECH*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
H68: *PROC POLLUT ABMT TECH*	0.420	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides fundamental understanding of the physical, chemical and biological properties and mechanisms that control the degradation and treatment of hazardous wastes on military installations. This research is used to obtain basic technical information necessary for the design of treatment systems for both cleanups of existing hazardous waste sites and control of future hazardous waste generation. Wastes of concern include explosives, propellants, chemical agents and smokes. This project supports applied research efforts in Program Element (PE) 0602720A, Projects AF25 and DO48. Work in this project is performed by the Army Corps of Engineers Engineer Research and Development Center.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.420	0.000	0.000	0.000	0.000

Degradation and treatment of hazardous waste: In FY09, conducted redox system experiments to determine Cyclotrimethylenetrinitramine (RDX) degradation enzymatic processes. Initiated mineralization rates and mass balance studies. Completed explosive exposures and cellular assays, and initiate proteomic and genomic analyses. In FY10, basic research efforts in project H68 move to project T25, Environmental Science Basic Research.

FY 2009 Accomplishments:
FY 2009

FY 2010 Plans:
FY 2010

Base FY 2011 Plans:
FY 2011 Base

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	0.420	0.000	0.000	0.000	0.000

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S04: *MIL POLLUTANT/HLTH HAZ*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S04: *MIL POLLUTANT/HLTH HAZ*	0.701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides basic research in innovative, less costly, and less time consuming toxicity assessment methods for determining potential human health and environmental effects of military-unique hazardous wastes and chemicals, including explosives, propellants, and smokes. These new testing techniques will help to prioritize hazardous waste and waste treatment technologies and screen new Army chemicals for potential toxic effects. The work is conducted at U.S. Army Center for Environmental Health Research (CEHR) and U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM). Work in this project is performed by the Army Corps of Engineers Engineer Research and Development Center.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.701	0.000	0.000	0.000	0.000

Human health and environmental effects research: In FY09, completed measurements of the fundamental aspects of control-fractured versus un-fractured mineral surface affects on the fate and transport of explosives. Continued the study of neurotoxicants on neurotransmitter pathway related gene expression in a gene regulatory network. Utilized systems biology, toxicogenomics, computational modeling and bioinformatics in the approach. In FY10, basic research efforts in project S04 move to project T25, Environmental Science Basic Research.

FY 2009 Accomplishments:
FY 2009

FY 2010 Plans:
FY 2010

Base FY 2011 Plans:
FY 2011 Base

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	0.701	0.000	0.000	0.000	0.000

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S13: *SCI BS/MED RSH INF DIS*	10.747	10.481	10.652	0.000	10.652	10.900	11.121	11.348	11.544	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research that provides for healthy, medically protected Soldiers. This project funds basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research provides understanding of the mechanisms that make organisms infectious and the effective human body response which prevents disease. 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 disease. 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: Conduct basic research to better understand the biology of malaria and Leishmania (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, user-friendly drugs and vaccines. A highly effective vaccine could reduce/eliminate the use of anti-malarial drugs and the development of drug resistance to current/future drugs. (2) Bacterial Threats: Conduct research to better understand the biology of bacterial organisms and their effects on humans and how to prevent wound infections, diarrhea and scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics).(3) Viral Threats: Conduct research to better understand highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (leakage of blood from vessels), such as dengue hemorrhagic fever and hantaviruses (Korean hemorrhagic fever). 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 interaction with the human body. (4) Diagnostics and Disease Transmission Control: Conduct research to investigate the biology of biting insects (including mosquitoes and Leishmania-infected sand flies and mosquitoes) and other organisms that transmit disease (called disease vectors) and their control. Expand medical diagnostic and disease surveillance capabilities in the field. This research will help to direct new interventions into preventing disease transmission.Work is managed by the US Army Medical Research and Materiel Command 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. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the co-located Walter Reed Army Institute of Research (WRAIR) and Naval Medical Research Center (NMRC), Silver Spring, MD, and its their overseas laboratories.

B. Accomplishments/Planned Program ($ in Millions)

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	6.200	5.758	5.829	0.000	5.829
Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases: In FY09, applied established medicinal chemistry techniques and computer modeling for Structure-Based Drug Design (SBDD) to discover candidate drugs to prevent or treat malaria infection. Employed bioinformatics to identify genes and proteins to help in the discovery of malaria vaccine components. In FY10, apply new tools for discovery of promising compounds as potential leads to new classes of anti-malarial drugs and for potential vaccine components. In FY11, will continue iterative approaches for the discovery, design and synthesis of promising new anti-malarial drug compounds and potential vaccine components. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2	0.930	1.474	1.724	0.000	1.724
Bacterial Threats: In FY09, identified proteins and other components produced by diarrheal organisms for their role in disease and possible use as a vaccine component. Studied bacterial disease factors affecting the health and illness in selected overseas populations at potential candidate vaccine test sites. In FY10, assess and improve selected proteins and other components identified from diarrheal causing bacteria as potential components of candidate vaccines. Conduct exploratory studies to evaluate methods to prevent wound infection from combat injuries. In FY11, will develop further knowledge of the epidemiology (study of factors affecting the health					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
and illness of populations) of diarrhea and wound infections in military personnel. Will assess basic wound management measures (concentrated oxygen, nutritional 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 reduce antimicrobial resistance. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Viral Threats Research: In FY09, conducted basic research to understand hemorrhagic viral diseases and other lethal viruses of military importance. Assessed emerging viral threats for their potential to impact military operations and to determine whether any identified new threat requires further study. In FY10, conduct basic research to better understand the biological basis of disease and protection in humans from naturally occurring viruses of military importance. Develop a better understanding of which parts of the immune system are needed to provide a protective response in humans. In FY11, will continue to study and evaluate the basis of disease and how the immune system reacts to diseases of interest. *FY 2009 Accomplishments:* FY 2009	1.794	1.763	1.764	0.000	1.764

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Diagnostics and Disease Transmission Control: In FY09, explored the biology of disease carrying insects and methods of control to expand medical diagnostic and disease surveillance capabilities with a focus on providing new approaches. Completed preparation of the new Preventive Medicine Units (PMU) mosquito identification guides for SOUTHCOM and PACOM regions, and evaluated novel methods for vector control. In FY10, conduct studies on the diversity, description and classification of medically-important insects, including mosquitoes, ticks and sand flies as the scientific foundation for a web-based guide to identification. Explore new designs for devices to collect insects, and will assess medical threats from disease-carrying insects in deployed areas. In FY11, will conduct mosquito identification within US Northern Command region using DNA markers to identify specimens. Will conduct research leading to a new generation of detection assays for diagnosis of Rickettsial and lethal virus infectious agents within insect vectors. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.823	1.335	1.335	0.000	1.335

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5 Small Business Innovative Research/Small Business Technology Transfer Program *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.151	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	10.747	10.481	10.652	0.000	10.652

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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E. Performance Metrics

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

Exhibit R-2A, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S14: *SCI BS/CBT CAS CARE RS*	6.067	6.505	6.818	0.000	6.818	7.049	7.725	7.860	7.990	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research to understand the basic mechanisms of severe trauma to advance treatment and surgical procedures to save lives and improve medical outcomes for the Soldier. Experimental models are developed to support in-depth trauma research studies. It 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.. Starting in FY10, S19 (T-Medical/Soldier Status) funding is merged into project S14. Research conducted in this project focuses on the following six areas:(1) Hemorrhage (bleeding) Control, Blood, and Resuscitative Fluids: Conduct studies of genetic pathways and metabolic mechanisms associated with bleeding to understand the relationships between the human immune processes and blood clotting in trauma. In FY10 and FY11, funding shifts to the Damage Control Resuscitation area.(2) Damage Control Resuscitation: Conduct studies of genetic pathways and metabolic mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma; this research area starts in FY10.(3) Combat Trauma Therapies: Conduct studies of trauma to tissues and organs, and ways to mitigate and/or repair this damage. Research will address cellular repair/ growth mechanisms to treat Traumatic Brain Injury (TBI), eye and facial/maxillary (jaw bone) trauma, and burns.(4) Combat Casualty Bioinformatics and Simulation: Conduct basic research to develop improved training simulators and approaches for novel patient monitoring solutions using computational biology (interdisciplinary field that applies computer science, applied mathematics, and statistics to address solutions to biology problems). In-house modeling and simulation research ended in FY08 and is now conducted by the Program Executive Office, Simulation, Training, and Instrumentation (PEO-STRI). The bioinformatics area will be funded by the Combat Critical Care Engineering research area in FY101. (5) Combat Critical Care Engineering: Conduct 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 FY101.(6) Clinical and Rehabilitative Medicine: Conduct basic studies of mechanisms of tissue growth and traumatic injury to gain an understanding that will allow us to assist the healing or transplantation process; this research area starts in FY10.Promising results identified in this project are further matured under PE 0602787A, project 874.The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the US 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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.393	0.000	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Hemorrhage Control, Blood, and Resuscitative Fluids: In FY09, utilized more definitive procedures to locate the exact gene(s) involved in animals that demonstrated survival to assist in identifying new forms of treatment for severe hemorrhage. In FY10 and FY11, this work will be funded under the Damage Control Resuscitation area. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Damage Control Resuscitation In FY10, extend survival studies to determine the biochemical and genetic relationships between blood clotting and inflammation -- factors causing death following severe bleeding. In FY11, will investigate genetic components of the response to hemorrhage with specific strains of rats. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	0.000	1.058	0.962	0.000	0.962

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3	5.674	1.890	2.038	0.000	2.038
Combat Trauma Therapies: In FY09, expanded Penetrating Ballistic-type Brain Injury (PBBI) studies to a larger animal model; continued exploring cellular mechanisms of tissue growth through Armed Forces Institute of Regenerative Medicine (AFIRM); and began basic science exploration of a single dose wound healing therapeutic. In FY10, realign Armed Forces Institute of Regenerative Medicine (AFIRM) and vision restoration to the Clinical and Rehabilitative Medicine program area; conduct PBBI protein and gene regulation and neuroprotection mechanism studies; investigate PBBI biomarkers as surrogate markers to show effectiveness of neuroprotection drugs; refocus dental disease research to repair of maxillofacial bone and soft tissue injury repair; and begin research in eye trauma to understand the cellular and neuronal mechanisms of eye injuries. In FY11, will continue gene regulation and neuroprotection mechanism studies including those to understand cellular mechanisms of cell death; characterization of a polytrauma model; and discovery of novel pharmaceuticals to mitigate TBI brain hypothermia; will investigate new therapies based upon dentally derived stem cells for traumatic dental wound healing and repair; and will explore causes of low vision from head trauma. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Program #4 Clinical and Rehabilitative Medicine: In FY10, begin research in eye trauma to understand the cellular and neuronal mechanisms of eye injuries; and through AFIRM explore different innovative regenerative tissue strategies, including scaffold-like tissue mats containing blood vessels, cell based therapies to augment regenerative tissue, approaches that yield a pool of responding cells that can be cued biologically to specific cell types, and biomaterials that direct cell growth. In FY11, and AFIRM will continue the iterative process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	3.432	3.818	0.000	3.818
Program #5 Small Business Innovative Research/Small Business Technology Transfer Programs	0.000	0.125	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	6.067	6.505	6.818	0.000	6.818

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S15: *SCI BS/ARMY OP MED RSH*	9.374	7.083	8.839	0.000	8.839	9.381	10.338	10.531	10.723	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds 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 and 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: Conduct research on the body's effects from non-ionizing radiation and directed energy and the physiological mechanisms of musculoskeletal injury. (2) Physiological Health: Conduct research on the physiological mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being. (3) Environmental Health and Protection: Conduct research on the physiological mechanisms of exposure to extreme heat, cold, altitude and other environmental stressors. (4) Network Sciences: Conduct research on the fundamental processes of interactions at the molecular and cellular level. In FY10, the funding for Network Science Initiative effort transfers to project T64.(5) Computational Biology: Conduct 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 starts in FY11.(6) Psychological Health and Resilience: Conduct 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 protective factors and treatment for Post-Traumatic Stress Disorder (PTSD). Promising results identified in this project are further matured under PE 0602787A, project 869.The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; and the US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.296	1.304	1.392	0.000	1.392
Injury Prevention and Reduction: In FY09, investigated the process by which inheritable information from a gene, such as the DNA sequence, is made into a functional gene product or a protein, and how cellular interactions with the environment affect the nature of bone-marrow derived stem cell treatment for laser eye injury; and investigated the effects of hormone levels on cell control of muscle and bone tissue to enhance tissue repair. In					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY10, investigate hormone and cell-level adaptations in skeletal muscle in response to military-relevant training and injury to include mechanisms of skeletal muscle repair, regeneration, and adaptation; explore how bone components are associated with stress fracture risk.; identify laser eye injury thresholds in an animal model for single short duration pulses and repetitive pulse exposures for small and large retinal spot sizes to enhance risk assessment tools for eye protection. In FY11, will identify specificity of hormonal fatigue markers in Soldiers during states of physical exertion and energy status and investigate responses to physical fatigue to prevent musculoskeletal injury; will examine dose-response relationships to blood and tissue changes and model results for visible and infrared wavelengths as a risk assessment tool for laser eye injury. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Physiological Health: In FY09, refined the individual components to establish a more robust fatigue performance prediction model. In FY10, investigate the extent individual resilience generalizes across various types of sleep loss; explore the relative effects of countermeasures for reversing deficits caused by fatigue; investigate and model optimal recovery sleep and recycle rate following missions; and identify healthy weight management strategies to improve Soldier health and retention. In FY11, will investigate the extent to which the recuperative value of recovery sleep and the rate of recuperation can be enhanced through use of medication; will identify the	2.784	2.367	2.237	0.000	2.237

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
nutritional strategies required to sustain health in the modern training environment; will explore the impact of micronutrient status on performance and immune function during military training. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Environmental Health and Protection: In FY09, initiated a rodent animal model of classic heat stroke and examine the efficacy of a novel treatment intervention to enhance long-term recovery and return to duty. In FY10, explore rodent models of heat stroke to evaluate and enhance long-term recovery and return to duty; investigate dose response of medication countermeasures for the efficacy of preventing altitude illness versus probability and severity of adverse side-effects. In FY11, will explore molecular mediators of tissue, organ and skeletal muscle injury associated with exertional heat injury and/or stroke in the rodent model; and will expand the investigation of dose response of medication countermeasures for the efficacy of preventing altitude illness at moderate altitude (3,000 meters). *FY 2009 Accomplishments:* FY 2009	3.305	1.267	1.239	0.000	1.239

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Network Sciences / Computational Biology: In FY09, developed mathematical models to predict host-pathogen protein-protein interaction networks, and metabolic models to predict phenotypical (the genetically and environmentally determined physical appearance of an organism) responses induced by external stimuli. In FY10, the funding for this effort transfers to project T64. Computational Biology: In FY11, will conduct computational biology modeling to advance development of protein-protein interaction models for the prediction of host-pathogen interaction networks. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.989	0.000	0.923	0.000	0.923

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #5	0.000	2.080	3.048	0.000	3.048
Psychological Health and Resilience: In FY10, investigate a behavioral screening tool to induce and evaluate PTSD-like symptoms in rodents; investigate potential correlations between anti-depressant medication use and suicidal behaviors; investigate neuropsychological performance tests/batteries as a diagnostic for concussion in Soldiers; identify factors that predict or correlate severity of post-concussion symptoms. In FY11, will induce and evaluate PTSD-like symptoms in rodents for potential drug and behavioral intervention to treat combat-related PTSD; will further explore associations of completed and attempted suicides with the use of anti-depression medication; and will investigate the predictive value of neuropsychological and neurological measures for prediction of likelihood and/or severity of subsequent post-concussion symptoms. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #6	0.000	0.065	0.000	0.000	0.000
Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	9.374	7.083	8.839	0.000	8.839

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S19: *T-MED/SOLDIER STATUS*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
S19: *T-MED/SOLDIER STATUS*	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

The purpose of this program is to perform research contributing to superior combat casualty care for troops through faster diagnosis and treatment while allowing on-site health care providers to consult with specialists worldwide. This work will focus on advancing the means to determine soldier physiological status and aiding medical diagnosis and treatment. A significant thrust area will work to ascertain the sensors most relevant to determine change in soldier physiological status.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.729	0.000	0.000	0.000	0.000

In FY09, developed algorithms and completed analysis to analyze real-time beat-to-beat electric signals from the body as it approaches shock in controlled human studies. Compared changes in these signals with other changes to determine if these changes in signal provide an early indicator of progression to circulatory shock and therefore represent a simple algorithm for the triage of battlefield casualties. In FY10, this Project is consolidated with Project S14.

FY 2009 Accomplishments:
FY 2009

FY 2010 Plans:
FY 2010

Base FY 2011 Plans:
FY 2011 Base

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	0.729	0.000	0.000	0.000	0.000

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*	25.085	20.573	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Defense Research Sciences.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	3.186	3.182	0.000	0.000	0.000
Perpetually Assailable and Secure Information System (PASIS). In FY09 this Congressional Interest Item project developed technologies that directly impact the Army's and DoD's capabilities, including secure information processing, transmission and storage, and educates and trains scientists and engineers in the areas of information assurance, reliable software engineering, and network science. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2	1.595	0.000	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Technology Commercialization and Management Network. This Congressional Interest Item project developed policy-based parameters for the flow of information in a tactical environment. The various echelons involved in any command and control operation requires that information be disseminated up and down the spectrum, often involving both classified and unclassified environments. This effort facilitated the information distribution while maintaining the fidelity and security of the data. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Cyber Threat Analytics. In FY09, this Congressional Interest Item project conducted research to accelerate the ability of organizations to defend against large scale network threats by creating the underlying technologies to enable next-generation privacy-preserving digital threat analysis centers. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	2.392	2.388	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Flexible Electronics Research Initiative. In FY09 this Congressional Interest Item project developed flexible electronics materials. The materials enabled improved organic light emitting diode and thin film transistor performance. The devices were integrated with flexible active matrix backplanes from the Flexible Display Center. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.595	1.592	0.000	0.000	0.000
Program #5 UT-Tyler Organic Semiconductor Modeling and Simulation. In FY09, this Congressional Interest Item developed modeling and simulation for organic electronics. The modeling results were used to design and advance electronic devices fabricated at University of Texas Dallas and the Flexible Display Center.	1.192	0.875	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #6 Global Military Operating Environments. This Congressional Interest Item developed technologies for characterizing critical natural environments for support of high op tempo military operations world-wide. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.991	0.000	0.000	0.000	0.000
Program #7	1.194	0.756	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Nanocrystal Source Display. In FY09, this Congressional Interest Item developed novel quantum dot light emitting devices. The QD devices are being advanced for improved efficiency and stability. The device will be integrated with active matrix backplanes from the Flexible Display Center. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #8 Fuel Logistics Reduction Through Enhanced Engine Performance. This Congressional Interest Item project developed a "bottoming device", for diesel engines. It is designed to capture the normally wasted heat from the exhaust and use it to generate additional engine power. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010	1.194	0.000	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Base FY 2011 Plans: FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #9 Nanostructured Materials for Photovoltaic Applications. This Congressional Interest Item conducted research to understand the fundamental science and engineering necessary to develop efficient and robust organic, inorganic and hybrid photovoltaic systems with a focus on dye-sensitized solar cells to generate photovoltaic systems for evaluation of energy conversion. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.592	0.000	0.000	0.000	0.000
Program #10 Center for Advanced Energy Storage Research and Technology. This Congressional Interest Item conducted research on electrical energy storage using an experimental test bed. The results will be applicable to a number of military APU applications including the use of solar energy, wind energy, and other intermittent power sources.	1.592	0.000	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #11 Sustainable Alternative Energy for DoD. In FY09 this Congressional Interest Item project developed methods for generating JP-8 Diesel fuel from bio waste, including tree pulp and other vegetation materials. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	2.389	1.990	0.000	0.000	0.000
Program #12	1.193	0.000	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Urban Patterns and Signatures to Support Counter-Insurgency Operations. This Congressional Interest Item project created and exploited opportunities for new understanding of the urban battlespace to better anticipate, discover and track adversary actions before and during combat. Line-of-sight and non-line-of-sight sensor technologies have emerged that allow persistent surveillance of urban areas and complex terrain. This, along with the added dimensionality that new sensing approaches can bring, points to the potential for monitoring and baselining the signature space of the cluttered, "noisy" urban environment. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #13 Toxic Particles. In FY09 this Congressional Interest Item project conducted research to determine the effects of nanoparticles on DNA and their potential carcinogenicity in human lung cells, including studying how surface composition modulates these effects. *FY 2009 Accomplishments:* FY 2009	0.795	1.592	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #14 High Frequency Devices and Circuits for Nanotubes and Nanowires. This is a Congressional Interest Item. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	1.433	0.000	0.000	0.000
Program #15 Lightweight Polymer Designs for Soldier Combat Optics. This is a Congressional Interest Item.	1.193	0.796	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #16 Fighting Drug Resistant Infections. This is a Congressional Interest Item. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	1.992	0.000	0.000	0.000	0.000
Program #17	0.000	2.388	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Secure Open Systems Initiative. This is a Congressional Interest Item. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #18 Bioactive Polymers and Coating Systems for Protection Against Bio-Threats. This is a Congressional Interest Item. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	3.581	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Accomplishments/Planned Programs Subtotals	25.085	20.573	0.000	0.000	0.000

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T22: *SOIL & ROCK MECH*	2.208	2.299	2.358	0.000	2.358	2.426	2.481	2.531	2.581	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project correlates 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 the 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. This research provides the basis for applied research in PE 0602784A (Military Engineering Technology), project T40 (Mobility/Weapons Effects Technology), that supports the civil engineering technologies for adaptive protection, scalable weapons effects, near surface computational testbed, and austere entry and maneuver for the future force. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.208	2.286	2.358	0.000	2.358
Military Engineering Basic Research: In FY09, produced a simulation capability for a full, dynamic micro-scale air-water-solid system to examine soil moisture in porous media. Developed an initial modeling and experimental capability for the multi-scale structuring of cementitious materials for enhanced impact and penetration resistance applications. In FY10, develop a model for ultra high strength fiber reinforced concrete (FRC) subjected to highly dynamic loading conditions (e.g., blast, impact, and penetration events). Gain an understanding of the rate effects in high performance concrete to determine if mesoscale models under development inherently generate the strain rate effects seen in macroscopic concrete response. In FY11, will develop a mathematical techniques to create continuum models for engineering-level analysis at coarser scales using discrete variables from nanoscale models express discrete variables from nanoscale models in terms of continuum models that can be used in engineering models at coarser scales.					

Exhibit R-2A, PB 2011 Army **RDT&E Project Justification**		**DATE:** February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T22: *SOIL & ROCK MECH*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.013	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	2.208	2.299	2.358	0.000	2.358

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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*

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T23: *BASIC RES MIL CONST*	1.688	1.761	3.839	0.000	3.839	1.901	1.970	2.005	2.042	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project supports facilities research initiatives. The project 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. This project supports exploratory development efforts in PE 0602784A (Military Engineering Technology), projects T41 (Military Facilities Engineering Technology) and project T45 (Energy Technology Applied to Military Facilities). The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.688	1.733	3.839	0.000	3.839
Facilities Research: In FY09, conducted validations to support the development of next generation nanotechnology for facilities, sensor coatings, and constitutive models for micro-particle dispersion. Investigated the phenomena that govern the synthesis and properties of carbon nanotube coatings. Also investigated light-triggered release of biocides from liposome photosensitive polymers to neutralize biological contaminants. Finalized the complex interactions between a forest edge and an acoustic wave, including the dependence on acoustic ground impedance, microclimate, and biomass structure. In FY10, investigate mechanisms for on-demand release of biocides and free radicals to determine photolytic degradation phenomena. Develop a fundamental understanding of the use of electrophoresis in producing new composite materials for present and future military applications. In FY11, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to the next generation nanotechnology research initiatives of military interest. Also,					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
will complete investigation of electric field effects on chemical reactions in confined nanoporous geometries. Will initiate 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. Will explore atomistic- and poly-crystalline-level mechanical properties of materials such as graphene or carbon nanotube (CNT) - ceramic composites for use in optimal performance designs that scale to macro-system levels. The goal will be to discover the properties and relationships the lead to a means to create new bio-inspired composite materials that are lighter and better performing. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009	0.000	0.028	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	1.688	1.761	3.839	0.000	3.839

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T24: *Signature Physics and Terrain State Basic Research*	1.451	1.513	1.573	0.000	1.573	1.616	1.660	1.693	1.727	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project increases knowledge in the areas of terrain state and signature physics. It provides 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. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.451	1.510	1.573	0.000	1.573
Terrain State and Signature Physics: In FY09, investigated the variance in disturbed and undisturbed soil physical, thermal, and optical properties to establish physical parameters that govern the signature response and variance in changing environmental conditions, thus optimizing below surface target detection in prevailing environmental conditions. In FY10, observe, characterize, and model the variation of forward scattering at near to grazing angles for both vertical and horizontal polarization to determine if significant geometric roughness will deteriorate, rather than not affect, the forward scattering of RF energy; investigate the controlling influences of radio signal energy loss in deserts and thus poor depth penetration into low clay soils through examination of gypsum and carbonates by determining the complex permittivity spectra and attenuation rates at clay through sand size. Test hypothesis that urban ambient sound and vibration signals can be characterized as a baseline for actionable warnings for future sensor arrays. In FY11, will investigate the topography and morphology of a high					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
relief mountain basin as a major factor driving the spatial distribution of snow melt onset as measured by passive microwave sensors. Devise 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 identify the characteristics and significance of random terrain effects on wave scattering. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base	0.000	0.003	0.000	0.000	0.000

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	1.451	1.513	1.573	0.000	1.573

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T25: *Environmental Science Basic Research*	5.980	7.917	8.106	0.000	8.106	8.234	8.562	8.719	8.870	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project investigates 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. The project supports applied research under 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 Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.838	3.702	3.923	0.000	3.923
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants: In FY09, defined the equilibrium expressions of major tungsten reactions under relevant geochemical conditions and elucidated tungsten toxicity mechanisms related to intracellular phosphorylation reactions. Combined computational and toxicological approaches to assess basis of environmental risk. In FY10, complete new computational chemistry equations to predict solubility and other physical characteristics of munitions constituents (MC). and establish biological models of soil invertebrate neurotransmission networks as affected by less-than-lethal doses of RDX. Construct computational chemistry models of the physiological reaction of bacteria to explosives contaminants. Investigate the use of engineered proteins as cell-based toxicology sensors of MCs. Explore the use of endophytes					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
(microorganisms living inside plants) as biosensors of MC contamination. In FY11, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to the environmental and ecological fate of contaminants of military interest. Continue investigations of degradation and transformation mechanisms of insensitive munitions and emerging contaminants. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Remediation of Explosives, Energetics, and UXO: In FY09, defined and quantified the effect of disturbance on the sorption and transformation properties of explosives in soils. Quantified surface and vadose zone phenomena such as the role of colloidal transport in migration of explosives. In FY10, complete investigations of degradation of and by nanomaterials. Investigate the chemical composition of metal-rich granules (MRG) produced by soil invertebrates when exposed to MC to reduce uncertainty factors in environmental risk assessment. Elucidate the potential for abiotic and biotic degradation of new insensitive explosives to determine their potential for transport in soils and environmental affects. In FY11, will continue to establish a base of understanding of the physical, chemical, and biological phenomena specific to the remediation of explosives and energetics on training ranges.	1.561	2.302	2.360	0.000	2.360

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2009 Accomplishments: FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #3 Training Land Natural Resources: In FY09, identified the complex interactions between forest edge and an acoustic wave (such as artillery) incorporating relevant descriptive parameters into appropriate computational techniques allowing noise impact visualization. Completed determination of responses and impacts of multigenerational RDX exposure. In FY10, define the fundamental properties of pollination networks on Army ranges. Investigate environmentally benign bioadhesion resistant coatings (modification of surface microstructure) as a means to reduce transport of invasive species. In FY11, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigations, and rehabilitation. Investigate 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 2009 Accomplishments:* FY 2009	0.605	0.721	0.735	0.000	0.735

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #4 Network Science: In FY09, identified and defined mechanisms controlling the genetic networks associated with ovarian hormone production. A model ecological system was used to develop numerical-mechanistic descriptions of how learning and environmental heterogeneity contribute to adaptation in hunter prey relationships. Investigated the theories/algorithms of animal learning and communication on the propagation of information affecting the survival of individuals in a hunter prey network in static versus dynamic heterogeneous hunter/ prey environments. In FY10, identify metabolic network control structures that govern the degradation / transformation of RDX. Determine the relationship of complex biological network architecture to fragility in hormone production. In FY11, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to network science applications. Will evaluate alternative compositions of heterogeneity in population vigilance affording resilient/adaptive behavior at reduced cost. Will develop cognitive elements to dynamically elicit the emergence of desired composition in heterogeneity. Will define the network structure involving steroidogenesis genes using time series analysis. Will develop approaches using genetic tools to perturb network dynamics by gene silencing or over expression. *FY 2009 Accomplishments:* FY 2009	0.976	1.006	1.088	0.000	1.088

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #5 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.186	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	5.980	7.917	8.106	0.000	8.106

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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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T61: *Basic Research Initiatives - MRMC (CA)*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T61: *Basic Research Initiatives - MRMC (CA)*	2.392	4.775	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Medical Basic Research Initiatives.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	2.392	1.592	0.000	0.000	0.000
Combat Mental Health Initiative. In FY09 this Congressional Interest Item collected data from a random sampling of Ohio National Guard members for a study to better understand why some people develop Post Traumatic Stress Disorder (PTSD) and other do not. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2	0.000	3.183	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Vision Integrating Strategies in Ophthamology and Neurochemistry (VISION). This is a Congressional Interest Item. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	2.392	4.775	0.000	0.000	0.000

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.453	1.224	1.463	0.000	1.463	1.457	1.935	1.969	2.001	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research in technical 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 Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed internally by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	1.453	1.190	1.463	0.000	1.463

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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 Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Robotics autonomy and human robotic interface research: 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. In FY09, developed small staring Laser Detection and Ranging (LADAR) and super-resolution LADAR techniques to provide a small lightweight perception capability; studied hybrid-electric propulsion systems with appropriate size, weight, and logistics to provide the necessary power for high energy mobility combined with a silent-drive, silent-watch capability; developed autonomous processing techniques and algorithms for navigation, mapping, object recognition, and intelligent decision making to address increasingly complex dismounted scenarios; conducted validations utilizing advanced mechanical and biomimetic components to advance technologies that support high ground speeds, robust maneuvering, and efficient stair and obstacle climbing capabilities. In FY10, develop dexterous manipulation systems with high density sensors and intelligent control algorithms to support complex task performance such as opening doors and moving objects or impediments. These manipulation systems are to be studied statically and in combination with highly mobile robots. In FY11, new combinations of advanced sensor data will be fused in real time to provide enhanced dynamic situation awareness for small robotic systems, increasing the speed and agility of operation. *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #2	0.000	0.034	0.000	0.000	0.000
Small Business Innovative Research/Small Business Technology Transfer Programs					
FY 2009 Accomplishments: FY 2009					
FY 2010 Plans: FY 2010					
Base FY 2011 Plans: FY 2011 Base					
OCO FY 2011 Plans: FY 2011 OCO					
Accomplishments/Planned Programs Subtotals	1.453	1.224	1.463	0.000	1.463

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, PB 2011 Army RDT&E Project Justification			DATE: February 2010
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 2009 Actual	FY 2010 Estimate	Base FY 2011 Estimate	OCO FY 2011 Estimate	Total FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	0.000	1.279	1.278	0.000	1.278	1.177	1.271	1.294	1.318	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds 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. The information gained provides a better understanding of the overall biological system and its molecular network of interactions, which leads to improved early strategic decision-making in 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. Funding for this research is in project S15 prior to FY10. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan. Work in this project is performed by the US Army Medical Research and Material Command (MRMC), Fort Detrick, MD.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
Program #1	0.000	1.243	1.278	0.000	1.278
Network Sciences Initiative: In FY09, this research was funded in project S15. In FY10, complete development of mathematical models, which predict host-pathogen (infectious agent or germ) networks. These mathematical models will be used to predict environmentally-produced observable responses induced by external stimuli at the molecular (genomic, proteomic, metabolomic) level; and establish and test mathematical and computational models that address identified gaps in network biology. In FY11, will validate these models in the laboratory in animal models.					
FY 2009 Accomplishments: FY 2009					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	Base FY 2011	OCO FY 2011	Total FY 2011
FY 2010 Plans: FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO					
Program #2 Small Business Innovative Research/Small Business Technology Transfer Programs *FY 2009 Accomplishments:* FY 2009 *FY 2010 Plans:* FY 2010 *Base FY 2011 Plans:* FY 2011 Base *OCO FY 2011 Plans:* FY 2011 OCO	0.000	0.036	0.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	0.000	1.279	1.278	0.000	1.278

Exhibit R-2A, PB 2011 Army RDT&E Project Justification		DATE: February 2010
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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.