ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**

	COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
	Total Program Element (PE) Cost	166403	165020	176959	169627	179744	184747	200742
305	ATR RESEARCH	1190	2236	2314	2365	2376	2406	2437
31B	INFRARED OPTICS RSCH	2092	2425	2560	2611	2616	2659	2698
52C	MAPPING & REMOTE SENS	2126	2624	2706	2741	2763	2823	2886
53A	BATTLEFIELD ENV & SIG	2554	2817	3013	3055	3093	3153	3237
74A	HUMAN ENGINEERING	2518	2942	5545	4588	5208	5481	6401
74F	PERS PERF & TRAINING	3244	3458	6508	5938	6162	6418	7226
F20	ADV PROPULSION RSCH	1929	2184	3332	3280	3321	3363	4078
F22	RSCH IN VEH MOBILITY	475	541	558	564	569	581	594
H42	MATERIALS & MECHANICS	2014	2184	7332	6017	6948	7446	8713
H43	RESEARCH IN BALLISTICS	5618	6103	8157	8226	8263	8404	9200
H44	ADV SENSORS RESEARCH	3486	3998	7212	6320	6603	6903	7546
H45	AIR MOBILITY	1797	2280	2349	2375	2395	2447	2501
H47	APPLIED PHYSICS RSCH	2456	2789	2886	2925	2951	2994	3086
H48	BATTLESPACE INFO & COMM RSC	6112	6677	8920	9070	12012	12097	14837
H52	EQUIP FOR THE SOLDIER	1046	936	982	1007	1032	1051	1078
H57	SCI PROB W/ MIL APPLIC	58303	56478	68333	66888	69176	71022	75607
H66	ADV STRUCTURES RSCH	1508	1608	1717	1764	1803	1839	1887
H67	ENVIRONMENTAL RESEARCH	735	811	911	924	931	951	972
H68	PROC POLLUT ABMT TECH	357	413	426	431	435	445	454
S04	MIL POLLUTANT/HLTH HAZ	600	689	712	721	726	742	758
S13	SCI BS/MED RSH INF DIS	8397	10430	10932	10307	10375	10603	10836
S14	SCI BS/CBT CAS CARE RS	3626	4489	6207	5511	5779	6010	6708
S15	SCI BS/ARMY OP MED RSH	5706	6278	9556	8341	10039	10471	11564
S19	T-MED/SOLDIER STATUS	589	715	752	717	731	747	764
T14	BASIC RESEARCH INITIATIVES - AMC (CA)	34224	25437					

T22	SOIL & ROCK MECH	1769	2158	2228	2257	2274	2324	2375
T23	BASIC RES MIL CONST	1411	1638	1719	1762	1824	1885	1958
T24	SNOW/ICE & FROZEN SOIL	1146	1413	1456	1478	1504	1532	1574
T25	ENVIRONMENTAL RES-COE	4417	5484	6136	6194	6335	6450	6767
T60	BRAIN IMAGING RESEARCH							
T61	Basic Research Initiatives - MRMC (CA)	4958	2785					
T63	ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH			1500	1250	1500	1500	2000

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, provides new concepts and technologies for the Army's Future Force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. It fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) and where the commercial incentive to invest is lacking due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigators on research areas of Army interest, such as 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 expeditiously transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry. This translates to a coherent, well-integrated program which is executed by 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 Science and Technology Reliance (Defense Basic Research Advisory Group), and other inter-service working groups. This program responds to the scientific and technological requirements of the Department of Defense Basic Research Plan by enabling technologies that can significantly improve joint war fighting capabilities. The projects in this PE involve basic research efforts directed toward providing fundamental knowledge that will contribute to the solution of military problems related to long-term national security needs. Projects not specifically addressed through R-2a exhibits include F22 - Research in Vehicle Mobility that focuses on research within the advanced military ground vehicle mobility/propulsion areas; H52 - Equipment for the Soldier that focuses on understanding the role of fiber internal structure in responding to ballistic impact, with the goal of establishing the science base to support the design of more effective body armor materials; H67 - Environmental Research that focuses on research on innovative environmentally-friendly technologies for the future with particular emphasis on energetics processing, surface protection for armaments and tactical vehicles, Solider support systems, non-stockpile chemical warfare site remediation and decontamination of biological warfare agents; H68 - Processes and Pollution Abatement Technology focuses on in situ explosive biodegradation mechanisms and direct analysis and identification of explosives degradation pathways in contaminated soils and mechanisms of neurotoxicological effects in mammals caused by exposure to RDX and MNX; S04 - Military Pollutant/Health Hazards focuses on research is to increase knowledge in the area of toxicology effects of military relevant compounds on mammals as well as endangered species; S19 - T-Medical/Soldier Status that focuses on fundamental science and technology for improved training methods for battlefield medical personnel that includes measurement of tissue properties to permit more accurate simulation of the human body, and development of predictive algorithms for heart and respiration rate.

The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work in this PE is managed by: the US Army Research Laboratory (ARL); the US Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC); the US Army Natick Soldier Center (NSC); the Medical Research and Materiel Command (MRMC); the US Army Engineer

Research and Development Center (ERDC); and the US Army Research Institute for the Behavioral and Social Sciences (ARI).

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	170122	137676	141423
Current BES/President's Budget (FY 2009)	166403	165020	176959
Total Adjustments	-3719	27344	35536
Congressional Program Reductions		-1056	
Congressional Rescissions			
Congressional Increases		28400	
Reprogrammings	-555		
SBIR/STTR Transfer	-3164		
Adjustments to Budget Years			35536

FY09 was increased for basic research efforts in support of the current and future forces in such areas as the Single Investigator Program, Network Science, Neuroscience, and High Deformation Rate Materials.

Sixteen FY08 congressional adds totaling $28400 were added to this PE.

($800) Semiconductor-based Nanotechnology Applications
($1000) Document Exploitation for Handwriting Recognition
($1000) Flexible Electronics Research Initiative
($1000) Innovative, Computational Water-Borne Pathogen Research for Chemical/Biological Detection
($1000) UT-Tyler Organic Semiconductor Modeling and Simulation
($1200) Activated Nanostructures for Deicing
($1600) Direct Methanol Fuel Cell Recharger Program
($1600) Global Military Operating Environments
($1600) Integrated Nanosensors for NBC Threat Detection
($1600) Technology Commercialization and Management Network
($2000) John H. Hopps, Jr. Defense Research Scholars Program
($2400) Cyber Threat Analytics
($2400) Functionally Integrated Reactive Surface Technology (FIRST) Program
($2400) Secure Open Systems Institute
($4000) Perpetually Available and Secure Information Systems (PASIS)
($2800) Combat Mental Health Initiative

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**305**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
305 ATR RESEARCH	1190	2236	2314	2365	2376	2406	2437

A. Mission Description and Budget Item Justification: Automatic Target Recognition (ATR) Research seeks to enhance the effectiveness of Army systems through application of ATR technology 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. It is increasingly desirable to have 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. Electro-optic/infrared imaging systems that use advanced algorithms for compressing data, and detecting and identifying targets over extended battlefield conditions are needed for the Future Force. 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 Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement.

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

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Investigate new algorithms to improve unaided target detection and identification. In FY07, investigated motion and change detection algorithms that exploit the benefits of color and FLIR video fusion, study new methods of fusing visible, near-IR, and IR imagery to improve target detection and classification. In FY08, explore advanced methods for aided tracking via fusion of video modalities and detection likelihoods; investigate statistical algorithms for application in hyperspectral imagery; evaluate methods to classify tracked objects in color and FLIR video; and investigate novel nonlinear fusion methods for anomaly detection using hyperspectral and synthetic aperture radar (SAR). In FY09, will research novel behavior characterization algorithms for color and FLIR video; will research methods to develop ATR algorithms that exploit the fusion of disparate spatial views of a target for unattended ground sensor (UGS) network applications; and design advanced nonlinear band selection methods and implement new hyperspectral algorithms based on the selected bands.	1190	1212	1314
Conduct basic research to support advances in state-of-the-art clandestine Targeting, Tracking, and Locating (TTL) for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are classified and in accordance with the Hostile Forces TTL Capabilities Development Document (HFTTL CDD) 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 FY08, activities are synchronized with research in the Micro Autonomous Systems and Technology (MAST) Collaborative Technology Alliance (CTA). In conjunction with the start of the MAST CTA, investigate		988	1000

microtechnology, Micro Electro Mechanical System (MEMS), nanotechnology, quantum dot technology, aptamer based sensors, nanomicroencapsulation of taggants, hyperspectral imaging algorithms, biomimetics, and carbon nanotubes. Identify technologies that have potential to achieve the goals of clandestine TTL. In FY09, technologies selected for further exploration will begin to be matured. This will include both device and algorithm development. Technologies that are of sufficient technology readiness will transition to applied research.			
Small Business Innovative Research/Small Business Technology Transfer Programs		36	
Total	1190	2236	2314

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**31B**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
31B INFRARED OPTICS RSCH	2092	2425	2560	2611	2616	2659	2698

A. Mission Description and Budget Item Justification: This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems. 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 for the Future Force, IR Focal Plane Arrays (FPAs), and interband cascade lasers (ICLs) with significantly improved performance, lower cost, and increased operating temperatures. 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. 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 are applied to the control of microwaves. The technical barriers in the research program include control of 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 Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
The objective of this project is to support Army research in materials and devices for active and passive IR imaging systems to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance IR countermeasure (IRCM) protection against missile threats. In FY07, investigated high power IR lasers for IRCM and chemical/biological sensing applications, researched dynamic IR photonic-crystal waveguides for control of Radio Frequency signals, and evaluated dry etching and surface passivation procedures for LWIR Type II FPAs. In FY08, investigate high-power IR lasers for free space (ground-to-satellite and satellite-to-ground) communications, design 2-color MWIR/LWIR detector structures, and research nano-scale photonic crystal waveguide device that can reconfigure by a MEMS feature. In FY09, will research frequency modulated IR lasers for covert communication applications, fabricate high operating temperature 2-color MWIR/LWIR Type II FPAs, and design and research chip-scale integrated IR-photonic circuit based on the reconfigurable photonic crystal-MEMS waveguide devices for microwave radar application.	2092	2414	2560
Small Business Innovative Research/Small Business Technology Transfer Programs		11	
Total	2092	2425	2560

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**52C**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
52C MAPPING & REMOTE SENS	2126	2624	2706	2741	2763	2823	2886

A. Mission Description and Budget Item Justification: The objective of this basic research project is to increase 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 capabilities for the Future Force. The research provides the theoretical underpinnings for program element (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. The US Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Sensor Phenomenology: In FY07, researched exploitation of multiple types of sensors to characterize critical battlespace environment features. Experimented with mimicking biological sensory functions to characterize the battlespace environment. Examined environmental impacts on steady-state fluorescence time-series of endospore germination as well as amplification methods for uranyl oxide for greater operational stability of detection substrate. Investigated numerous factors believed to influence human behavior in an effort to better understand cause and effect within the battlespace. Similarly, increased understanding between cause and effect will assist in tool development, future experimentation, and simulations of spatial-temporal knowledge discovery models. In FY08, investigate innovative approaches to hyperspectral sensing of labeled targets by stand-off illumination, as well as research fluorescent nanowire arrays and molecular prisms as tunable chemical/biological/radiological sensors. In FY09, will research social network concepts to better assess important interaction within and between our adversaries, directly relating events, and actions to time and geographic space. Will mature research on innovative sensing science focusing on micro-nano sensors and concentrate additional focus on multi-sensory approaches to identifying specific target phenomenology.	2126	2596	2706
Small Business Innovative Research/Small Business Technology Transfer Programs		28	
Total	2126	2624	2706

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**53A**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
53A BATTLEFIELD ENV & SIG	2554	2817	3013	3055	3093	3153	3237

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 disparate terrain requiring new approaches to understanding, characterizing, and depicting micro-scale atmospheric phenomena. The lack of a complete understanding of the meteorological aspects of the complex micro-scale 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 over land and urban terrain. It supports the Army's transformation to the Future Force through formulation of future capabilities and techniques in such areas as the characterization and identification of bio-warfare agents, enhanced acoustic, and 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, and the mobility required for future combat operations. 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 Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
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 FY07, simulated atmospheric effects on aerial mounted acoustic arrays to enhance urban acoustic propagation methodologies to improve model performance. Evaluated results of SWIR system field experiments against model for SWIR performance under a range of optical turbulence conditions to improve system designs. In FY08, measure Two-Dimensional Angular Optical Scattering (TAOS) of atmospheric particles using improved instrumentation designed to improve detection and identification of chem/bio hazards. Implement an inversion technique to extract the optical constants of the spherical atmospheric aerosol particles to enhance capabilities for discrimination/identification of chem/bio hazards. Investigate effects of single urban structure on sound fields to enhance detection and avoidance capabilities. Implement model for propagation through atmospheric water vapor fluctuations at TeraHertz frequencies to improve sensor accuracy. In FY09, will devise and employ a model for radiative transfer effects of clouds on night vision illumination to improve visibility, investigate techniques for classification of non-spherical aerosol particles for improved chem/bio aerosol identification, and investigate effects of multiple urban structures on sound fields to enhance detection avoidance.	1602	1751	1889
Increase survivability of the Future Force and improve situational awareness through research to improve the accuracy of high-resolution meteorology focused on urban and complex terrain in order to account for the natural atmospheric and battle-induced variability. In FY07, investigated critical stable boundary layer phenomena in complex terrain for improved understanding of boundary layer characteristics as they applied to an urban environment; investigated and evaluated the use of coupled modeling capabilities to investigate methods for identifying plume source location that improved plume tracking; and simulated co-located Doppler radar and Doppler lidar to evaluate the ability to improve wind and cloud detection for enhanced capabilities of transport and dispersion models for chem/bio hazards. In FY08,	952	1066	1124

explore the fine-scale structure within the urban boundary layer for input to models depicting transport of chemical/biological and other dispersants. Investigate the vertical flux effects of water vapor in the boundary layer to determine their effects on near-millimeter wavelengths sensor atmospheric propagation models. In FY09, will investigate atmospheric modeling technology for very fine-scale flows to improve local area forecast timeliness and accuracy. Will investigate water vapor fluctuation spectra as influenced by the urban boundary layer for propagation effects in complex terrain that affects sensor performance and imaging capabilities.			
Total	2554	2817	3013

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**74A**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
74A HUMAN ENGINEERING	2518	2942	5545	4588	5208	5481	6401

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. Accordingly, 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 Army Modernization Strategy and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Research to improve Soldier auditory performance. In FY07, explored applications of localization algorithms to maximize audibility of unidentified sound sources; compared noise attenuation provided by the new Improved Combat Arms Earplug (ICAE) with that of the current Combat Arms Earplug (CAE); determined the effects of ICAE on Soldier auditory performance (e.g., localization, speech intelligibility, acoustic signature detection) in the presence of both continuous and impulse noise. In FY08, determine feasibility and limitations of ultrasonic hearing. Explore the effect of sound duration on auditory localization accuracy. In FY09, will investigate synergy between bone conduction and tactile communication for military applications. Will formulate an algorithm for predicting localization error due to headgear.	1425	1225	1461
Research to assess, predict, and improve Soldier performance. In FY07, explored integrated use of real-time neuro-physiological and other objective measures and models to measure Soldier performance in dynamic battlefield environments. In FY08, expand neurophysiological signal artifact reduction techniques to measure Soldier temporal-cognitive processes. In FY09, merge state-of-the-art neuro-sensor technologies with data filtering techniques to enhance brain monitoring and classification methodologies in realistic environments.	1093	1711	2075
Research in neuroergonomics, or the study of the brain at work. In FY09, will investigate human performance and brain function to design Soldier systems for safer and more efficient operation. Will advance understanding of human brain function in relation to cognitive processes and performance in real-world tasks and will conduct research to better understanding the relationship of cognitive functions under stress.			2009

Small Business Innovative Research/Small Business Technology Transfer Programs		6	
Total	2518	2942	5545

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**74F**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
74F PERS PERF & TRAINING	3244	3458	6508	5938	6162	6418	7226

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 network science. 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 are likely to 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/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. The cited work is consistent with Director, Defense Research and Engineering Strategic Plan, the Army Modernization Plan, and the Army Science and Technology Master Plan. This project is managed by the US Army Research Institute for the Behavioral and Social Sciences (ARI). Research in this project is related to and fully coordinated with efforts funded in program element (PE) 0602785A, Project 790.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In FY07, examined the human dimensions for optimizing training and performance for complex tasks; investigated methods for accelerating leader development; and identified and modeled the development and relationships among the psychological, demographic, and motivational factors that influence recruit enlistment, Soldier retention, productivity, and organizational citizenship. Examined new approaches to developing unbiased tests of abilities and intelligence that better predict performance; explored relationships among pattern recognition, mental flexibility, creativity, and success; and conducted research on value of multimedia tests for selection and training of future leaders. In FY08, develop methods to identify individuals most susceptible to information biases in complex environments and methods to assess motivation for leadership self-development. Also identify and measure individual-difference variables that predict organizational citizenship and adaptive performance and continue examination of unbiased testing and relationships of pattern recognition, creativity, and mental flexibility. In FY09, will identify and measure individual attributes and learning principles that foster adaptive performance and promote rapid adaptability skill acquisition and retention. Will also develop a new, culture free measure of self-control that will allow prediction of achievement above and beyond cognitive ability. Will mature technology addressing the human dimension for training and enhanced performance.	2283	2379	4507
In FY07, as part of the Army's new initiative in Network Science, began research on human networks with a focus on cognitive and social domains (research focused on individual, unit, and organizational behavior in context of networked environments), with the long-term	961	992	2001

goal of improving network science theory to assist Army counterterrorism efforts. Began a research program that focuses on behavioral modeling, automated tools for dynamic network analysis, trust in distributed teams, and support of scientific collaboration. In FY08, conduct research on human use of networks, communication, and command and control technologies to include automated agents, distributed environments, and improved, integrated assessment. Create new technologies for collaborative scientific inquiries into network science, working with the Army Research Laboratory and Army Research, Development, and Engineering Centers. In FY09, will conduct 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. Will create 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. Will explore the regularities of networked social behavior within massively multi-user online environments as simulations of real behavior. 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 Technology 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.			
Small Business Innovation Research/Small Business Technology Transfer Programs		87	
Total	3244	3458	6508

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**F20**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
F20 ADV PROPULSION RSCH	1929	2184	3332	3280	3321	3363	4078

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 Force. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, the lack of capability to accurately simulate the flow physics and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead service in these technology areas (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, experiments, 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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
This research 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 and enable the design of more fuel efficient and reliable propulsion systems. In FY07, analyzed autonomous diagnostic and repair concepts for gas turbine engine components, and completed baseline experimentation of gear tooth bending strength at elevated temperatures experienced in helicopter transmissions. In FY08, formulate life prediction models for low conductivity thermal barrier coatings to improve turbine design process and complete the face gear dynamic load prediction modeling computer code to improve the transmission design process. In FY09, will investigate 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.	1929	2184	2326
Research in small, highly efficient propulsion for air and ground vehicles. In FY09, will research high priority engine technology shortfalls associated with small Unmanned Aerial Systems (UAS), and will also benefit emerging robotic platforms and energy generation platforms that have similar power requirements. Will conduct research to create small engine-class analytical database and tools.			1006
Total	1929	2184	3332

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H42**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H42 MATERIALS & MECHANICS	2014	2184	7332	6017	6948	7446	8713

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 major issue associated with the current approach of using materials to gain added functionality for Army systems is that one must 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 Force. This research supports materials technology applied research in program element (PE) 0602105A, Project H84. 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 Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the Future Force In FY07, enhanced the synergistic effects of structure and electromagnetic interactions within scaled survivable structures, and characterized transport behavior and relevant properties of nanoparticles. In FY08, implement and validate models for fragmentation, reactive materials, and ballistic penetration; enhance processing and non-destructive evaluation for improved armor ceramics; use directed assembly to embed functionality into polymer materials; and validate multifunctional material performance. In FY09, will perform comprehensive materials characterization for damage-tolerant sub-micron SiC ceramic materials, and develop 1st-generation phenomenological constitutive and failure model for SiC-N ceramic materials for armor.	2014	2184	2271
High deformation rate materials. In FY09, will investigate engineered scalable materials for armor applications using nanoscale building blocks. Will characterize their properties and feed ballistic modeling efforts to rapidly screen for performance. Future electromagnetic armor requires better field responsive adaptive materials. Will quantify and model the effect of static and transient electric/magnetic/flow fields on the properties of materials for active concepts. Will create underpinning understanding to enable the engineering of expedient materials.			2516
Materials research and processing at small scale. In FY09, will research concept of materials by design which will conduct material modeling studies to enable bottom-up armor materials design. Will research methods relating processing to materials microstructure that feeds ballistic property models. Will focus effort largely on ceramics and complex textile composite materials.			2545
Total	2014	2184	7332

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H43**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H43 RESEARCH IN BALLISTICS	5618	6103	8157	8226	8263	8404	9200

A. Mission Description and Budget Item Justification: This project seeks to improve 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 for the Future Force. 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 program element (PE) 0602618A, Project H80. 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 Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In support of the National Advanced Energetics Initiative, expand and validate physics-based models and experimental techniques to enable design of novel insensitive propellants/explosives with tailored energy release for revolutionary Future Force survivability and weapons effectiveness In FY07, devised predictive meso/multiscale molecular models for design of insensitive propellant/explosive formulations; characterized/modeled ignition and combustion of multi-purpose reactive materials; and derived computational theory for energy storage and release mechanisms in energetic, strained solids/metastable states. In FY08, simulate energy transfer and conversion within shocked and heated energetic materials formulations; fabricate and characterize reduced sensitivity nano-engineered energetic materials; derive theoretical descriptions and produce hyper-energetic polymeric nitrogen; characterize structural bond energy release materials; and refine models to include hot fragment impact, shear ignition sensitivity, emerging multiphase fluid dynamics, thermo-mechanical coupling, and reactive materials initiation. In FY09, will design smart, molecularly engineered energetics; design insensitive, nano-reactive energetic materials/structural energetic composites; differentiate initiation reactions caused by conductive versus shear stimuli; explore turbulent mixing and combustion in late-time energy release; and characterize sensitivity and performance of insensitive warhead explosive fills and validate refined propellant models.	2706	2635	2732
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 FY07, proved ability to accurately depict the degradation of ceramic materials in the terminal effects environment; applied the generalized fracture framework to simulate failure penetrators and armor materials; and studied failure and damage of urban structural materials for terminal ballistic events. In FY08, quantify damage in select ceramics using destructive and non-destructive techniques; devise reactive material ignition model; devise a controlled fragmentation model; and implement models for urban structural material failure in continuum codes. In FY09, will devise 1st-generation physically consistent phenomenological constitutive and failure model for select damage-tolerant ceramics; implement both controlled fragmentation and reactive material ignition models into a continuum mechanics code; and model effects of secondary debris on humans and compare	2512	2501	2520

model results with actual human injury data obtained from the medical community.			
Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. In FY07, employed efforts to increase computational horsepower, and advances in tissue engineering to develop integrated modeling and experimental approaches to link kinetic energy loading conditions to human injury at the macroscale. Designed and fabricated diffractive optical elements for better light extraction from high energy laser slabs. In FY08, exploit advances in biotechnology to develop more refined modeling and experimental techniques to ascertain the effects of blunt trauma and impulse loading at the cellular level. Attempt to coherently combine multiple optical fibers to enhance high intensity laser output at kilowatt levels. In FY09, will focus research efforts on bridging gaps that link these governing mechanisms and lay the groundwork for the prediction of overall response, including human functions such as cognitive and physical performance. Will attempt to demonstrate man-portable microwave sources operating at 94 GHz for active denial and crowd control, intending to leverage the development of the micro-machined VE sources in FY06.	400	880	898
Armor research. In FY09, will investigate modeling and simulation of ballistic impact events to include modeling materials response with enhanced failure models that capture realistic behavior with minimum parameterization. Will create fundamental ceramic/glass model and develop mesoscale approaches; For electromagnetic armor technology, in FY09, will create physics based models to address coupling ballistic and electrodynamics models for solid mechanics, computational fluid dynamics, and material failure models; and validate model predictions.			2007
Small Business Innovative Research/Small Business Technology Transfer Programs		87	
Total	5618	6103	8157

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H44**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H44 ADV SENSORS RESEARCH	3486	3998	7212	6320	6603	6903	7546

A. Mission Description and Budget Item Justification: This project funds basic research to enable new sensing capabilities for the Army's Future Force and 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, and battlefield acoustic signal processing algorithms. Research performed under this project supports survivable sensor systems, 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's Future Force, 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 signal processing techniques for acoustic/seismic sensing systems, improved cryptography techniques, and hazardous material 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 Army Modernization Strategy, and the Army Science and Technology Master Plan.

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

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Research addresses the maturation of technologies for adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications In FY07, performed research into the use of an active Hybrid/RF/optical laser communications and imaging network for Army applications including laser designation and explosives detection. In FY08, research potential configurations for small agile adaptive apertures for high-bandwidth optical communications and directed energy applications, and define conformal adaptive optical components for Gigabit free-space laser communications and directed energy configurations. In FY09, will research parameters and define the operational envelop for the use of ultra short (femtosecond) laser illumination for the Army's active imaging and directed energy applications.	1327	1535	1672
Research focused on improving sensor capabilities to create more survivable/secure systems and displays, and improved hazardous material monitoring. In FY07, used modeling and imaging tools to evaluate UWB image formation options; collaborated with RDEC partners to assess transition possibilities of QC systems; researched decentralized signal processing for ad-hoc sensor networks; studied noise in MEMS flux concentrators and accelerometers; and improved Organic Thin Film Transistor (OTFT) and photovoltaic performance for flexible displays. In FY08, develop methods to mitigate sensitivity of imaging radar to multipath-induced false alarms; conduct limited error rate analyses to assess the potential for compromising quantum systems; research distributed spatial and temporal processing and data fusion algorithms for networks of heterogeneous and possibly mobile sensor nodes; investigate new magnetic sensor technologies for personnel detection; and produce final SERS hazardous material sensing assessment report. In FY09, will research target and clutter	2159	2435	2529

scattering phenomena to support radar detection of a multitude of concealed targets; evaluate completed signal processing algorithms for networks of heterogeneous sensor nodes; assess biologically-inspired techniques for advanced photonic structures, and integrate Organic Light Emitting Diodes (OLEDs) with OTFTs to investigate stability of system for next generation flexible displays.			
Research focused on biologically-inspired sensing and power generation. In FY09 will conduct research to mature novel biologically inspired chemical/biological sensors and sensor arrays and electronic sensors for rapid detection of biological threat hazards and pathogens. Will research bio-inspired materials for lightweight, portable energy generation and storage, and research methods to optimize performance of these materials.			3011
Small Business Innovative Research/Small Business Technology Transfer Programs		28	
Total	3486	3998	7212

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H45**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H45 AIR MOBILITY	1797	2280	2349	2375	2395	2447	2501

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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (BRP). Work in this program element is performed by the US Army Aviation and Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In FY07, demonstrated tightly coupled CFD/CSD methods for calculating helicopter airloads and structural loads in maneuvering flight. Explored aeromechanical benefits and issues for advanced rotorcraft configurations. In FY08, develop new methods for accurate aeroelastic stability prediction. Explore rotor fuselage interactions for complex configurations using advanced CFD methods. Investigate aeromechanics issues for high altitude rotors. In FY09, will demonstrate active rotor modeling tool using National Full-scale Aerodynamic Complex validation data, develop improved turbulence models for rotorcraft application and assess improved modeling and simulation tools on heavy-lift interactional aerodynamics validation data.	1797	2236	2349
Small Business Innovative Research/Small Business Technology Transfer Programs		44	
Total	1797	2280	2349

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H47**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H47 APPLIED PHYSICS RSCH	2456	2789	2886	2925	2951	2994	3086

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 for 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 Army Modernization Strategy and the Army Science and Technology Master Plan.

Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
This 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; and cold-atom chip devices for advanced sensors and ultra-stable atomic clocks In FY07, investigated the fabrication and characterization of prototype carbon nanotube (CNT) and other nanowire-based sensor devices, created a protocol for determining fundamental failure mechanisms in Silicon Carbide (SiC) and Gallium Nitride (GaN) Schottky diodes, and evaluated the improved SiC and GaN devices in test circuits; trapped a cold-atom cloud on a chip and transported the cloud using optical tweezers and a magnetic waveguide to construct miniature sensors; explored highly reversible electrode materials for fast charge of Li-ion batteries, designed efficient air-electrodes for lithium/oxygen cells, and explored sulfur tolerant catalyst for JP-8 reformation. In FY08, investigate CNT and other nanowire-based active electronic devices, explore thermal characteristics of relevant nanostructures, and detect atom interference in a waveguide; investigate regenerable sulfur sorbents for JP8 reformation and materials for high power Li-ion batteries. In FY09, will investigate system insertion for nanoelectronic devices and sensors and failure mechanisms for wide-bandgap electronic devices; will sense a gravitational field gradient using a waveguide atom interferometer for possible use as inertial navigation; and will study thin-film battery materials.	2456	2751	2886
Small Business Innovative Research/Small Business Technology Transfer Programs		38	
Total	2456	2789	2886

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H48**

COST (In Thousands)		FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H48	BATTLESPACE INFO & COMM RSC	6112	6677	8920	9070	12012	12097	14837

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/dismounted commanders/leaders/Soldiers, improve the timeliness, quality and effectiveness of actions and, in the long run, 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 Army Modernization Strategy and the Army Science and Technology Master Plan.

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

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Perform research to provide communications capability for a fully mobile, fully communicating, situationally aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes. In FY07, analyzed experimental data, to determine scalable routing algorithms for protocols (proactive/reactive) using communications traffic and topology scenario generation. In FY08, refine scalable algorithms to incorporate technologies in sensor radios. In FY09, will perform experimental analysis to incorporate technologies in mobile radio units.	1433	1605	1653
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 FY07, implemented first-order laboratory experiments to evaluate and enhance algorithms describing agent generated patterns and events used to refine and optimize algorithms for 3D scene reconstruction from a robotic platform. In FY08, investigate the application of information mediation service techniques to produce fused actionable intelligence for military mission planning and execution such that data providers, including robotic sensors, Soldiers, and agency-based data systems, are connected using service oriented architecture networking techniques and information agents. Investigate pose recognition from imagery to determine location in GPS-denied areas. In FY09, will experiment with and evaluate 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.	1234	1379	1452
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 FY07, investigated high mobility, channel impairment issues	1440	1601	1691

which are MANET-unique. Algorithms are tailored to MANETS that are severely constrained including topology variation and fading wireless channels. In FY08, design and evaluate intrusion detection algorithms on mobile ad hoc networking protocols, including under hostile conditions, using formal methods to represent protocols. In FY09, will design and evaluate analytically and via simulation/emulation, robust classes of algorithms that will provide a dynamic architecture that will support detection of attackers under conditions of mobility.			
Design and implement a laboratory scale common information-processing infrastructure that commanders and troops can use to bridge language barriers in order to anticipate adversaries' behaviors and collaborate with allies. In FY07, refined and optimized algorithms for automated language identification of speech and document machine translation and linked test bed with AFRL and NRL. In FY08, investigate, evaluate, and implement Service Oriented Architecture (SOA) concepts required to transition language technologies to Deployable Harmony Document Exploitation (DOCEX) System (DHDS) and Distributed Common Ground System-Army (DCGS-A). In FY09, will experiment with algorithms for processing and exploiting handwritten documents such as Arabic and Farsi, which are input to machine translation.	1005	1058	1113
Beginning in FY07, studied the behavior of MANETs as part of the Army's new initiative on Network Science. Emphasis is on mobile communications networks for the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology at the University of California - Santa Barbara. In FY08, design formal models, abstractions, and metrics for mobile ad hoc networking and extend to simulations, and conduct scalability analyses and design models of mobile ad hoc routing protocols and their functional concepts, incorporating biological paradigms where applicable. In FY09, will conduct component-based performance modeling and analysis of routing protocols and design networking protocols that adapt to varying operating environments in order to optimize performance.	1000	1000	1000
Advanced Computing. Beginning in FY09, research in advanced computing algorithms and techniques will address implementation issues for mobile networking, machine based language translation, and information processing infrastructure. Will research computer based modeling, simulation and data analysis techniques for the study of scientific phenomena and engineering designs.			2011
Small Business Innovative Research/Small Business Technology Transfer Programs		34	
Total	6112	6677	8920

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H57**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H57 SCI PROB W/ MIL APPLIC	58303	56478	68333	66888	69176	71022	75607

A. Mission Description and Budget Item Justification: This extramural research project seeks to discover and exploit 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 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, biology, and materials science), the engineering sciences (mechanical sciences, electronics), and mathematical and information sciences (mathematics, computer, and information sciences), environmental sciences (atmospheric and terrestrial sciences), and the Army's new initiative - 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. This project also funds assessments of international technologies. 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 extramurally by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Basic research in environmental and life sciences Soldier performance, Soldier protection, and novel biotechnologies and biomaterials for new Army capabilities. In FY07, investigated new bioremediation approaches to maintain usable Army training facilities with reduced Soldier toxin exposure and operational and environmental compliance costs; advanced capabilities in bionanoengineering, neurophysiology, and molecular biology for improved Soldier protection; devised airborne Doppler lidar with 4-D wind measurement capabilities; developed new simulations for soil moisture estimation; developed understanding of phenomenological modeling approaches applicable to various sensor types to discriminate low-metal targets and buried unexploded ordinance (UXO) from anthropogenic environmental clutter and to separate closely spaced object sensor signatures; and improved explosives detection from airborne surveillance imagery. In FY08, focus on lower cost technologies for bioremediation, on biomaterials for better Soldier protection and on landmine and UXO detection. In FY09, will focus on new biotechnologies for soldier protection; bionanoengineering for new biomaterials and will invest in basic research to understand biological construction of novel materials, structures and processes. Will research fundamental studies in biochemistry, cell biology, biophysics; will devise a Soldier scale atmospheric test bed addressing unique atmospheric Army operational needs.	6172	6001	8367
Basic research in chemical sciences for advanced power generation, propellants, protective materials, and threat detection In FY07, increased research on selective transport, systems integration of compact power sources, and multi-scale modeling for materials damage based on molecular interactions. In FY08, emphasize research on fuel reformers, molecular control for chem./bio/explosive detection,	6144	6003	7550

and new initiative on chemical information theory for armor materials. In FY09, will focus on optimum design for chemically reacting systems, microreactors for threat detection and health assessment, and structure/function relations for membrane transport.			
Basic research in physics for precision guidance, superior optics, and signature management properties, ultra-sensitive sensors, quantum computing, and secure communications. In FY07, devised negative index materials and photonic materials in the visible range for imaging and sensing applications; provided accurate computational tools to aid in design of new drugs and functional materials, beginning the process of subsuming biochemistry and quantum biology for a firmer basis for nanoscience; explored existence of new superfluid matter with unequal spin; developed theories to determine quantum phases/phase transitions and controls to simulate condensed-matter. In FY08, develop negative-index materials with attempts to build flat lenses and show sub-wavelength images; explore 1 to 2 band loading of optical lattices; conduct preliminary simulations of Hubbard and Heisenberg models; develop continuously tunable microwave filters and sources (10-100 GHz) for communications and imaging RADAR. In FY09, will develop novel quantum cascade lasers and IR photodetectors for remote Chem/Bio detection (CBD), enhanced Light Detection and Ranging (LIDAR) for target tracking, and high power (>100 KW) fiber lasers; will explore use of light filament based sensors for remote CBD, environmental sensing by novel enhanced spectroscopies, solar power at greater than 50 percent conversion efficiency (as a Soldier power source), and free space communications.	8362	8004	9990
Basic research in electronics, photonics, and communications for unmatched networked Command, Control, Communications, and Computing and Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities. In FY07, devised an integrated nanoscale sensor platform at THz frequencies for biological detection. In FY08, complete a comprehensive model providing fundamental insights into high power quantum dot lasers. In FY09, will develop extremely small tactical antennas operating with high system efficiency across the HF, VHF, and UHF bands.	12881	12005	13650
Basic research in mechanical and material sciences for survivable armor, more lethal anti-armor, improved mobility, and flexible displays for Soldier systems In FY07, created adaptive multiple scale computational models to predict material failure; synthesized carbon nanotube-based damping polymers for vibration reduction in rotor blades; investigated optical switching behavior in novel polymer architectures and excited-state systems for laser protective films; fabricated fully dispersed single-wall carbon nanotube composites, devise the first simultaneously ferroelectric and ferromagnetic materials; synthesized prototype electron gas piezoelectric sensors. In FY08, obtain full flow field diagnostics around an oscillating rotor blade under realistic helicopter flow conditions; perform precise experiments and detailed simulations to understand the dynamic response and failure of multilayered micro-electro-mechanical systems (MEMS) at both the material and structural levels. In FY09, will validate chemical kinetic mechanisms for high temperature and pressure alternative hydrocarbon-based fuels in diesel and turbine engine application. Will research new materials for armor and soldier protection, improve techniques to predict material failures, and study high deformation strain rate materials for ballistic tolerance.	12574	11781	13350
Basic research in mathematical and computer sciences as the backbone for complex, multi-system analysis, modeling and simulation, and information systems. In FY07, developed intelligent processing systems to improve fusion of hard (sensor)/soft (human) information, and also to exploit the network centric nature of the fusion problem. In FY08, develop a theory to support creation of tools for design of heterogeneous swarms for desired tactical emergent behavior. In FY09, will demonstrate the effectiveness of the developed products and tools on swarming in laboratory test-beds. Will enhance research efforts in quantum information sciences. Will research computer techniques to identify attacks against information systems, protecting information systems from attack, and on developing techniques for inherently hardened software.	10530	10020	13121
Basic research to gain an understanding of the fundamental aspects of how networks develop, function, and adapt to environmental pressures and the rate of information flow across the network in manmade and naturally occurring networks. In FY07, performed basic research to extract the common elements of networks across various disciplines, perspectives, layers, theories, and applications to create a	1640	1410	2305

sound basis for a science of networks. The science was aimed at developing theoretical models that can explain and predict network behavior. In FY08, explore the science aimed at developing experimental/theoretical/computational models that can explain and predict the overall behavior of the layered structure of networks of importance to the Army. At the base of the layer cake is the physical network, followed, for example, by the information network, then the communication network and terminating in the social network, with multiple nonlinear interactions within each layer and among the various layers. In FY09, will examine candidate 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 will be constructed to enable network interfacing and control across multiple scales. Moreover the barriers (lack of mathematical infrastructure) to network control across multiple scales will be addressed in this general information context. Will accelerate research to enhance understanding of network systems that provide basis for their properties to function, research network model representations of physical, biological, and social phenomena leading to predictive approaches to these phenomena.			
Small Business Innovative Research/Small Business Technology Transfer Programs		1254	
Total	58303	56478	68333

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H66**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H66 ADV STRUCTURES RSCH	1508	1608	1717	1764	1803	1839	1887

A. Mission Description and Budget Item Justification: This project funds basic research for improved tools and methods to enable 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 Plan. 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 maturation 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 Army Modernization Strategy and the Army Science and Technology Master Plan. Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
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 system components of future aircraft In FY07, formulated mechanics methodology to analyze selectively reinforced metallic and hybrid composite material structures, explored advanced concepts for lightweight, highly tailored and multi-functional composite structures using embedded sensors/actuators. In FY08, research lightweight damage tolerant structures for future large airframes, analyze computational fluid dynamic methods to support unsteady low Reynolds number aerodynamic models for flapping wing Microsystems. In FY09, will evaluate multibody-compatible thin-walled elastic finite element methods to enable aeroelastic predictions for small-scale air vehicle systems.	1508	1608	1717
Total	1508	1608	1717

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S13**

COST (In Thousands)		FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S13	SCI BS/MED RSH INF DIS	8397	10430	10932	10307	10375	10603	10836

A. Mission Description and Budget Item Justification: This project supports basic research that provides for healthy, medically protected Soldiers for the Future Force. This research investigates medical countermeasures for naturally occurring diseases that have had historically severe impacts on military operations. Malaria is the most significant military infectious disease threat. The malaria parasite becomes resistant to fielded drugs making it necessary to continually search for new drugs to feed the development and licensure pipeline. A vaccine to prevent malaria infection would be ideal but has been elusive, requiring additional basic research for novel vaccine approaches. Basic research to discover what components of an infectious organism cause disease and how the human reacts to these organisms will provide new approaches to prevent disease. In addition, identification of unique features of disease organisms will aid in developing diagnostic tools. Research into the transmission of disease by insects and other organisms (vectors) that carry the disease organisms will help to direct new interventions into preventing disease transmission. The Army is the Department of Defense's lead service for military infectious diseases research, and work in this project is managed by the U.S. Army Medical Research and Materiel Command. 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 The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, the Army Science and Technology Master Plan, and the DoD Basic Research Plan.

Work in this project is performed by the Walter Reed Army Institute of Research, Silver Spring, Maryland, and its overseas laboratories; the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Maryland; and the Naval Medical Research Center, Silver Spring, Maryland, and its overseas laboratories.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Prevention/Treatment of Parasitic Diseases: Conduct basic research to better understand malaria parasites, a necessary foundation to discover medical countermeasures to protect Soldiers from infection. In FY07, designed and screened new drug compounds and new parasite molecules (such as proteins critical for parasite growth) as malaria drug targets. In FY08, utilize molecular technological and modeling to discover new approaches to address malaria, screen thousands of drugs for antimalarial activity and assess potential for development, and search for new malaria proteins as drug targets and vaccine candidates. In FY09, will apply new technologies as they become available to identify novel approaches to prevent/treat malaria, such as improved computer modeling for drug discovery and bioinformatics to better identify important parasite genes and proteins that can be used for drug screening and vaccine targets.	3742	5727	6235
Bacterial Threats Vaccine Programs: Conduct basic research to better understand the biology of bacterial organisms and how to prevent diarrhea and scrub typhus. In FY07, conducted basic research to understand how bacteria cause diarrhea (such as interactions between bacteria and humans) with a focus on discovering new approaches to prevent diarrheal diseases. In FY08, conduct basic research to expand discoveries/studies of those bacterial components that are integral in the disease process and assess them as potential vaccine or other countermeasure candidates. Assess proteins from the scrub typhus organism to better define their role in causing disease and use as potential vaccine targets. In FY09, will continue to assess the proteins and other components expressed on diarrheal and scrub typhus organisms for their role in disease and possible use in protection.	850	1049	918
Viral Threats Vaccine Programs: Conduct basic 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 like Korean hemorrhagic	1002	1149	1794

fever. Basic research includes global risk to the warfighter, virus biology, disease process, and interaction with the human body. In FY07, conducted basic research to better understand hemorrhagic viruses and potential prevention approaches including studies of human-virus interactions between different dengue viruses that may affect vaccine strategies. Continued to study genes of highly lethal viruses to better understand which may provide protection if incorporated into a vaccine. In FY08, perform long-term studies to understand how naturally induced changes in the virus impact the virus's ability to cause disease. In FY09, will conduct basic research to understand hemorrhagic viral diseases and other lethal viruses of military importance and to assess emerging viral threats for their potential to impact military operations to determine whether any identified new threat requires further study.			
Insect Vector Control and Infectious Disease Diagnostics Programs: Conduct basic research to investigate the biology of biting insects and other organisms that transmit disease (called disease vectors) and their control (including Leishmania-infected sand flies) and to expand medical diagnostic and disease surveillance capabilities in the field. In FY07, conducted basic research to identify suitable markers (proteins or other disease-specific molecules) for potential use in insect-based pathogen detection systems and for field clinical diagnosis of human infection. Assembled insect identification keys for use by Preventive Medicine Units (PMUs) in US Central Command region. In FY08, conduct basic research to investigate the biology of insect vectors including vector identification and assembly of insect identification aids for use by PMUs focusing on US Southern Command and Pacific Command regions. Study biology of insects to better understand ways to control them through novel repellents or insect attractants and insecticides. In FY09, will explore the biology of insect vectors and methods of control to expand medical diagnostic and disease surveillance capabilities with a focus on providing new approaches.	2803	2343	1985
Small Business Innovative Research/Small Business Technology Transfer Program		162	
Total	8397	10430	10932

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S14**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S14 SCI BS/CBT CAS CARE RS	3626	4489	6207	5511	5779	6010	6708

A. Mission Description and Budget Item Justification: This project supports basic research for healthy, medically protected Soldiers for the future force, focusing on a basic understanding of the mechanisms of combat-related trauma. This research identifies trauma-related topic areas for basic techniques and the experimental models necessary to support in-depth trauma research studies. Research conducted under this project forms the basis for the advancement of trauma treatment and surgical procedures to delay cell death and reduce bleeding following traumatic injury, minimize lost duty time from minor battle and non-battle injuries, and provide military medical capabilities for far-forward medical/surgical care of battle and non-battle injuries. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, the Army Science and Technology Master Plan, and the DoD Basic Research Plan.

Work in this project is performed by the Walter Reed Army Institute of Research, Silver Spring, Maryland, and the U.S. Army Institute of Surgical Research, Fort Sam Houston, Texas.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Hemorrhage Control, Blood, and Resuscitative Fluids: In FY07, completed collaborative studies with the National Heart, Lung, and Blood Institute that focused on novel approaches to restoring and maintaining blood pressure lost due to hemorrhagic shock. In FY08, investigate genetic determinants associated with differences in survival from hemorrhage in an animal model. In FY09, more definitive procedures will be used to more accurately locate the exact gene(s) involved in animals that demonstrated survival.	2386	281	873
Combat Trauma Therapies: In FY07, completed mechanism of action studies for an experimental neuroprotectant drug (NNZ2566) to treat silent seizures caused by brain trauma, defined effects of brain inflammation and genes or proteins associated with delayed cell death on secondary injury using a penetrating ballistic-type brain injury (PBBI) model, and identified and characterized agents that accelerate and enhance soft-tissue wound healing. In FY08, study the effect of novel neuroprotection therapies on cellular responses to injury; continue to examine delayed cell death mechanisms leading to malfunction of brain electrical impulses using PBBI; and begin basic research on tissue reengineering, which will focus on cellular-level mechanisms of tissue growth. Work will be conducted through the Armed Forces Institute of Regenerative Medicine (AFIRM). In FY09, will expand PBBI studies to a larger animal model, continue exploring cellular mechanisms of tissue growth through AFIRM, and begin basic science exploration of repair of maxillofacial bone and soft tissue injuries.	1159	3604	5334
Combat Casualty Bioinformatics and Simulation: In FY07, determined that major hemorrhage can be diagnosed during transport based on vital signs. In FY08, refine the diagnosis of major hemorrhage; modify and develop new algorithms for real-time qualification of vital-sign data; and develop and start testing hardware/software for real-time collection, qualification, and diagnosis of trauma data.	81	524	
Small Business Innovative Research/Small Business Technology Transfer Programs		80	
Total	3626	4489	6207

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S15**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S15 SCI BS/ARMY OP MED RSH	5706	6278	9556	8341	10039	10471	11564

A. Mission Description and Budget Item Justification: This project supports basic research required to sustain a future force of healthy, medically protected warfighters, including delineation of injury, sustainment, and enhancement of the physiological and psychological capabilities of military personnel under combat operations in all environments. The focus is on physiological and psychological factors limiting Soldier effectiveness and on the characterization of health hazards generated by military systems and resulting from military operations. This includes development of concepts for medical countermeasures to sustain performance when the opportunity for adequate rest is impaired or impossible due to combat conditions. Research is conducted on militarily relevant aspects of environmental physiology and the neurobehavioral aspects of stress. The hazards of exposure to several classes of nonionizing radiation, directed energy, blast, jolt, vibration, noise, and toxic industrial chemicals as environmental contaminants are also investigated under this project. The six main thrust areas are (1) nervous system regulation of stress and cognition, (2) metabolic regulation, (3) control of regional blood flow, (4) oxidative stress interventions, (5) tissue remodeling/plasticity, and (6) biomechanical/biodynamic mechanisms of injury. The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, the Army Science and Technology Master Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, Maryland; the US Army Research Institute of Environmental Medicine (USARIEM), Natick, Massachusetts; and the US Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In FY07, explored, through an in-depth literature review, bone marrow-derived stem cell research as an innovative therapeutic mechanism for traumatic retinal injury and initiated identification and isolation of stem cells derived from bone cell injections. In FY08, conduct bone marrow stem cell research as a potential therapeutic intervention for laser-induced eye injury. In FY09, will investigate the gene expression profile and phenotypic nature of bone-marrow derived stem cell inventions for retinal cell trauma.	1454	1498	2362
In FY07, expanded the mathematical model for predicting performance to include individual differences between personnel. In FY08, examine individual components of the performance prediction model within a laboratory environment. In FY09, will refine the individual components to establish a more robust prediction model.	1330	1160	2876
In FY07, explored cold-temperature regulation and its impact on physical activity. In FY08, explore tissue protein analysis as a predictor of performance degradation from exposure to cold. In FY09, will develop a large animal model of classic heat stroke and examine the efficacy of a novel treatment intervention.	2422	3040	3318
In FY07, evaluated computational approaches to identify networks of specific organisms and cellular processes in support of the Army's new initiative in Network Science. This work was conducted in close coordination with researchers at the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology, at the University of California, Santa Barbara. In FY08, characterize newly discovered networks by developing new mathematical and computational methods that address identified gaps. Investigate whether protein-protein network models, developed for a particular pathogen, are portable to a different pathogen sharing a common set of proteins. In FY09, will develop 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	500	500	1000

external stimuli.			
Small Business Innovative Research/Small Business Technology Transfer Programs		80	
Total	5706	6278	9556

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T22**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T22 SOIL & ROCK MECH	1769	2158	2228	2257	2274	2324	2375

A. Mission Description and Budget Item Justification: The objective of this basic research project is to correlate the effects of the 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 understand the sensor data within a heterogeneous geological system. 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 experimental techniques that provide measurements at the fundamental scale, and fundamental theories for relating micro-scale phenomena to macro-scale performance. This research provides the basis for applied research in Program Element 0602784A (Military Engineering Technology), Project T40, Mobility/Weapons Effects Technology, that supports the civil engineering technologies for force projection, mobility, maneuver support, and survivability of the Future Force. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (BRP). The US Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Military Engineering Basic Research: In FY07, determined the feasibility of biological stabilization of soil surfaces for rapid construction on these surfaces; produced techniques for optimizing hardening reactions in organic cements allowing them to become the basis for high-strength, lightweight composites; and produced a concept for low-velocity probe that could provide the capability to remotely determine soil properties. In FY08, produce simulation capabilities for a full, dynamic, micro-scale air-water-solid system and for molecular dynamics of selected carbon nanotubes. In FY09, will extract macro-scale models from the micro-scale simulation capability (air-water-solid) and produce final molecular dynamics modeling for the understanding of cement-based and ceramic materials.	1769	2143	2228
Small Business Innovative Research/Small Business Technology Transfer Programs		15	
Total	1769	2158	2228

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T23**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T23 BASIC RES MIL CONST	1411	1638	1719	1762	1824	1885	1958

A. Mission Description and Budget Item Justification: The objective of this basic research project is to support 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 Program Element 0602784A (Military Engineering Technology), Projects T41 and T45, Military Facilities Engineering Technology and Energy Technology Applied to Military Facilities. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). The US Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Facilities Research: In FY07, developed physics based constitutive equations for heat transfer of fluids containing carbon nanotubes (CNT) nanoparticles. Matured molecular level design tool for CNT reinforced composite materials. In FY08, develop robust model-based support for the "Sensing Through Walls" (STW) problem, taking into account critical high-level building design logic and constraints. Determine the complex interactions between a forest edge and an acoustic wave, including the dependence on acoustic ground impedance, microclimate, and biomass structure. Develop predictive understanding of blast wave interaction with man-made barriers. In FY09, will conduct experimentation to be used in developing next generation nanotechnology for facilities, sensor coatings, and constitutive models for micro-particle dispersion.	1411	1611	1719
Small Business Innovative Research/Small Business Technology Transfer Programs		27	
Total	1411	1638	1719

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T24**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T24 SNOW/ICE & FROZEN SOIL	1146	1413	1456	1478	1504	1532	1574

A. Mission Description and Budget Item Justification: The objective of this basic research project is to increase knowledge in the areas of terrain state and signature physics. 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. It provides the knowledge base for understanding and assessing environmental impacts critical to battlespace awareness. 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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). The US Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Terrain State and Signature Physics: In FY07, investigated characteristic length scales (one to one thousand meters) of terrain response to atmosphere forcing, and related results to scale effects on electromagnetic and acoustic propagation. In FY08, investigate how high frequency radio waves propagate over topographically and electrically complex ground (roughness); specifically, the degree to which roughness controls local and extensive radio frequency coverage and develop theory to predict coverage given surface roughness and electrical variability. In FY09, will investigate 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.	1146	1412	1456
Small Business Innovative Research/Small Business Technology Transfer Programs		1	
Total	1146	1413	1456

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T25**

COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T25 ENVIRONMENTAL RES-COE	4417	5484	6136	6194	6335	6450	6767

A. Mission Description and Budget Item Justification: The objective of this basic research project is to investigate fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts include: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment, or neutralization of organics in water, soil, and sediments resulting from military activities; adhering to applicable federal, state, and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; reducing pollution associated with military activities; and the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative. The project supports applied research under program element (PE) 0602720A (Environmental Quality Technology), projects 048, 835, and 896, Military Environmental Restoration Technology, Industrial Operations Pollution Control Technology, Military Medical Environmental Criteria, and Base Facilities Environmental Quality. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). The US Army Engineer Research and Development Center, headquartered in Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants: In FY07, matured a basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and environmental risk assessment. Conducted research to gain fundamental knowledge of ecosystem genomic and proteomic issues to understand how ecosystems form and maintain robust communication networks to ensure survival of their members. Identified DNA gene sequences involved in the anaerobic biodegradation and alterations of cell wall pass-thru proteins for use in probe biosensors for an explosive nitroamine (Cyclonite-RDX) and Perchlorate. Determined the physiological response of soil bacteria to identify protein biomarkers of Hexanitrohexaazaisowurtzitane (CL-20) exposure and metabolism. In FY08, apply computational chemistry to identify molecular structural reactivity to predict degradation mechanisms and products and define the molecular mechanisms of neurotoxicity for an invertebrate neurobiology model to assess sublethal neurotoxic effects of CL-20 and other munitions constituents (MCs). Investigate detection of biomolecule binding and cleavage events using biomolecules as switches for ultra-sensitive monitoring of MCs. Identify chemical reactions between the DNA sequence and contaminant for applications toward contaminant-unique biosensors. Integrate toxicogenomics data with biological network analysis to serve as a basis to identify mechanisms and interactive toxicity effects of MC mixtures. Improve estimates of waterborne lead absorption, distribution, and subcellular partitioning in prey invertebrates and reptiles. In FY09, will define the equilibrium expressions of major tungsten reactions under relevant geochemical conditions and elucidate tungsten toxicity mechanisms related to intracellular phosphorylation reactions.	2621	3256	2910
Remediation of Explosives, Energetics, and UXO: In FY07, matured RDX microbial and molecular interactions, regulatory genetic networks, breakdown modes and pathways, and novel signaling molecules that lead to improved capability to assess, control, design, and track progress of RDX bioremediation. Determined the physiological response of soil bacteria to identify protein biomarkers of CL-20	1283	1495	1606

exposure and metabolism. Continued to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization. In FY08, define mechanisms of high explosives movement through the unsaturated soil zone to the groundwater to support range management and remediation approaches. Investigate the application of the unique physical, chemical, and biological interactions with the environment of DoD specific nanomaterials to potentially support advanced environmental technologies. Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization. In FY09, 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. Will define and quantify the effect of disturbance on the sorption and transformation properties of explosives in soils. Surface and vadose zone phenomena such as the role of colloidal transport in migration of explosives will be quantified.			
Training Land Natural Resources: In FY07, defined the fundamental relationships between landscape structure - habitat feature and effects on the genetic viability of threatened and endangered bird populations. Continued to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation. In FY08, determine potential use of bioassay guided fractionation (BGF) to assess reptilian developmental and reproductive effects, toxicity, and risk of endocrine active compounds for a large number of contaminants. Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation. In FY09, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigations, and rehabilitation. The complex interactions between forest edge and an acoustic wave, such as generated by artillery, will be described. Relevant descriptive parameters will be incorporated into appropriate computational techniques to allow visualization of noise impact on surrounding lands.	513	612	619
Network Science: In FY09, will identify and define mechanisms controlling the genetic networks associated with ovarian steroidogenesis. A model ecological system will be used to develop numerical-mechanistic descriptions of how learning and environmental heterogeneity contribute to adaptation in hunter prey relationships. The theories/algorithms of animal learning and communication on the propagation of information that affects the balance of survival of individuals in a hunter prey network will be investigated, including an assessment of hierarchical network dynamics in static versus dynamic heterogeneous environments.			1001
Small Business Innovative Research/Small Business Technology Transfer Programs		121	
Total	4417	5484	6136

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T63**

COST (In Thousands)		FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T63	ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH			1500	1250	1500	1500	2000

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 Army Modernization Strategy and the Army Science and Technology Master Plan. Work in this project is performed internally by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2007	FY 2008	FY 2009
In the area of robotics autonomy and human robotic interface research, several promising high-risk high-payoff areas of basic research will be conducted in-house with a focus on enabling robust autonomous mobility for small robotic systems, including autonomous operations in 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, small staring LADAR and super-resolution LADAR techniques will be developed to provide a small lightweight perception capability that is currently unavailable; hybrid-electric propulsion systems with appropriate size, weight, and logistics will be studied to provide the necessary power for high energy mobility combined with a silent-drive, silent-watch capability; autonomous processing techniques and algorithms for navigation, mapping, object recognition, and intelligent decision making will be developed to address increasingly complex dismounted scenarios; experiments utilizing advanced mechanical and biomimetic components will be conducted to mature technologies that support high ground speeds, robust maneuvering, and efficient stair and obstacle climbing capabilities.			1500

Total			1500