

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY		PE NUMBER AND TITLE					
1 - Basic research		0601104A - University and Industry Research Centers					
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	92263	110100	105622	101814	105671	110259	117867
H04 HBCU/MI CENTERS - TRADOC BATTLELABS	2518	2643	2732	2790	2847	2910	2974
H05 INSTITUTE FOR COLLABORATIVE BIOTECHNOLOGIES	7633	7122	11069	8728	9918	11545	12916
H09 ROBOTICS COLLABORATIVE TECH ALLIANCE (CTA)	2518	3046	4380	4617	5207	5440	5676
H50 Comms & Networks Collab Tech Alliance (CTA)	7277	6988	7198	7489	7572	7655	7812
H53 ADV DIS INTR SIM RSCH	2013	1973	3496	3500	3800	4072	5318
H54 Micro-Autonomous Systems (MAST) CTA	2915	5958	7661	8187	8205	8385	8570
H56 Adv Decision Arch Collab Tech Alliance (CTA)	5760	5515	5957	6061	6259	6413	6571
H59 UNIV CENTERS OF EXCEL	2368	2858	5219	4488	4549	5368	6502
H62 ELECTROMECH/HYPER PHYS	5949	5979	6154	6542	6672	6819	6969
H64 MATERIALS CENTER	2587	2728	2823	2884	2941	3006	3072
H65 MICROELECTRONICS CTR	871						
H73 NAT AUTO CENTER	2763	2874	2950	2982	3004	3070	3138
J08 INSTITUTE FOR CREATIVE TECHNOLOGY	7104	7436	7698	7918	8079	8259	8443
J09 POWER & ENERGY COLLABORATIVE TECH ALLIANCE (CTA)	2908						
J12 NANOTECHNOLOGY	9413	9834	10097	10432	10755	11105	11260
J13 UNIVERSITY AND INDUSTRY INITIATIVES (CA)	13655	24414					
J14 ECYBERMISSION	4820	5086	5245	5359	5466	5586	5709
J15 NETWORK SCIENCES INTERNATIONAL TECHNOLOGY ALLIANC	5943	7138	7916	8278	8278	8460	8646
J16 NANOTECHNOLOGY AND MICROELECTRONICS INSTITUTE	1989	2958	2995				
J17 VERTICAL LIFT RESEARCH CENTER OF		1972	2032	2077	2119	2166	2213

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BUDGET ACTIVITY		PE NUMBER AND TITLE					
1 - Basic research		0601104A - University and Industry Research Centers					
	EXCELLENCE						
J19	NAT'L AUTO CENTER (CA)	1259	3578				
J22	NETWORK SCIENCE AND TECHNOLOGY RESEARCH CENTER			10000	9482	10000	10000 12078

A. Mission Description and Budget Item Justification: A significant portion of the work performed within this program directly supports Future Force requirements by providing research that supports enabling technologies for Future Force capabilities. Broadly, the work in this project falls into three categories: Collaborative Technology Alliances (CTAs), University Centers of Excellence (COE), and paradigm-shifting centers - University-Affiliated Research Centers (UARCs). The Army has formed CTAs to leverage large investments by the commercial sector in basic research areas that are of great interest to the Army. CTAs involve partnerships between industry, academia, and the Army Research Laboratory to incorporate the practicality of industry, the expansion of the boundaries of knowledge from universities, and Army scientist to shape, mature, and transition technology. CTAs have been competitively established in the areas of Advanced Sensors, Advanced Decision Architecture, Communications and Networks, Power and Energy, and Robotics. The Advanced Sensors CTA has been renamed the Micro-autonomous Systems Technology (MAST) CTA. The work done under the Advanced Sensors CTA and the Power and Energy CTA is being combined into the MAST CTA starting in FY08. This program element (PE) includes the Army's COE, which focus on expanding the frontiers of knowledge in research areas where the Army has enduring needs, such as rotorcraft, automotive, microelectronics, materials, and information sciences. COEs couple state-of-the-art research programs at academic institutions with broad-based graduate education programs to increase the supply of scientists and engineers in information sciences, materials science, electronics, automotive, and rotary wing technology. Also included is eCYBERMISSION, the Army's national web-based competition to stimulate interest in science, math, and technology among middle and high school students. This program element also includes the four Army UARCs, which have been created to exploit opportunities to advance new capabilities through a sustained long-term multidisciplinary effort. The Institute of Advanced Technology funds basic research in electromagnetics and hypervelocity physics. The Institute for Soldier Nanotechnologies focuses on Soldier protection by emphasizing revolutionary materials research for advanced Soldier protection and survivability. The Institute for Collaborative Biotechnologies, focusing on enabling network centric-technologies, will broaden the Army's use of biotechnology for the development of bio-inspired materials, sensors, and information processing. The Institute for Creative Technologies is a partnership with academia and the entertainment and gaming industries to leverage innovative research and concepts for training and simulation. Examples of specific research of mutual interest to the entertainment industry and the Army are technologies for realistic immersion in synthetic environments, networked simulation, standards for interoperability, and tools for creating simulated environments. Historically Black Colleges and Universities and Minority Institution (HBCU/MI) Centers of Excellence address critical research areas for Army Transformation. 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 Army Research Lab (ARL); the US Army Tank-Automotive Research, Development, and Engineering Center (TARDEC); the Simulation and Training Technology Center (STTC); and the US Army Research Institute for the Behavioral and Social Sciences (ARI).

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1 - Basic research	0601104A - University and Industry Research Centers		

<u>B. Program Change Summary</u>	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	95748	84034	87814
Current BES/President's Budget (FY 2009)	92263	110100	105622
Total Adjustments	-3485	26066	17808
Congressional Program Reductions		-2104	
Congressional Rescissions			
Congressional Increases		28170	
Reprogrammings	-796		
SBIR/STTR Transfer	-2689		
Adjustments to Budget Years			17808

FY09 was increased to support the basic research in support of the current and future forces in such areas as Robotics, Neuroscience, Network Science Technology Research Center, High Performance Computing Center and Network Science.

Nineteen FY08 congressional adds totaling \$28170 were added to this PE.

- (\$300) Transparent Nanocomposite Armor
- (\$800) Center for Information Assurance
- (\$800) Integrated Systems in Sensing, Imaging and Communications
- (\$950) Florida Collaborative Development of Advanced Materials for Strategic Applications
- (\$1000) Manufacturing and Industrial Technology Center
- (\$1000) Modeling and Analysis of the Response of Structures
- (\$1000) Research Support for Nanoscale Sciences and Technologies
- (\$1120) Visualization for Training and Simulation in Urban Terrains
- (\$1200) Detecting and Eradicating Corrosion in Army Vehicles
- (\$1500) Electron Microprobe Research
- (\$1600) Center of Excellence In Industrial Metrology & 3D Imaging Research
- (\$1600) Development of Enabling Chemical Technologies for Power from Green Sources
- (\$1600) National Network Security Test Bed
- (\$2400) Infotonics Research
- (\$2400) MEMS Antenna for Wireless Comms/UAVs
- (\$2500) Nanoscale Biosensor Research
- (\$2800) Nanotubes Optimized for Lightweight Exceptional Strength Composite Materials
- (\$1600) NAC University Automotive Research Coalitions

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BUDGET ACTIVITY

PE NUMBER AND TITLE

1 - Basic research

0601104A - University and Industry Research Centers

(\$2000) University-based Automotive Research

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H04	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H04 HBCU/MI CENTERS - TRADOC BATTLELABS	2518	2643	2732	2790	2847	2910	2974	

A. Mission Description and Budget Item Justification: Centers of Excellence have proven effective in harnessing a critical mass of university research expertise and focusing their intellectual capabilities on Army unique science and technology problems. The objective is to transition advances resulting from basic research to technology demonstration as rapidly as possible. This project takes that approach one step further by partnering the university researchers at Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) with Army Training and Doctrine Command (TRADOC) Battle Labs to gain first hand perspective of the end-user's needs. Through these centers, the Army user begins the collaboration with university researchers from the outset of the research. These Centers of Excellence will join with Army and industrial partners to accelerate the transition from research phase to actual technology demonstration. In addition, these Centers of Excellence will recruit, educate, and train outstanding students and post doctoral researchers in science and technology areas relevant to Army Transformation. This project was previously funded in Program Element 0601104A, Project H59 and is a restructuring of ongoing research into a distinct project for visibility and management. 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 on this project is performed extramurally by the Army Research Laboratory (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
The HBCU/MI Centers of Excellence for Battlefield Capability Enhancements are: Tuskegee University, research on flexible extremities protection; NCA&T State University, research on flexible displays and predictive modeling of group situational awareness; Tennessee State University, research on sensor fusion; and Prairie View A&M University, research on Beyond-Line-of-Sight Lethality. Collaborations with TRADOC Battle Labs will help accelerate technology transitions to the battlefield. In FY07, devised improved stab resistance using new fabric designs; refined computer-based experimental sense-making model test beds; continued investigation of semiconductor materials growth on flexible substrates; devised multi-modal model sensor networks; devised simulation test bed to determine network performance. In FY08, refine fabric designs with new testing strategies; validate sense-making models with test command groups; characterize semiconductor materials on flexible substrates for optical properties; show use of multi-modal sensor network in urban terrain; refine wireless network protocols using simulation test bed. In FY09, will devise enhanced protection capability of final fabric designs; will deliver deployable decision support programs for test command groups; will design and fabricate hybrid semiconductor devices on flexible substrates and evaluate environmental stability; will show full data-fusion for large-scale sensor networks; will show protocols for wireless sensor network.	2518	2569	2732
Small Business Innovative Research/Small Business Technology Transfer Programs		74	
Total	2518	2643	2732

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H05	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H05 INSTITUTE FOR COLLABORATIVE BIOTECHNOLOGIES	7633	7122	11069	8728	9918	11545	12916	

A. Mission Description and Budget Item Justification: This project supports the Army's Institute for Collaborative Biotechnologies (ICB), a University Affiliated Research Center led by the University of California-Santa Barbara, and two major supporting partners, the California Institute of Technology and the Massachusetts Institute of Technology. The ICB is the Army's primary conduit for leveraging biotechnology for: 1) advanced sensors; 2) new electronic, magnetic, and optical materials; and 3) information processing and bioinspired network analysis. The objective is to perform sustained multidisciplinary basic research supporting technology to provide the Army with biomolecular sensor platforms with unprecedented sensitivity, reliability, and durability; higher-order arrays of functional electronic and optoelectronic components capable of self-assembly and with multi-functions; and new biological means to process, integrate, and network information. These sensor platforms will incorporate proteomics (large scale study of proteins) technology, DNA sequence identification and detection tools, and the capability for recognition of viral pathogens. A second ICB objective is to educate and train outstanding students and post doctoral researchers in revolutionary areas of science to support Army Transformation. The ICB has many industrial partners, such as IBM and SAIC, and has strong collaborations with Argonne, Lawrence Berkley, Lawrence Livermore, Los Alamos, Oak Ridge, and Sandia National Laboratories, the Army's Institute for Soldier Nanotechnologies, the Institute for Creative Technologies, and Army Medical Research and Materiel Command Laboratories. 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).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Institute for Collaborative Biotechnologies In FY07, provided foundation for incorporation of deterministic and stochastic dynamic models from biological systems, improving engineered Army network robustness; used the power and selectivity of biomolecular recognition and accelerated genetic selection and rapid evolution for elaboration of growth-directing peptides for specific crystalline semiconductor materials and electrode bridges with potential for electronic device application; enabled controlled surface functionalization and ligand display on, and integration into, materials for application in sensors, multi-functional materials, and device assembly; and devised genetically engineered microbial systems that efficiently incorporated unnatural amino acids into proteins for unique materials for the Army. In FY08, establish biologically based development path toward flexible high-efficiency batteries and new high-efficiency solar energy materials; provide a means to greatly enhance sensitivity in detection of viral pathogens; and enable electronic detection of DNA. In FY09, will define a biocatalytically derived route to low-cost fuel and fuel-cell feedstock using microbes to produce fuels directly from biomass including novel cellulase enzymes to break down biomass; characterize and further develop microfluidic chip-based bioseparation technology; research new bio-inspired nanoparticles to yield optimal signal enhancement in microfluidic channel biomolecular sensors; investigate bio-templated ultra-lightweight batteries for micro unmanned air vehicles.	7633	6923	7969
Neuroscience. In FY09, will perform research in the emerging area of cognitive neuroscience, examining functional magnetic resonance imaging (fMRI) techniques coupled with electroencephalogram (EEG) results to increase understanding of fast decision making processes, memory retrieval, categorization, aptitudes for specific tasks and other brain functions. Will investigate the use of other potential brain			3100

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT	
1 - Basic research	0601104A - University and Industry Research Centers	H05	
imaging techniques such as positron emission tomography (PET) and magnetoencephalography (MEG) and to enhance understanding of brain function. Will study and categorize individual differences in cognitive strategy. Will research methods within neuroscience to provide optimal control for human/machine interfaces.			
Small Business Innovative Research/Small Business Technology Transfer Programs		199	
Total	7633	7122	11069

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H09	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H09 ROBOTICS COLLABORATIVE TECH ALLIANCE (CTA)	2518	3046	4380	4617	5207	5440	5676	

A. Mission Description and Budget Item Justification: This project supports a collaborative effort between the competitively selected industry/university consortium, the Robotics Collaborative Technology Alliance (CTA), and the Army Research Laboratory for the purpose of leveraging world-class research in support of the Future Force and Army transformation needs. This project conducts basic research in areas that will expand the capabilities of intelligent mobile robotic systems for military applications with a focus on enhanced, innate intelligence, ultimately approaching that of a dog or other intelligent animal, to permit unmanned systems to function as productive members of a military team. Research is conducted in machine perception, including the exploration of sensor phenomenology, and the maturation of basic machine vision algorithms enabling future unmanned systems to more fully understand their local environment for enhanced mobility and tactical performance; intelligent control, including maturation of artificial intelligence techniques for robot behaviors permitting future systems to autonomously adapt, and alter their behavior to dynamic tactical situations; and understanding the interaction of humans with machines focusing upon intuitive control by Soldiers that minimizes cognitive burden. The program will conduct both analytic and experimental studies. Research products will be transitioned to the companion applied technology program, program element 0602618A, project H03, for integration and evaluation in test bed platforms and will form the scientific basis for new technology that will migrate into Army and Joint advanced and system development programs to provide highly capable unmanned systems for the Future Force. 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:	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Explore new opportunities to enable revolutionary, autonomous, highly mobile systems for the Future Force. Research focuses on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations. In FY07, extended perception research to explore algorithms that were specialized for application to urban environments and incorporated contextual information into planning processes to create a more natural (human-like) response to dynamic changes in the tactical environment. In FY08, explore methodologies to permit unmanned systems to perform as co-combatants, examining approaches for real-time evaluation of multiple possible adversarial responses, each possessing differing levels of likelihood based upon considerations such as terrain, and a dynamic tactical environment that also includes friendly and non-combatant forces; expand the range of perception algorithms available for classification of structures found in the urban environment and explore methods to fuse detections from individual sensor modalities and/or algorithmic approaches. In FY09, will focus upon techniques for fusion of the key perception algorithms to enable an unmanned vehicle to maneuver with a high degree of autonomy in urban environments; examine perception based navigation, especially for indoor and GPS denied environments; explore approaches for autonomous activity recognition: explore approaches for autonomous activity recognition; evaluate the performance of both perception, and behavior algorithms in varied tactical environments. Will conduct research to explore human robot interaction, dynamic scene understanding and contextual situational awareness.	2518	2961	4380
Small Business Innovative Research/Small Business Technology Transfer Programs		85	
Total	2518	3046	4380

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H50	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H50 Comms & Networks Collab Tech Alliance (CTA)	7277	6988	7198	7489	7572	7655	7812	

A. Mission Description and Budget Item Justification: This project supports a competitively selected university/industry consortium, the Communication and Networks Collaborative Technology Alliance (CTA) that was formed to leverage commercial research investments to provide solutions for the Army's requirements for robust, survivable, and highly mobile wireless communications networks. The Future Force has a requirement for state-of-the-art wireless mobile communications networks for command-on-the-move. The objectives include designing communications systems for survivable wireless mobile networks; providing signal processing for communications-on-the-move; secure jam-resistant communications; and tactical information protection. The CTA facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, as well as the use of state-of-the-art facilities and equipment at the participating organizations. This CTA accelerates the transition of communications and networks technology to program element (PE) 0602783A (Computer and Software Technology). The results of this work will significantly affect Future Force communications/networking formulation efforts. This program will be re-focused to more strongly emphasize Information Assurance and Network Science as defined by the December 2005 National Research Council Board on Army Science and Technology study. When the International Technology Alliance on Network and Information Sciences (PE/project 0601104A/J15) was established in 2006, joint planning of the research programs will prevent redundancies and leverage accomplishments from both programs. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Department of Defense Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Survivable Wireless Mobile Networks: Perform research in dynamically self-configuring wireless network technologies that enables secure, scaleable, energy-efficient, and reliable communications for command on-the-move. Devise techniques to model, design, analyze, predict, and control the performance of mobile ad hoc networks. In FY07, conducted analytical and experimental studies validating dynamic and survivable resource control to enable mobile networks to predictably exploit distributed network infrastructures. Devised and validated adaptive distributed control of physical, medium-access, and network layers based on statistical inferencing to adapt communications parameters for improved performance. In FY08, devise formal models, abstractions, metrics, and validation techniques for understanding the behavior of large scale military mobile ad hoc networks. Design techniques that combine social networking and network structure control functions in real time to dramatically increase the level of resource utilization in keeping with the stated intentions (outcomes) of a particular military objective. In FY09, will design networking techniques for sensing the networking operating environment, identifying the best networking functional components, and dynamically composing protocols for superior performance.	2812	2631	2804
Signal Processing for Communication-on-the-Move: Perform research in signal processing techniques to enable reliable low-power multimedia communications among highly mobile users under adverse wireless conditions. In FY07, conducted analytical and experimental studies of signal processing aided medium access control algorithms that improved communications performance while on-the-move. In FY08, design and validate multi-input multi-output multi-carrier waveforms that exploit non-contiguous spectrum during mobile operations. In FY09, will design optimal channel-adaptive distributed multiple access techniques to provide high capacity, interference-robust, multiple access networks for communications-on-the-move.	1701	1524	1651

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT		
1 - Basic research	0601104A - University and Industry Research Centers	H50		
Secure Jam-Resistant Communication: Perform research in secure, jam-resistant, multi-user communications effective in noisy/cluttered and hostile wireless environments enabling low probability of detection/intercept. In FY07, devised and studied sensor array processing and interference techniques that enabled adaptive antennas for improved interference rejection and spectrum reuse. In FY08, devise low power adaptive medium access control algorithms that are energy-efficient and support duty-cycling to extend the life of sensor networks. In FY09, will design signal separation techniques to mitigate packet collisions and improve signal detection for improved network performance.	1241	1085	1054	
Tactical Information Protection: Perform research in scalable, efficient, adaptive, and secure information protection for very resource-constrained and highly mobile ad hoc networks. In FY07, devised and studied security schemes for distributed servers supporting dynamic network infrastructures. Designed energy-efficient and low-latency key management and trust algorithms to enable flexibility in group access control without reliance on strategic security services. In FY08, design and evaluate formal-methods-based protocol specification intrusion detection techniques on mobile ad hoc networking protocols. In FY09, will design resilient clustering algorithms to provide a dynamic detection hierarchy to support detection and localization of attackers under mobile conditions.	1523	1552	1689	
Small Business Innovative Research/Small Business Technology Transfer Programs		196		
Total	7277	6988	7198	

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H53	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H53 ADV DIS INTR SIM RSCH	2013	1973	3496	3500	3800	4072	5318	

A. Mission Description and Budget Item Justification: This project supports Army critical research at the Army High Performance Computing Research Center (AHPCRC). Research at the AHPCRC is focused on the Lightweight Combat Systems Survivability, computational nano- and bio-sciences, computational battlefield network and information sciences including evaluating materials suitable for armor/anti-armor and sensor applications, defense from chemical/biological agents, and associated enabling technologies requiring computationally intensive algorithms in the areas of combat systems survivability, battlefield network sciences, chemical/biological defense, nanoscience and nanomechanics, and computational information sciences, scientific visualization enabling technologies that support the Future Force transition path. This project also supports the Robotics Collaborative Technology Alliance which explores new opportunities to enable revolutionary autonomous mobility of unmanned systems for the Future Force. This research is an integral part of the larger Army Robotics Program and feeds technology into program element 0602618A, project H03 (Robotics Technology). The project will also address research focusing on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations. 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.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Research at the Army High Performance Computing Research Center (AHPCRC). In FY07, developed a computational framework for modeling the dispersion of contaminated agents in turbulent air flow that enables the prediction of the dispersion of aerosolized biological warfare agents during various indoor or outdoor attack scenarios; explored and developed robust wireless communications links in complex environments with possibly hostile jamming while keeping low power at terminals; developed fast and scalable parallel iterative solvers for large-scale electromagnetic problems and their application to the innovative design and optimization through simulations of antenna systems with millions of components. In FY08, explore new interdisciplinary methods to evaluate lightweight fabric structure systems, Develop the Flexible Architecture Research Machine to accelerate architecture and algorithmic research on novel parallel models and facilitate experiments on heterogeneous systems that combine central processing units (CPU), graphical processing units (GPU), and field programmable gate arrays (FPGA); investigate and plan new computational approaches to analyze very large-scale networks for battlefield applications. In FY09, will implement interdisciplinary methods to evaluate lightweight fabric structure systems, will implement and test the Flexible Architecture Research Machine to accelerate architecture and algorithmic research on novel parallel models and facilitate experiments on heterogeneous systems that combine CPUs, GPUs, and FPGAs; implement computational approaches to analyze very large-scale networks for battlefield applications; will explore new multi-scale computational approaches for assisting micro-systems design, will develop advanced simulations to develop new materials for military vehicles and equipment, improve wireless battlefield communication, advance detection of biological or chemical attacks and stimulate innovations in supercomputing itself.	1644	1918	3496
Perform research that focuses on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations. In FY07, investigated coupling of tracking and trajectory prediction algorithms with dynamic planning algorithms.	369		

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BUDGET ACTIVITY	PE NUMBER AND TITLE		PROJECT
1 - Basic research	0601104A - University and Industry Research Centers		H53
Small Business Innovative Research/Small Business Technology Transfer Programs		55	
Total		2013	1973
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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H54	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H54 Micro-Autonomous Systems (MAST) CTA	2915	5958	7661	8187	8205	8385	8570	

A. Mission Description and Budget Item Justification: This project supports two competitively selected industry/university consortia, the Advanced Sensor Collaborative Technology Alliance (CTA) and the Micro Autonomous Systems and Technology (MAST) CTA, that leverage world-class commercial research necessary to address Future Force and Army Transformation needs. The CTAs link a broad range of government technology agencies, as well as industrial and academic partners with the Army Research Lab (ARL). The Advanced Sensors CTA is focused on innovative research in three main technical areas: micro-sensors, electro-optic smart sensors, and advanced radar concepts. Payoff to the warfighter will be advanced sensing technologies to support Future Force requirements. Technical areas addressed under this project include overcoming technical barriers associated with: autonomous calibration and management of micro-sensor networks; multi-domain smart sensors (including multi-spectral infrared focal plane arrays); a novel concept for laser radar (LADAR); multifunctional radar sensors; and sensor modeling and algorithms for automatic target recognition (ATR) through fusion of data from multiple sensors and signal processing. Work in the Advanced Sensors CTA accelerates the transition of technology to program element (PE) 0602120A (Sensors and Electronic Survivability). The MAST CTA will focus on innovative research in four main technical areas related to the coherent and collaborative operation of multiple micro autonomous platforms: microsystem mechanics, processing for autonomous operation, microelectronics, and platform integration. Payoff to the warfighter will be advanced technologies to support Future Force requirements in situational awareness. Both CTAs facilitate the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, as well as to use state-of-the-art facilities and equipment at the participating organizations. In FY08, this project (Advanced Sensors CTA) transitions to Micro Autonomous Systems and Technologies CTA and is restructured to include FY08 and FY09 funding from project J09 of this program element. The cited works are consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Department of Defense Basic Research Plan (BRP).

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

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
The MAST CTA will focus on innovative research related to the coherent and collaborative operation of multiple micro autonomous platforms to enhance situational awareness. In mid-FY08, the MAST CTA begins operation and is investigating platform stability and control in high-disturbance environments; bio-inspired, bio-mimetic leg, and wing concepts with integrated sensors and actuators; autonomous and semi-autonomous navigation and control over a network; group cooperative behavior and planning efficient sensing; and information extraction and utilization. Investigations may include vortex-dominated unsteady aerodynamics of flapping wings at low Reynolds numbers, high-force high-bandwidth large-displacement linear actuators, and autonomous and semi-autonomous navigation and control over a network. In FY09, the first full year of operation, the MAST will mature investigate constrained information management within a node; distributed signal processing, including low complexity techniques for distributed multi-modal sensing and fusion, dynamic collaborative processing accounting for sporadic sensing and sensor management, lightweight robust and possibly asymmetric networking; integrated cross-layer communications and network design, architecture analysis to understand fundamental limits, system modeling and simulation, and design tools capable of balancing and optimizing trade-offs in a microsystem architecture, technologies required for the coherent and collaborative operation of multiple micro autonomous platforms, technologies required for the coherent and	2915		

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February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT	
1 - Basic research	0601104A - University and Industry Research Centers	H54	
collaborative operation of multiple micro autonomous platforms. Investigations include communications and networking, synthesis, and development of three-dimensional materials and circuit architectures, development of smart multifunctional structures, and materials, low power devices, hybrid power systems and power management, microsystems architectures modeling and simulation, and functional packaging.			
The MAST CTA will focus on innovative research related to the coherent and collaborative operation of multiple micro autonomous platforms to enhance situational awareness. In mid-FY08, the MAST CTA is investigating platform stability and control in high-disturbance environments; bio-inspired, bio-mimetic leg, and wing concepts with integrated sensors and actuators; autonomous and semi-autonomous navigation and control over a network; group cooperative behavior and planning; efficient sensing and information extraction and utilization; constrained information management within a node; distributed signal processing, including low complexity techniques for distributed multi-modal sensing and fusion, dynamic collaborative processing accounting for sporadic sensing and sensor management, lightweight robust and possibly asymmetric networking, integrated cross-layer communications and network design, architecture analysis to understand fundamental limits, system modeling and simulation, and design tools capable of balancing and optimizing trade-offs in a microsystem architecture, technologies required for the coherent and collaborative operation of multiple micro autonomous platforms. Investigations may include vortex-dominated unsteady aerodynamics of flapping wings at low Reynolds numbers, high-force high-bandwidth large-displacement linear actuators, and autonomous and semi-autonomous navigation and control over a network. In FY09, will mature technologies required for the coherent and collaborative operation of multiple micro autonomous platforms. Investigations may include communications and networking, synthesis, and development of three-dimensional materials and circuit architectures, development of smart multifunctional structures, and materials, low power devices, hybrid power systems and power management, microsystems architectures modeling and simulation, and functional packaging.		5791	7661
Small Business Innovative Research/Small Business Technology Transfer Programs		167	
Total	2915	5958	7661

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H56	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H56 Adv Decision Arch Collab Tech Alliance (CTA)	5760	5515	5957	6061	6259	6413	6571

A. Mission Description and Budget Item Justification: This project supports a competitively selected industry/university consortium, the Advanced Decision Architecture Collaborative Technology Alliance (CTA), for the purpose of leveraging world-class commercial research in support of the Future Force and Army transformation needs. The Future Force will require state-of-the-art user-centered decision support technologies to include user-interface concepts, design practices, and principles. These technologies will provide for real-time situational awareness, distributed commander-staff-subordinate collaboration and planning, and execution monitoring in high-tempo, high-stress battlefield environments at speeds that permit the commander and his staff to operate inside the enemy's decision cycle. This project will conduct an intensive and accelerated program to formulate, validate, and transition basic research to provide solutions for the many requirements for understanding situational awareness, expert decision making, team collaboration, the ability to display information in a way that facilitates knowledge assimilation on the battlefield, and visualization and decision support architectures. Research is conducted in four areas: cognitive process modeling and measurement, analytical tools for collaborative planning and execution, user adaptable interfaces, and auto-adaptive information presentation. The technical barriers associated with this project are: human-computer interface in an information rich environment; display configuration; real time visualization; information presentation; and control coupling. The CTA also facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, as well as the use of state-of-the-art facilities and equipment at the participating organizations. This CTA accelerates the transition of advanced decision architecture technology to program element (PE) 0602716A (Human Factors Engineering Technology) and PE 0602783A (Computer and Software Technology). This program will be re-focused to emphasize individual Soldier, squad, and platoon level tools and information and knowledge fusion. Research partnerships will be established with the Institute for Creative Technology (PE 0601104A, project J08) and the Flexible Display Center (PE 0602705A, project H17) to establish collaborative and synergistic research programs. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Department of Defense Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Modeling and measurements of cognitive processes of Army commanders and staffs (decision makers): In FY07, validated decision architecture for information fusion, which used diagrammatic reasoning as an aid to evaluate the commander's preferred course of action. In FY08, extend and improve a system for the automatic generation of Cognitive Models of Situation Awareness (CMSA). In FY09, will validate software agent architecture for enhancing the performance of human teams using advanced artificial intelligence techniques including context-sensitive information sharing, automated development of shared situation awareness and recognition-primed decision support, a naturalistic decision making (NDM) technique used by experienced decision makers to quickly scan an array of displays or information and "instantly" know the best course of action to pursue.	1400	1320	1400
Analytical tools for collaborative planning and execution: Create tools that effectively support teams in coordinating and collaborating to achieve mission success across the spectrum of operations. In FY07, completed prototype decision-making architecture for collaboration and visualization test bed. In FY08, provide tools and techniques to foster better adaptive learning, expert decision-making, and teamwork. In FY09, will devise theoretical foundations and empirical findings on the design of collaborative systems to make Soldiers more effective as sensors in the Brigade and Below Battlefield Awareness Network environment and to enhance Soldier-automation collaboration.	1392	1208	1343

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT		
1 - Basic research	0601104A - University and Industry Research Centers	H56		
User-adaptive interfaces: Explore ideas, frameworks, and technologies that assist the Soldier in understanding, problem solving, planning, and decision-making. In FY07, integrated capability for multinational, multilingual communication in stability and support test bed. In FY08, investigate interface technologies to fuse and visualize sensed information (persistent surveillance) as relevant tactical events to improve Commander's real time situational awareness. In FY09, will validate functional model of the capabilities of new sensor/network technologies as they could contribute to perceptual awareness including concepts such as trust.	1684	1618	1902	
Auto-adaptive information presentation: Investigate how to make autonomous machines team players with their human partners or supervisors in warfighting operations. In FY07, extended software agent systems to provide an agile computing infrastructure for brigade combat teams. In FY08, experimentally test an agile computing infrastructure integrated with agent-based policy and domain services to enable efficient use of scarce computing and network resources and coordination of human-robot teams in realistic Army future combat system scenarios. In FY09, will devise a distributed system for real-time target tracking of multiple entities in an area under surveillance exploiting a reasoning-based approach to include diagrammatic reasoning, domain knowledge, and algorithmic solutions.	1284	1214	1312	
Small Business Innovative Research/Small Business Technology Transfer Programs		155		
Total	5760	5515	5957	

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H59	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H59 UNIV CENTERS OF EXCEL	2368	2858	5219	4488	4549	5368	6502

A. Mission Description and Budget Item Justification: Army Centers of Excellence (COE) couple state-of-the-art research programs with broad-based graduate education programs at academic institutions with the goal of increasing the supply of scientists and engineers who can contribute to Army Transformation. The Rotorcraft Center of Excellence is the only program funded in this project in FY06 and FY07. This COE supports Army Transformation by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing vehicles. Beginning in FY08, the Rotorcraft COE will transition to the Vertical Lift Research Center of Excellence under program element (PE) 0601104A, project J17. Also beginning in FY08, this project will fund the International Technology Centers (ITCs) and the Foreign Technology (and Science) Assessment Support (FTAS) program. The nine ITCs located in Australia, the United Kingdom, Canada, France, Germany, Japan, Chile, Argentina, and Singapore support the Army's goals of providing the best technology in the world to our warfighters by leveraging the Science and Technology (S&T) investments of our international partners. The ITCs perform identification and evaluation of international technology programs to assess their potential impact on the Army's S&T investment strategy. ITC "technology finds" are submitted as technology information papers (TIPs) to various Army S&T customers including the Army Research Laboratory (ARL), the Research Development and Engineering Centers (RDECs) of the Research Development and Engineering Command (RDECOM), RDECOM technology Integrated Process Teams, the Rapid Equipping Force (REF), and others for evaluation and consideration for further research and development. The ITC TIPs also serve as input into the international section of the Army S&T Master Plan. The FTAS program builds upon the TIPs submitted by the ITCs. In some cases the TIP is truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. In such cases, the FTAS program can provide initial resources (seed money) to fund basic research in these technology areas identified by the TIPs as having potential relevance to the Army's S&T plan. The research will provide information useful in making an early assessment of the technology's potential contributions to the Army's S&T strategy. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Department of Defense Basic Research Plan (BRP).

Work in this project is performed extramurally by the Army Research Laboratory (ARL) and Aviation and Missile Research, Development, and Engineering Center (AMRDEC).

Accomplishments/Planned Program:	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
International Technology Centers (ITC)/Foreign Technology (and Science) Assessment Support (FTAS): In FYs 08 and 09, the ITCs will complete the development of their international technology search process by utilizing technology roadmaps provided by the Research, Development, and Engineer Command's (REDCOM) technology Integrate Process Teams (IPTs) to focus on critical technology capability gaps. The ITCs will further refine their country-specific technology search strategies based upon the analysis of foreign Science and Technology (S&T) investment patterns in areas of technology relevant to the US Army. Technology search efforts will then focus on those countries and in those areas of technology having the greatest potential benefit to the US Army. In FYs 08 and 09, FTAS will evaluate progress on the initial program investments from FYs 06 and 07, and solicit new technology proposals for review and selection. The program will solicit technology projects focusing on the maturation of counter terrorism technologies, providing enhanced force protection, enhanced medical life saving projects and providing enhanced Soldier capabilities. A review of the lessons learned from the initial round of FTAS investments, including the selection and review process, will be utilized to improve the program. Prior to FY08, the ITC and FTAS efforts were funded in PE 0601102A, project H57.		2778	5219

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT	
1 - Basic research	0601104A - University and Industry Research Centers	H59	
Vertical Lift Research Center of Excellence (VLRCOE): In FY07, the VLRCOE developed structures and materials concepts for lightweight composite rotor blades; investigated next generation carbon-nanotube/carbon-fiber composites for mechanical properties enhancement and real-time structural health monitoring; studied, experimentally and analytically, aerodynamic characteristics of active flaps and microflaps for reducing rotor vibration, power, and noise; and developed performance improvements in ducted-fan systems for vertical lift systems and unmanned air vehicle (UAVs). For FYs 08-09, this effort will be restructured into PE 0601104A, project J17 for added focus and management oversight.	2368		
Small Business Innovative Research/Small Business Technology Transfer Programs		80	
Total		2368	2858
			5219

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H62	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H62 ELECTROMECH/HYPER PHYS	5949	5979	6154	6542	6672	6819	6969

A. Mission Description and Budget Item Justification: This project funds a University Affiliated Research Center, the Institute for Advanced Technology (IAT) at the University of Texas, to conduct basic research in electromechanics and hypervelocity physics in support of electromagnetic (EM) guns. Of particular interest are EM power, EM launchers, EM integrated launch packages, and hypervelocity terminal ballistics. Advanced computational models are devised and/or applied to solve complex problems in each of these areas. In keeping with the Army EM Armaments Program strategy, highest emphasis has been placed on advancing the state-of-the-art in pulsed power. The sponsored research provides the scientific underpinning for EM gun pulsed power including switching; addresses technical barriers associated with EM gun launcher life; and researches advanced technologies for hypervelocity target defeat. The sum of these focused efforts serves as a catalyst for technological innovation and provides crucial support to the Army technology base for advanced weapon systems development with applications for anti-armor, artillery, air defense, and the Future Force. 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 monitored and guided by the Army Research Laboratory (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Pulsed Power: In FY07, modeled electromagnetic, mechanical, and thermal properties of candidate EM pulsed power systems and defined techniques to increase their efficiency. In FY08, model and experimentally validate prototype alternate pulsed power systems. In FY09, will provide technology for large-scale solid state converters.	2379	2494	2650
Launch: In FY07, showed long-life, multi-shot EM launcher operation. In FY08, examine advanced materials for launcher components. In FY09, will examine thermal management of EM launchers.	1587	1518	1700
Electromagnetic Lethality: In FY07, established bounds on launch package parasitic mass; designed, fabricated, and tested full scale in-flight deployment mechanisms for second generation novel kinetic energy penetrators. In FY08, measure material properties under short duration electrodynamic and structural loads; examine the target interaction physics of reactive material during hypervelocity impact. In FY09, will complete and validate numerical model of armature physics including gouging and transition; will examine coupled high density/reactive materials during target interaction at hypervelocity.	1983	1800	1804
Small Business Innovative Research/Small Business Technology Transfer Programs		167	
Total	5949	5979	6154

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H64	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H64 MATERIALS CENTER	2587	2728	2823	2884	2941	3006	3072	

A. Mission Description and Budget Item Justification: This project concentrates scientific resources on materials research for lightweight vehicle protection and is executed through Cooperative Research Agreements (CRAs). The effort funds collaborative research in three Materials Science and Engineering Research Areas (MSERAs): (1) Composite Materials Research; (2) Advanced Metals and Ceramics Research; and (3) Polymer Materials Research. Each MSERA pursues thematic research thrusts that address topics pertinent to lightweight vehicle protection and that are aligned with the Army's strategic materials research vision enabling long-term synergistic collaboration between the Army Research Laboratory (ARL) scientists and university researchers. The Materials Cooperative Research Agreements provide for mutual exchange of personnel and sharing of research facilities with the University of Delaware, Johns Hopkins University, Rutgers University, Drexel University, and Virginia Tech. Lightweight, multi-functional composites, advanced armor ceramics, dynamic response of metals, protective polymer, and hybrid systems are emphasized. This project is closely coordinated with ARL in-house materials research projects (program element (PE) 0601102A, project H42) to promote effective and efficient transfer of fundamental scientific research addressing lightweight protective material requirements for the Future Force. The center accelerates the transition of technology to PE 0602105A (Materials Technology). 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).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
In FY07, devised appropriate physics based models describing the attributes of multifunctional materials; determined the fundamental response of protective polymer based materials; devised new inorganic materials that incorporated microstructures designed for specific armor related properties. In FY08, validate models for multifunctional composite attributes and show multifunctional capabilities in single composite material; devise schemes for synthesis of protective polymers with enhanced energy absorption; identify key materials parameters for the improved performance of metal matrix nanocomposite materials. In FY09, will utilize multifunctional composites to validate potential composite weight reductions; characterize and quantify performance of newly synthesized energy absorbing polymers; and validate effects of armor ceramic processing and materials selection on mechanical properties.	2587	2652	2823
Small Business Innovative Research		76	
Total	2587	2728	2823

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT H73	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H73 NAT AUTO CENTER	2763	2874	2950	2982	3004	3070	3138	

A. Mission Description and Budget Item Justification: The Center of Excellence for Automotive Research is a key element of the basic research component of the National Automotive Center (NAC), a business group within the US Army Tank-Automotive Research, Development, and Engineering Center (TARDEC). The Center is an innovative university/industry/government consortium leveraging commercial technology for potential application in Army vehicle systems through ongoing and new programs in automotive research, resulting in significant cost savings and performance enhancing technological opportunities. The goal of this project is to significantly enhance the Army's transformation to the Future Force by the application of novel, high payoff technologies that can be integrated into Army ground platforms as cost and schedule appropriate. The research performed in this project contributes to formulating and establishing the basic scientific and engineering principles for these technologies. Efforts are fully coordinated and complementary to those performed by the NAC and TARDEC under program element (PE) 0602601A (Combat Vehicle and Automotive Technology). Selected university partners include: University of Michigan, University of Wisconsin, Wayne State University, University of Alaska, University of Tennessee, and Clemson University. Key industry partners include all major US automotive manufacturers and suppliers. The Automotive Research Center (ARC) formulates and evaluates advanced automotive technologies and advances state-of-the-art modeling and simulation for the Army's future ground vehicle platforms. 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 TARDEC, Warren, MI.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Automotive Research Center (ARC): In FY07, evaluated and analyzed models suitable for ground vehicle design decisions relative to vehicle reliability, reliability based design optimization, high mobility and fuel economy, high power density propulsion, thermal management and parasitic losses, advanced control, robust modeling, and validation of vehicle systems. In FY08, refine and optimize computational models for ground vehicle characteristics including: fuel economy, acceleration, survivability, reliability, and cost effectiveness. Also in FY08, perform unique advanced experimental validation of optimized models to assure proper predictions relative to actual real-world conditions. In FY09, will extend the applicability of the advanced automotive models to future Army ground vehicle requirements that address vehicles exposed to elevated temperatures, increased terrain severity, and other extreme environmental and operational conditions that occur in deployment areas that vehicles must be designed to for achieving performance and protection requirements. In addition, FY09 research will extended new experimental model validations of these broadened areas of Army ground vehicle automotive models, using advanced instrumentation and efficient state-of-the-art data analysis procedures.	2763	2797	2950
Small Business Innovative Research/Small Business Technology Transfer Programs		77	
Total	2763	2874	2950

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J08	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J08 INSTITUTE FOR CREATIVE TECHNOLOGY	7104	7436	7698	7918	8079	8259	8443	

A. Mission Description and Budget Item Justification: This project supports simulation and training technology research at the Institute for Creative Technologies (ICT) at the University of Southern California, Los Angeles, California. The ICT was established to support Army training and readiness through research into simulation and training technology for applications such as mission rehearsal, leadership development, and distance learning. The ICT actively engages industry (multimedia, location-based simulation, interactive gaming) to exploit dual-use technology and serves as a means for the military to learn about, benefit from, and facilitate the transfer of applicable entertainment technologies into military systems. The ICT also works with creative talent from the entertainment industry to adapt concepts of story and character to increase the degree of participant immersion in synthetic environments and to improve the realism and usefulness of these experiences. Creating a true synthesis of the creativity, technology, and capability of the industry and the R&D community is revolutionizing military training and mission rehearsal by making it more effective in terms of cost, time, range of experiences that can be trained or rehearsed, and the quality of the result. This project accomplishes this by performing basic research in modeling and simulation in accordance with the core competencies for the ICT University Affiliated Research Center (UARC). 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).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Conduct basic research in immersive environments, to include virtual humans, three dimensional (3D) sound and visual media, to achieve more efficient and affordable training, modeling, and simulation solutions. Research includes investigation of techniques and methods to address the rapid development of synthetic environments that can be used for mission rehearsal and training of military operations. In FY07, investigated the timing, synchronization, and rendering techniques for augmenting the test beds with holographic imagery. In FY08, create custom, multi-view, holographic display solutions for visualizing command data sets. In FY09, will investigate use of Organic Light Emitting Diodes, nano-technologies, and programmable matter (the creation of rudimentary elements which can be programmed into software for simulation components and innovative visual displays) in mixed reality immersive environments.	2743	2784	2966
Conduct basic research in two significant aspects of immersive environments - graphics and sound. Research will improve computational techniques in graphics for achieving real-time photo-realistic rendering of physical and synthetic environments for training and simulations. Research into auditory aspects of immersion will provide the sound stimulus for increasing the realism for military training and simulation devices. In FY07, investigated the concept of generalized reciprocity as it relates to how objects transform incident illumination into reflected light. Examined perceptual cues needed to produce 3D audio via hybrid headphone-loudspeaker techniques. Extended harmonic warping of ambient sounds to use beat tracking techniques to ensure smooth transitions of effects. In FY08, implement hybrid 3D audio system to create perception of auditory depth in mixed reality environments. Develop facial and body animation techniques that can capture a person and then re-light and re-animate him or her in new environments. In FY09, will explore concepts for facial and body animation controlled by avatars in real time and investigate methods for development of virtual speakers in immersive environments.	1579	1618	1722

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT		
1 - Basic research	0601104A - University and Industry Research Centers	J08		
Techniques and human - virtual human interaction: In FY07, explored and conducted research on intelligent avatars for virtual environments to enhance realism of interactions with trainee(s) and increase training effectiveness. In FY08, investigate techniques for appropriate modeling and social schema for avatar based crowd behaviors. In FY09, will assess adequacy of virtual human models against models of human behavior and use feedback to guide further research. Develop tools and techniques to speed creation and adaptation of virtual humans.	2782	2826	3010	
Small Business Innovative Research/Small Business Technology Transfer Programs		208		
Total	7104	7436	7698	

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J12	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
J12 NANOTECHNOLOGY	9413	9834	10097	10432	10755	11105	11260

A. Mission Description and Budget Item Justification: This project supports sustained multidisciplinary nanotechnology research for the Soldier at the Institute for Soldier Nanotechnologies (ISN) at the Massachusetts Institute of Technology. The ISN emphasizes revolutionary materials research for advanced Soldier protection and survivability. The ISN works in close collaboration with several major industrial partners including Raytheon and DuPont, the Army Research Laboratory (ARL), the Army's Natick Soldier Center (NSC), and other Army Research Development and Engineering Command (RDECOM) centers in pursuit of its goals. The institute is designated as a University Affiliated Research Center (UARC) to support the Army Future Force Warfighter through research to devise nanotechnology-based solutions for the Soldier. This research emphasizes revolutionary materials research toward an advanced uniform concept. The future uniform will integrate a wide range of functionality, including ballistic protection, responsive passive cooling and insulating, screening of chemical and biological agents, biomedical monitoring, performance enhancement, and extremities protection. The objective is to lighten the Soldier's load through system integration and multifunctional devices while increasing survivability. The new technologies will be compatible with other Soldier requirements, including Soldier performance, limited power generation, integrated sensors, communication and display technologies, weapons systems, and expected extremes of temperature, humidity, storage lifetimes, damage, and spoilage. 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 Lab (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Conduct research in light-weight, multifunctional nanostructured fibers and materials. In FY07, conducted limited fabrication of 2-D and 3-D polymeric structures that had complete band gaps for electromagnetic radiation and elastic waves; assessed the light and sound scattering properties of these materials. Used initiated chemical vapor deposition (iCVD) to impart novel properties to limited numbers of various substrates of interest for electromagnetic interference shielding and destruction of toxic substances. In FY08, devise a theory of a new type of "lasing" based on stimulated emission of hypersound in dual band gap (sound and light) composite polymeric structures; identify optimized structures for photon (light) flow control, and measure sound propagation in select materials. In FY09, will use Monte Carlo simulation methods to optimize 2-D and 3-D structural configurations for simultaneous control of light and sound propagation and reflection; fabricate desired structures by interference lithography and test the resulting materials for the directional dependence of energy flow. Will devise mechanically robust iCVD coatings fully compatible with electro-spun mats that provide high surface area and a diversity of substrate materials.	1939	2378	2565
Conduct research in Battle Suit Medicine and Blast and Ballistic Protection. In FY07, conducted initial synthesis of families of flexible backbone/pendant group polymers showing promise for high absorption of mechanical energy. In FY08, conduct low rate mechanical testing of mechanical energy absorption for promising polymers. In FY09, will explore relation of molecular structural features to resultant toughness including high strain rate testing.	3822	4865	4966
Conduct research on Soldier Survivability and Protection and Nanosystems Integration. In FY07, conducted initial synthesis and testing of polymers and components for transistors. In FY08, investigate nanoengineered electronic devices for sensing. In FY09, will explore	3652	2316	2566

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT	
1 - Basic research	0601104A - University and Industry Research Centers	J12	
chemical sensing based upon nanoelectronic building blocks.			
Small Business Innovative Research/Small Business Technology Transfer Programs		275	
Total		9413	10097

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J14	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J14 ECYBERMISSION	4820	5086	5245	5359	5466	5586	5709	

A. Mission Description and Budget Item Justification: This project supports eCYBERMISSION, a web-based science, math, and technology competition designed to stimulate interest and encourage advanced education in these areas among middle and high school students nationwide. The project supports Army Transformation through the sponsorship of a nation-wide, educational competition that encourages the nation's youth to pursue advanced education and careers in science, mathematics, and engineering, thereby providing a pool of technologically literate citizenry that potentially grow to become future soldiers and civilians for the Army workforce of tomorrow. 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, the Department of Defense Basic Research Plan and supports the President's initiative for education.

Work in this project is performed extramurally by the U. S. Army Research, Development and Engineering Command (RDECOM). Note: This project was previously funded in PE 0601104A Project H59 and was moved to Project J14 for increased visibility and management oversight.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
eCYBERMISSION is a national competition to stimulate interest in science, math and technology in middle and high school students. In FY07, completed a full-scale competition to all middle school (grades 6-8) and 9th grade high school students across the country and Department of Defense Educational Activity (DoDEA) schools. Increased student and teacher participation. In FY08 and FY09, sustain eCYBERMISSION and implement enhancements as necessary based on lessons learned from previous years. Will continue to seek to increase team participation.	4820	4944	5245
Small Business Innovative Research/Small Business Technology Transfer Programs		142	
Total	4820	5086	5245

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

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BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J15	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J15 NETWORK SCIENCES INTERNATIONAL TECHNOLOGY ALLIANC	5943	7138	7916	8278	8278	8460	8646	

A. Mission Description and Budget Item Justification: This project supports a competitively selected United States (US)/United Kingdom (UK) government, university, and industry consortium established to perform fundamental network and information science research in the areas of network theory, system-of-systems security, sensor processing and delivery, and distributed coalition planning and decision making. The focus is on enhancing distributed, secure, and flexible decision-making to improve coalition operations, and developing the scientific foundations for complex and dynamic networked systems-of-systems to support the complex human, social, and technical interactions anticipated in future coalition operations. The US Army Research Laboratory (ARL) and the UK Ministry of Defense (MOD) established a jointly funded and managed US and UK consortium, to be known as an International Technology Alliance (ITA) on Network and Information Sciences in FY06. The goal is fundamental science breakthroughs to enable superior coalition operations. Emphasis is on integration of multiple technical disciplines in an international arena. This program supports the Future Force transition path of the Transformation Campaign Plan (TCP). 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.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Perform fundamental network and information science research for US/UK coalition operations. In FY07, designed and validated interoperability models for disparate networks using cross-layer adaptation methodologies for distributed resource allocation to optimize application specific metrics. Investigated efficient and adaptive security algorithms to enable formation and operation of secure, flexible coalition operation communities-of-interest. Established initial ontologies for coalition structures and cultural models of planning. In FY08, investigate mathematical frameworks to model the structure and behavior of wireless networks to establish theoretical limits on capacity, scalability, reliability, and energy-efficiency to understand the performance of command-and-control, sensor, and communication coalition networks. Design protocols for automated policy negotiations and tools for refining high-level user-specified goals into low-level setting of components in coalition environments. Devise and validate analytical networked fusion architectures based on semantic information. In FY09, will investigate models, theory, and algorithms for creating self-organizing wireless networks inspired by highly adaptive biological systems. Will investigate cognitive and socio-cultural factors on coalition command processes and coalition networks to enhance situational awareness and decision-making. Will establish and validate analytic frameworks, leading to tradeoffs between sensing, computing, communications, and actuation, for classes of wireless sensor networks.	5943	6939	7916
Small Business Innovative Research/Small Business Technology Transfer Programs		199	
Total	5943	7138	7916

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J16	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J16 NANOTECHNOLOGY AND MICROELECTRONICS INSTITUTE	1989	2958	2995					

A. Mission Description and Budget Item Justification: This project conducts basic research in nano and micro technologies to improve the performance and effectiveness of portable electronic equipment for the warfighter. This will be accomplished by reducing power and weight while increasing real-time interactivity of vital information content between the warfighters and their environment. The Center for Nanotechnology and Microelectronics (CNAM) is a university research effort focusing on the development and application of nanotechnology that can be integrated with microelectronic systems while not duplicating existing nanoelectronics research programs. The objective is to accelerate the deployment of nanotechnology for military applications by focusing on applications where nanotechnology complements rather than replaces microelectronics. The research program will concentrate on four technology areas focused on resolving key issues associated with military applications of microelectronics and power electronics. Research thrusts include: 1) Thermal Management - the removal of heat from electronics and power electronics is the primary limit on the performance of small devices. Nanotechnology may improve the performance of thermal management systems by enhancing the cooling properties of materials, interfaces, and fluids for microelectronics; 2) Hybrid nano/micro structures and devices - bottom-up self-assembly of nanoscale components onto/into microelectronic platforms can lead to electronic components that integrate nanoscale optical interconnects, produce significantly less waste heat, and integrate on-board sensing; 3) Nanotechnology-enhanced transparent electronic materials - transparent materials can be used for microelectronics, increasing the designers flexibility in integrating microelectronics into other systems; 4) Active Cooling - nanotechnology-based active cooling technology such as high efficiency thermoelectric coolers and nano-enhanced adsorption/desorption cooling can, in theory, cool microelectronics to temperatures below ambient or even to cryogenic temperatures, thus improving performance. 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.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Research thrusts include thermal management, hybrid nano/microstructures and devices, nanotechnology-enhanced transparent electronic materials, and active cooling for improved portable warfighter electronic equipment. In FY07, researched enhanced materials for thermal management through tailoring the thermal conductivity of materials, fluids and reducing interface resistance; researched low power nano-electronics; researched nanotechnology-enhanced transparent electronic materials that may augment portable and flexible display technology; researched advanced nanotechnology-enhanced cooling including thermoelectric coolers and adsorption/desorption cooling. In FY08, research specialized thermal management techniques to provide improved cooling of army systems through the fabrication of materials with superior thermal conductivity and functionalized thermal interfaces to enhance heat transfer; research novel nano-technology based sensors and electronics devices, including potentially lower power systems; study nanotechnology-enhanced transparent electronic materials that may improve portable and flexible display technology; investigate advanced nanotechnology-enhanced cooling techniques including thermoelectric and adsorption/desorption cooling. In FY09, will implement thermal management techniques that provide improved thermal conductivity and will study methods to functionalize the thermal interfaces to improve heat transfer; will fabricate novel nano-electronics for low power sensors and systems; will study nanotechnology-enhanced electronic materials that provide	1989	2875	2995

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT	
1 - Basic research	0601104A - University and Industry Research Centers	J16	
superior electrical capabilities; will research advanced nanotechnology-enhanced cooling techniques including thermoelectric and adsorption/desorption cooling.			
Small Business Innovative Research/Small Business Technology Transfer Programs		83	
Total		1989	2958

2995

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J17	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J17 VERTICAL LIFT RESEARCH CENTER OF EXCELLENCE		1972	2032	2077	2119	2166	2213	

A. Mission Description and Budget Item Justification: Vertical Lift Research Center of Excellence couples state-of-the-art research programs with broad-based graduate education programs at academic institutions with the goal of increasing the supply of scientists and engineers who can contribute to Army Transformation. Work will support Army Transformation by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing vehicles. 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) and the Aviation and Missile Research, Development, and Engineering Center (AMRDEC).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Vertical Lift Research Center of Excellence: In FY08, investigate interactional aerodynamics for noise prediction of heavy lift rotorcraft configurations, investigate anti-icing and erosion protection systems for rotor blades, investigate high-lift airfoil concepts for delaying dynamic stall onset and reducing adverse pitching moments; and develop data fusion and biomimetic materials for rotorcraft health monitoring systems. In FY09, will develop light-weight high-flexibility rotorcraft shafts using flexible matrix composites and active bearing controls; and will develop efficient and affordable joining concepts for high-stiffness, light-weight composites.		1917	2032
Small Business Innovative Research/Small Business Technology Transfer Programs		55	
Total		1972	2032

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research		PE NUMBER AND TITLE 0601104A - University and Industry Research Centers					PROJECT J22	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
J22 NETWORK SCIENCE AND TECHNOLOGY RESEARCH CENTER			10000	9482	10000	10000	12078	

A. Mission Description and Budget Item Justification: This project funds the establishment of the Network Science and Technology Research Center (NSTRC) to be located at the U.S. Army Aberdeen Proving Ground (APG), Maryland. The NSTRC will be managed through the Army Research Laboratory as an annex to the Institute of Collaborative Biotechnologies (ICB). In this way the Army can leverage its investment in the ICB and three universities along with resources at ARL's APG location and Communications-Electronics Command assets. There will be an effort undertaken to include additional partners such as universities, industry, and other government agencies. Network Science is the study of network representations of physical, biological, and social phenomena leading to predictive models of these phenomena. As such, network science may be seen as the cornerstone for future military operations and the conduct of network-centric warfare. The mission of this center will be to strengthen the theoretical underpinnings of network science; conduct basic research on how and why biological and social (non-physical) networks function and determine their applications to military networks; to manage the activities in network science research, technology development, and network experimentation for the Army; to focus science and technology investments to enable network-centric operations and warfare; to focus applied science and technology to enable social networks important to Army operations; and to enable the development of network science applications and facilitate their transition to Army and joint operations. Network science, technology, and experimentation encompasses all information and information exchange, visualization, collaboration, manipulation, protection, restoration, transport, services, data storage, and application layers, including the knowledge that human use of networks is a critical component. Establishment of the center will require a phased approach to develop the required infrastructure, which must be capable of supporting development of fundamental network theory and network technologies, and carry out the assessment of impacts upon human performance; the integration of new technologies and social networks into capabilities; and experimentation as a means to test and confirm fundamental theories and predictive models and/or characterize new technologies and operational concepts while also being capable of promoting training of personnel when applicable. Unlike the Training and Doctrine Commands on-going efforts within their centers, schools, and battle-labs, the focus of the NSTRC will be to develop the framework to perform research important to the Army in the areas of modeling, simulation and testing of very large networks, command and control of joint/combined networked forces, impact of network structure on organizational behavior, security and information assurance of networks, swarming behavior, and managing network complexity. It will also have a significant focus on and investment in the discovery and foundational aspects of the science of networks both human engineered and biologically evolved. 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 will be performed both internally and extramurally by the Army Research Laboratory (ARL).

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
The magnitude and diversity of the required infrastructure to establish the Network Science and Technology Research Center will require a phased implementation approach over multiple years. The extensive infrastructure needed to support this center will be developed initially in FY09 from existing facilities and will require special planning efforts to synchronize with 2005 Base Realignment and Closure (BRAC) relocations already in progress. Facility plans for required infrastructure will be developed to provide for (1) flexible configurations of network experiments and integration, both internally and externally; (2) facility designs that enhance and encourage academic and industry partnerships; and (3) an environment with world class experimental capabilities and a campus-like atmosphere to			10000

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

BUDGET ACTIVITY 1 - Basic research	PE NUMBER AND TITLE 0601104A - University and Industry Research Centers	PROJECT J22	
attract truly talented personnel.			
Total			10000