RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2008
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA1 Basic Research	R-1 ITEM NOMENCLATURE: Defense Research Sciences; PE 0601101E

COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	139.521	174.996	195.657	226.125	231.195	236.361	241.652
Bio/Info/Micro Sciences BLS-01	40.454	44.235	49.925	77.722	74.625	74.946	74.925
Information Sciences CCS-02	17.885	28.448	39.494	39.364	40.069	40.154	42.282
Electronic Sciences ES-01	50.091	53.481	57.505	61.360	58.898	62.752	62.752
Materials Sciences MS-01	31.091	48.832	48.733	47.679	57.603	58.509	61.693

(U) Mission Description:

(U) The Defense Research Sciences Program Element is budgeted in the Basic Research Budget Activity because it provides the technical foundation for long-term National Security enhancement through the discovery of new phenomena and the exploration of the potential of such phenomena for Defense applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic, biological and materials sciences.

(U) The Bio/Info/Micro Sciences project will explore and develop potential technological breakthroughs that exist at the intersection of biology, information technology and micro/physical systems to exploit advances and leverage fundamental discoveries for the development of new technologies, techniques and systems of interest to the DoD. Programs in this project will draw upon information and physical sciences to discover properties of biological systems that cross multiple biological architectures and functions, from the molecular and genetic level through cellular, tissue, organ, and whole organisms' levels.

(U) The Information Sciences project supports long term national security requirements through scientific research and experimentation in new computational models and mechanisms for reasoning and communication in complex, interconnected systems. The project is exploring novel means to exploit computer capabilities; enhance human-to-computer and computer-to-computer interaction technologies; advance innovative computer architectures; and discover new learning mechanisms and innovations in software composition. It is also fostering the computer science academic community to address the DoD's need for innovative computer and information science technologies.

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(U) The Electronic Sciences project explores and demonstrates electronic and optoelectronic devices, circuits and processing concepts that will provide: 1) new technical options for meeting the information gathering, transmission and processing required to maintain near-real time knowledge of the enemy and the ability to communicate decisions based on that knowledge to all forces in near-real time; and 2) provide new means for achieving substantial increases in performance and cost reduction of military systems providing these capabilities.

(U) The Materials Sciences project is concerned with the development of: high power density/high energy density mobile and portable power sources; processing and design approaches for nanoscale and/or bimolecular materials, interfaces and microsystems; materials and measurements for molecular-scale electronics and spin-dependent materials and devices.

(U) **Program Change Summary:** *(In Millions)*	**FY 2007**	**FY 2008**	**FY 2009**
Previous President's Budget	145.239	152.622	156.242
Current Budget	139.521	174.996	195.657
Total Adjustments	-5.718	22.374	39.415
Congressional program reductions	0.000	-1.119	
Congressional increases	0.000	23.493	
Reprogrammings	-2.000		
SBIR/STTR transfer	-3.718		

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(U) Change Summary Explanation:

FY 2007	Decrease reflects the reprogramming of the John H. Hopps congressional add to OSD and the SBIR/STTR transfer.
FY 2008	Increase reflects reductions for Section 8097 Contractor Efficiencies and Section 8104 Economic Assumptions offset by congressional adds for Nanoscience Nanotechnology Institute, Illinois Institute of Technology, Nanocrystal Source Display, Bacterial Ghost Influenza Vaccine Development, Advanced Research to Further National Security Goals, Advanced Nano-Engineered Composites, Alternative Futures at the Range Complex Level for the Southwest U.S., Focus Center-GICUR University Research, and Advanced Photonic Composites Research.
FY 2009	Increase reflects the transfer of the Surface Enhanced Raman Scattering (SERS) program from PE 0602716E, Project ELT-01; Tip Based Nano Fabricate from PE 0603739E, Project MT-12; and increases to the University Photonic Centers, Quantum Entanglement Science and Technology Center, Computer Science Study Group and Young Faculty Awards.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences PE 0601101E, Project BLS-01

COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Bio/Info/Micro Sciences BLS-01	40.454	44.235	49.925	77.722	74.625	74.946	74.925

(U) Mission Description:

(U) This project is investigating and developing the intersections of biology, information technology and micro/physical systems to exploit important technological advances and leverage fundamental discoveries for the development of new technologies, techniques, and systems of interest to the DoD. This research is critical to the development of rapid responses to engineered biological warfare agents, radically new biomolecular computers, and novel materials for the DoD. Programs in this project will draw upon the information and physical sciences to discover properties of biological systems that cross multiple scales of biological architecture and function, from the molecular and genetic level through cellular, tissue, organ, and whole organism levels. This project will develop the basic research tools in biology that are unique to the application of biological-based solutions to critical Defense problems. This project is also providing the supporting basic research for the effort to revolutionize prosthetics.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Bio Interfaces	8.000	7.960	11.000

(U) The Bio Interfaces program will support scientific study and experimentation, emphasizing the interfaces between biology and the physical and mathematical/computer sciences. This unique interaction will develop new mathematical and experimental tools for understanding biology in a way that will allow its application to a myriad of DoD problems. These tools will help exploit the advances in the complex modeling of physical phenomena such as Electro-Magnetic Pulse (EMP) and blast with biological tissues and cells in order to understand and prevent the deleterious effects of traumatic brain injury. It is also expected that understanding the fundamentals of biology will aid in developing tools to understand complex, non-linear networks and force structures.

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(U) Program Plans:

FY 2007 Accomplishments:

- Developed quantum mechanical theory of viral evolution incorporating horizontal gene transfer based on a path integral formalism – particle/wave duality in biology.
- Developed theory of speciation based on randomness in a fitness landscape and consequent Anderson localization.
- Completed initial evaluation of the mechanisms of explosive-induced traumatic brain injury in experimental models.
- Initiated observational study of clinical symptoms and biomarkers of traumatic brain injury in warfighter populations.

FY 2008 Plans:

- Strengthen the foundations of the metagenomics approach to ecology using population genetics and the analysis of evolving populations.
- Understand and exploit the consequences of the occurrence of quantum mechanical structure in biology.
- Develop new mathematical methods targeting complexity and variability in biological systems.
- Determine the primary physical factors accounting for explosive-induced traumatic brain injury in experimental models.
- Complete epidemiologic study of factors associated with explosive traumatic brain injury in warfighters.

FY 2009 Plans:

- Test and verify theoretical mathematical formulations of the laws of biology on simple systems.
- Complete development of a generalized thermodynamic formalism for biological systems.
- Create protection and mitigation strategies, which greatly reduce the number and extent of traumatic brain injuries in warfighter population due to explosion.

	FY 2007	FY 2008	FY 2009
Biological Adaptation, Assembly and Manufacturing	8.869	10.675	11.000

(U) The Biological Adaptation, Assembly and Manufacturing program will examine the structure, function, and informational basis underlying biological system adaptation, particularly to harsh environments, and the factors employed by the organism to assemble and manufacture complex biological subsystems. The unique stability afforded biological systems in their ability to adapt to wide extremes of physical and endurance (e.g., heat, cold, and sleeplessness) parameters will be examined and exploited in order to engineer stability into biological systems

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required for the military (such as blood or other therapeutics). In addition, the fault tolerance present in biological systems will be exploited in order to assemble and manufacture complex physical and multi-functional systems, both biological and abiotic. Further activity in this area will investigate the adaptability of the brain to information processing and situational awareness. Applications to Defense systems include the development of chemical and biological sensors, and improved battlefield survivability of the warfighter.

(U) Program Plans:

FY 2007 Accomplishments:

- Genetically distinguished cells associated with regeneration from cells associated with a scarring response.
- Identified seven molecules that attract regeneration-associated cells.
- Identified novel human probiotic bacterial strains that reduce infectious diarrhea in experimental models.
- Demonstrated a novel bacterial ghost vaccine platform that increased survival after a lethal challenge of gut bacteria (Shigella).
- Identified novel human fibro-biotics that enable partial digestion of dietary fiber.

FY 2008 Plans:

- Decrease fibrotic collagen synthesis at a wound by 20% in an experimental model.
- Establish a population of blastema-like cells (defined by at least three genetic markers) at a non-regenerating wound site in a mammal.
- Develop strategies for production of ten red blood cell units per week for four weeks in an automated closed culture system using a non-renewing (replaceable) progenitor cell population.
- Identify promising strategies in nature that allow organisms to survive under environmental extremes and adapt those strategies to other cells, tissues, organs and organisms, including platelets and red blood cells.
- Identify non-contact approaches such as magnetic fields and dielectrophoresis that provide cell positioning in 3-dimensions without negatively impacting cell viability.

FY 2009 Plans:

- Demonstrate production of 100 red blood cell units per week for eight weeks in an automated closed culture system using a renewing progenitor cell population.
- Enhance or produce artificial cell membranes to control, repair and improve cellular processes in the warfighter.
- Demonstrate in vitro construction of multicellular tissue using one or more non-contact cell positioning approaches.

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	FY 2007	FY 2008	FY 2009
Nanostructure in Biology	11.885	12.000	12.925

(U) The Nanostructure in Biology program will investigate the nanostructure properties of biological materials to better understand their behavior and accelerate their exploitation for Defense applications. This new information about biomolecules and complex cellular systems will provide important new leads for the development of threat countermeasures, biomolecular probes and motors, and neuromorphic sensory systems. This program will also develop approaches to mathematically predict, a priori, the structure of biological materials, especially proteins, based on the desired performance. This will enable the rapid design of new biosensors against previously unknown threats and the design of advanced catalysts based on biological activity to produce new materials of interest to DoD (e.g., tailored explosives). The program will also create technology to reliably integrate nanoscale and microsystems payloads on insects that will extract power, control locomotion, and also carry DoD relevant sensors. In addition, research will be conducted in the interaction, at the nanoscale, of biotic and abiotic materials and functions, a critical aspect in the development of advanced prosthetics.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed nanochannel glass recording devices to obtain neural impulses in the visual pathway; commenced test and verification.
- Designed and assembled multi-photon microscope to simultaneously record large number of neurons in order to understand the interconnectivity of neurons across regions in the mammalian visual pathway.
- From a priori mathematical principles, designed proteins that perform known chemistry in ten systems and showed that the naturally occurring protein appeared as one of the top five designs.
- Established methodology to design enzymes with high catalytic rate.
- Established methodology to mathematically design protein binding pairs.
- Demonstrated locomotion control using MEMS platforms consisting of ultrasonic projectors, pheromone ejectors, insect mechano-sensor activation, and visual presentation manipulation, neural, or muscular interfaces.

FY 2008 Plans:

- Create an in vivo map of the feature sensitivity of populations of primary visual cortical neurons using nanochannel glass reocordings and two-photon microscopy techniques.

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- Deduce how object representation in the mammalian inferotemporal cortex is computed from downstream visual system (V4) inputs using tools from topology, geometry, and statistics.
- Design enzymes with catalytic activity 10x improved from 2007 designs.
- Design proteins with 10x binding affinity to a second target protein.
- Demonstrate autonomous locomotion control via RF control for an un-tethered cyborg.

FY 2009 Plans:

- Create a functional model of the entire mammalian object recognition pathway that is biologically valid and suitable for translation to algorithm development.
- Apply protein design methodology to: 1) perform region-specific nitration chemistry, and 2) develop a protein that inhibits the activity of influenza by preferential binding.
- Develop a fast high-throughput chemistry-based technique for determining biomolecule structures at sub-Å resolution (better than X-ray crystallography) in solution.
- Optimize MEMS components for locomotion control, communications and power generation to consume less power and to reduce size, weight and cost.

	FY 2007	FY 2008	FY 2009
Human Assisted Neural Devices	10.500	12.000	15.000

(U) The Human Assisted Neural Devices program will develop the scientific foundation for understanding the language of the brain for application to a variety of emerging DoD challenges, including improving performance on the battlefield and returning active duty military to their units. This will require an understanding of neuroscience, significant computational efforts, and new material design and implementation. Key advances expected from this research include the ability to improve decision making in a variety of DoD applications including imagery analysis. In addition, this thrust will provide an understanding of how the brain adapts as it learns. This understanding will be translated into improved training approaches that allow transition from novices to expert in military tasks such as marksmanship to be accomplished with minimum effort and time.

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(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated neurally stimulated tactile feedback by a non-human primate in a reaching and grasping task.
- Developed new methods to discern motor intention in non-human primates.
- Determined the functional Magnetic Resonance Imaging (fMRI) signatures associated with expert status on DoD relevant tasks, which include skills that can make a direct translation to military benefit such as language acquisition, marksmanship, and threat detection.
- Commenced investigations into the neural basis of expert performance using advanced functional neuroimaging technologies, state of the art spatio-temporal measurement techniques and novel signal processing methods.

FY 2008 Plans:

- Create an interface capable of enabling performance of a complex motor/sensory task through an assistive device.
- Map dynamic functional motor and sensory networks, develop methods for characterizing brain-wide sensory/motor tasks, and determine task performance changes resulting from learning and plasticity.
- Identify the specific brain networks and regions involved in the generation of expert performance; track and classify progression from novice to expert level using functional neuroimaging techniques.
- Investigate non-invasive interventions to increase the speed of expertise development and dramatically accelerate the transition from novice to expert in key military tasks including neurophsyiologically-driven training regimens, neurally optimized stimuli, and stimulatory/modulatory interventions.

FY 2009 Plans:

- Develop prototype training systems to implement the acceleration methodologies for improved training.
- Explore the extrapolation of task specific acceleration techniques from limited domains to wider, more general training applications.
- Identify memory neural codes that are specific to critical work related tasks, enabling possible memory restoration in a brain-wounded warfighter.
- Leverage recent advances in neuroscience and mathematics to construct an integrated mathematical model of the brain that is consistent and predictive, rather than merely biologically inspired.
- Develop a theory that overcomes the difficulties present in traditional approaches, such as artificial intelligence and artificial neural network, to properly model complex human brain processes such as logical reasoning, language, mental computation, and context-dependent mental set.

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	FY 2007	FY 2008	FY 2009
Drug Discovery and Development Initiative for National Security	1.200	0.000	0.000

(U) Program Plans:
FY 2007 Accomplishments:
– Effort concentrated on finding promising new methods for discovering drugs to enhance national security efforts.

	FY 2007	FY 2008	FY 2009
Bacterial Ghost Influenza Vaccine Development	0.000	1.600	0.000

(U) Program Plans:
FY 2008 Plans:
– Develop novel genetically inactivated bacterial-based vaccines to overcome disadvantages of egg-based vaccines.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences PE 0601101E, Project CCS-02

COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Information Sciences CCS-02	17.885	28.448	39.494	39.364	40.069	40.154	42.282

(U) Mission Description:

(U) This project supports scientific study and experimentation on new computational models and mechanisms for reasoning and communication in complex, interconnected systems in support of long-term national security requirements. The project is exploring novel means of exploiting computer capabilities; practical, logical and heuristic reasoning by machines; development of enhanced human-to-computer and computer-to-computer interaction technologies; innovative approaches to the composition of software; innovative computer architectures; and new learning mechanisms for systematically upgrading and improving these capabilities. Promising techniques will transition to both technology development and system-level projects.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Computer Exploitation and Human Collaboration	13.312	20.512	11.494

(U) The Computer Exploitation and Human Collaboration program supports research in broad areas of computational science having the potential for revolutionary advances in performance and other relevant metrics above and beyond extrapolations of current approaches. The research will yield significant advances in networking, software, hardware, and computational systems that will allow warfighters and commanders of the future to interact in a natural way with computers, enable a new generation of collaboration methods and information acquisition, and provide intelligent seamless exchange of information in a world where computing devices are ubiquitous and heterogeneous. The program is creating an information theory for ad-hoc mobile wireless networking in the absence of wired infrastructure; practical inferential reasoning techniques applicable in real-world situations with complexity and uncertainty; and revolutionary non-traditional processing architectures. The Computer Exploitation and Human Collaboration program consists of two efforts: Information Theory for Wireless Mobile Ad-Hoc Networks (ITMANET) and Real-World Reasoning (REAL).

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- The science of interconnected systems provides powerful mathematical tools for understanding the intrinsic properties and complexities of large-scale networks and other distributed systems. Such foundational research is imperative for the future design of robust systems that break away from the established tradition of piece-meal patching of current infrastructures. Research is focused on the development of an overarching "Information Theory for Wireless Mobile Ad-Hoc Networks" (ITMANET). This revolutionary information theory effort will enable the next generation of the DoD's wireless networks, and moreover provide insight concerning the acquisition and deployment of nearer-term systems.

- Research on machine intelligence over the last two decades has revealed that many reasoning problems are inherently computationally complex, and in many cases, intractable. Solutions to these problems typically require either enormous computer resources, or simplification of the problem resulting in major sacrifices to accuracy. The Real-World Reasoning (REAL) effort is developing foundational technologies, heuristic approaches, and tools necessary to enable effective, practical machine reasoning about increasingly complex and large-scale problems. These technologies will aid commanders and warfighters in assessing the consequences of specific actions and strategies, and will help in predicting future results. The key technologies under investigation are effective, practical inferential reasoning in real-world situations with complexity and uncertainty; novel paradigms for learning while reasoning; integration of multiple reasoning paradigms; representation and reasoning with information that changes over time; reasoning about the goals of other agents; and appropriate metrics for measuring cognitive behavior and performance.

(U) Program Plans:

– Information Theory for Wireless Mobile Ad-Hoc Networks (ITMANET)
  FY 2007 Accomplishments:
  -- Initiated work by two university research teams to develop a revolutionary information theory for mobile ad-hoc networks (ITMANET) that will provide theoretical underpinnings and performance goals/limits for the next generation of DoD wireless networks as well as practical guidance for the acquisition and deployment of near-term systems.
  -- Analyzed single flow "line" network containing key forms of dynamics in terms of throughput/delay-reliability trades.
  -- Used stochastic geometry to model cooperation in power control and scheduling; explored and quantified the benefits of cooperation using this model.
  -- Analyzed, prototyped, and demonstrated novel forms of physical-layer radio cooperation based on analog network coding and information-theoretic relaying.

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FY 2008 Plans:
-- Develop and analyze tractable and insightful metrics and network models that expand the definition of information theory to encompass the degrees of freedom, constraints and dynamics inherent to wireless networks.
-- Develop new upper bounding techniques for MANET capacity and other performance metrics, and evaluate these bounds for small to medium-sized networks under relatively simple assumptions.
-- Develop new achievability results for key performance metrics by optimizing dynamic node cooperation and resource allocation over available degrees of freedom.
-- Use rate distortion theory and network utilization to optimize the interface between networks and applications.

FY 2009 Plans:
-- Predict MANET performance in terms of throughput-delay-reliability for a specific pre-defined MANET realization (small number of nodes, maximum limited mobility, required outage, amount of allowed overhead, bandwidth efficiency, etc.).
-- Develop new achievability results for key performance metrics based on networks designed as a single probabilistic mapping with dynamics over multiple timescales.

– Real-World Reasoning (REAL)

FY 2007 Accomplishments:
-- Demonstrated, on problems of limited scope, a new learning-based algorithm that achieves a 10^9 speed-up in logical Quantified Boolean Formulae (QBF) reasoning.
-- Demonstrated, on small problems, new reasoning algorithms that combine pruning, consistency models, and statistical sampling to decide on a course of action even when the state of the world is unknown.
-- Determined, on small problems, that Nash equilibrium points could be identified in multi-party, mixed tactical/strategic settings, determining which action a commander should take and with whom to partner in a given situation.
-- Provided program planning support for the DARPA Urban Challenge.

FY 2008 Plans:
-- Develop innovative algorithms for dramatically reducing the complexity and processing required for reaching conclusions in logical reasoning systems where the problems are of an operationally realistic scale and complexity.
-- Develop reasoning algorithms that can analyze situations and decide on effective courses of action even when the exact state of the world is unknown (a.k.a. partial observability) on problems of realistic size and complexity.

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-- Develop strategic reasoning algorithms that analyze complex, multi-party, mixed tactical / strategic settings (like those found in modern warfare situations), and provide decision support to warfighters about who is partnered with whom and what posture might be taken with respect to these parties; where the problems are of realistic size and complexity.

FY 2009 Plans:

-- Develop a system architecture that integrates the different REAL technologies into a cohesive reasoning system.
-- Apply the REAL system (combined technologies) to a military training simulation called Decisive Action.
-- Create non-traditional computing architectures that go beyond the currently deployed instruction set architectures and the long-standing abstraction layer paradigm of application on operating system on kernel on assembler on firmware on hardware.

	FY 2007	FY 2008	FY 2009
Computer Science Study Group (CSSG)	4.573	6.936	12.000

(U) The Computer Science Study Group (CSSG) program supports emerging ideas from the computer science academic community to address the DoD's need for innovative computer and information science technologies; introduce a generation of junior researchers to the needs and priorities of the DoD, and enable the transition of those ideas and applications by promoting joint university, industry, and government projects. The CSSG project formalizes and focuses this research for efficiency and greater effectiveness.

(U) Program Plans:

FY 2007 Accomplishments:

- Established comprehensive study panels comprised of junior academic computer scientists and paired them with mentors with senior academic, industrial, and military talents.
- Conducted a series of research efforts in order to solve the most compelling problems facing the computer science community.
- Initiated development of a sensitive programming language focusing on code behavior in problem environments.
- Initiated development of a secure, coherent software methodology for information-sharing for both cross-domain and intra-domain communication applications.
- Developed research paradigm to solve bottlenecks and inefficiencies in network data transfer, using the novel concept of image hand-printing for efficiently locating sources of similar content.

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FY 2008 Plans:
- Further develop extensive collaboration among civilian computer scientists and DoD technologists and customers.
- Develop software models of human skin architecture including sensory neural system.
- Develop new computational learning theory, including learning from noisy data, to enhance algorithms for random noise tolerance.
- Develop software with increased capability and dependability, by combining static tools and human insight at the architectural level to defeat attacks.
- Develop process for networking wireless imaging systems and other wireless sensors emphasizing change detection and medical applications.

FY 2009 Plans:
- Identify and explore new computer science challenges that, when addressed, will yield extraordinary advances for DoD applications.
- Develop high-performance parallel computing, and interactive computer graphics.
- Explore bio-inspired computing emphasizing evolutionary computation and artificial neural networks (ANNs) to solve difficult real world tasks such as autonomous guidance of vehicles.
- Develop new approaches for management of network security, authentication, mobility, and handoff management with emphasis on self-organizing wireless networks in a battlefield environment.

	FY 2007	FY 2008	FY 2009
Programmable Matter	0.000	0.000	4.000

(U) The Programmable Matter program will develop a new functional form of matter, constructed from mesoscale particles that assemble into complex 3-Dimensional (3-D) objects upon external command. These objects will exhibit all of the functionality of their conventional counterparts and ultimately have the ability to reverse back to the original components.

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(U) Program Plans:
FY 2009 Plans:
- Build mathematical model that theoretically confirms a viable procedure for constructing macroscopic 3-D solid objects with functional properties that have real world use.
- Demonstrate externally-directed assembly of distinct macroscopic 3-D solids.
- Demonstrate interlocking/adhesion of mesoscale particles to create bulk matter.
- Demonstrate reversibility.

	FY 2007	FY 2008	FY 2009
Young Faculty Award	0.000	0.000	10.000

(U) The Young Faculty Award (YFA) program will identify rising research stars in junior faculty positions in academia and expose them to DoD needs and DARPA's program development process. The long term goal is to develop the next generation of academic scientists in key disciplines who will focus a significant portion of their career on DoD and National Security issues.

(U) Program Plans:
FY 2009 Plans:
- Identify brightest young academicians in microsystems, mathematics, neuroscience and other disciplines as candidates for the program.
- Conduct introductory meetings to introduce academicians/faculty to DoD needs and opportunities.
- Develop broad areas of scientific interest; solicit, evaluate, and fund proposals.

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	FY 2007	FY 2008	FY 2009
High School Science Study Group/CS Futures	0.000	1.000	2.000

(U) The DARPA Grand & Urban Challenges inspired a number of high school-age students and exposed them to the rewards of a research career. The future of DoD research depends on the continuing engagement of these students in science- and technology-related fields. An offshoot of the Computer Science Study Group program, the High School Science Study Group/CS Futures program will fund efforts to identify the computer science interests of high school students, and involve them in high-level research at the high school level.

(U) Program Plans:

FY 2008 Plans:

- Assemble a panel of academic computer scientists to identify potential areas of interest to high school students.
- Establish student study groups to gauge the attractiveness of the proposed ideas to students.
- Conduct student evaluation of potential research to include: robotics for traffic and vehicle management, robots for environmental surveillance and conservation, and object recognition for the blind.

FY 2009 Plans:

- Engage high school study groups to work on selected ideas.
- Continue evaluation of new potential ideas, including: human computer interactions, computational models of environmental adaptation, and automated evaluation of physical function for applications in rehabilitation medicine.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Electronic Sciences ES-01	50.091	53.481	57.505	61.360	58.898	62.752	62.752

(U) Mission Description:

(U) This project seeks to continue the phenomenal progress in microelectronics innovation that has characterized the last decades by exploring and demonstrating electronic and optoelectronic devices, circuits and processing concepts that will: 1) provide new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy and the ability to communicate decisions based on that knowledge to all forces in near real-time; and 2) provide new means for achieving substantial increases in performance and cost reduction of military systems providing these capabilities. Research areas include new electronic and optoelectronic device and circuit concepts, operation of devices at higher frequency and lower power, extension of diode laser operation to new wavelength ranges relevant to military missions, development of uncooled and novel infrared detector materials for night vision and other sensor applications, development of innovative optical and electronic technologies for interconnecting modules in high performance systems, research to realize field portable electronics with reduced power requirements, and system and component level improvements to provide greater affordability and reliability. Additionally, electronically controlled microinstruments offer the possibility of nanometer-scale probing, sensing and manipulation for ultra-high density information storage "on-a-chip," for nanometer-scale patterning, and for molecular level analysis and synthesis. These microinstruments may also offer new approaches to integration, testing, controlling, manipulating and manufacturing nanometer-scale structures, molecules and devices.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
University Photonic Research (UPR) Centers	7.102	5.782	7.500

(U) The University Photonic Research (UPR) Centers program is dedicated to coupling university based engineering research centers of excellence with appropriate industry groups to conduct research leading to development of advanced optoelectronic components. Such components are critical to enhancing the effectiveness of military platforms that provide warfighter comprehensive awareness and precision

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engagement. Topics researched include emitters, detectors, modulators and switches operating from infrared to ultraviolet wavelengths, and related heterogeneous materials processing and device fabrication technologies for realizing compact, integrated optoelectronic modules.

(U) The University Photonics Research (UPR) II program will continue long standing support of university-led research in photonics. The program will develop revolutionary capabilities leading to specific photonic intelligent microsystems by using university-based teams of interdisciplinary researchers engaged in a range of topics. These university-based research projects will be coupled with industry participation. Unfunded participation of industry researchers is expected to help guide and focus the Centers' activities toward specific and measurable research goals. The industrial liaisons are expected to facilitate transitioning the intermediate results of long term research into products in addition to providing an industry perspective. The overall vision of the Centers' research programs will be driven by the goal of creating new paradigms for realizing higher performance, lower energy requirements, greater environmental stability and adaptive behavior. Each team of university researchers will be formed into a University Photonics Research Center, and will be associated with an overarching vision of research directions.

(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated detection of a single molecule in a fluidic bath using an optical micro-resonator with a functionalized surface to show simultaneous high selectivity and high sensitivity detection of unlabeled biological or chemical compounds.
- Demonstrated nano-aperture vertical cavity surface emitting lasers with record high intensity output showing that established theory for sub-wavelength optical apertures is incorrect.
- Initiated projects jointly funded by industrial sponsors.

FY 2008 Plans:

- Design and fabricate prototype modules using the system-on-a-chip approach.
- Develop testbeds capable of fully measuring and characterizing the mixed technologies implemented in the chip-scale components.

FY 2009 Plans:

- Evaluate the performance characteristics of the prototype modules and determine the highest payoff dual use development paths.
- Identify and enlist industrial participants.
- Identify a common set of photonic devices most widely used/requested and make them immediately available for experimentation.

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	FY 2007	FY 2008	FY 2009
Semiconductor Technology Focus Centers	20.400	10.200	20.000

(U) The Semiconductor Technology Focus Centers research program is a collaborative effort between the Defense Advanced Research Projects Agency (DARPA), the Office of the Deputy Undersecretary of Defense for Science & Technology (DUSD/S&T), and the Microelectronics Advanced Research Corp (MARCO) which will establish new Focus Centers in "Materials, Structures & Devices" and in "Circuits, Systems & Software" at U.S. Institutions of Higher Education. The Focus Centers will concentrate research attention and resources on a discovery research process to provide radical innovation in semiconductor technology that will provide solutions to barrier problems in the path of sustaining the historical productivity growth and performance enhancement of semiconductor integrated circuits. The overall goal of this collaborative effort between the Department of Defense and industry is to sustain the unprecedented four decades of uninterrupted performance improvement in information processing power.

(U) Program Plans:

FY 2007 Accomplishments:

- Developed efficient platform based design methodologies and low latency interconnect technologies for complex integrated circuits that have application in high performance signal processing and communication systems.
- Developed circuit architectures that reduce long interconnects compatible with chip clock rates > 5 gigahertz (GHz).
- Explored novel device fabrication and integration approaches for deeply scaled transistors (<10 nanometers channels) and their effective integration for high performance mixed signal circuits for military needs.
- Demonstrated capabilities of platform-centered design methodology leading to rapid design and re-design of complex System on a Chip (SoC) for military applications.
- Demonstrated photonic, radio frequency (RF), and novel materials for on-chip interconnects.
- Demonstrated fabrication technologies for nanometer scaled transistors.
- Developed robust designs and architectures for fabricating circuits based on unreliable switches.

FY 2008 Plans:

- Demonstrate, via simulation, integration of nanometer-scaled devices into circuit macro functions that have application to military sensor signal processing or advanced communications protocols.

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– Explore integration processes for incorporating high mobility materials as transistor channels in deeply scaled field-effect transistors.
– Explore new materials and fabrication approaches to scale devices below 10 nanometers (nm).

FY 2009 Plans:

– Develop novel device fabrication and integration approaches for deeply scaled transistors and architectures for high performance mixed signal circuits for military needs.
– Develop concepts and validation methods in one or combinations of the following areas: electronics, photonics, micro-electro-mechanical systems (MEMS), architectures and algorithms.

	FY 2007	FY 2008	FY 2009
Focus Center - Government Industry Cooperative University Research (GICUR)	0.000	8.000	0.000

(U) The Focus Center - Government Industry Cooperative University Research (GICUR) program compliments the goals and objectives of the above Semiconductor Technology Focus Centers. All plans are identical. All funding is applied to the Semiconductor Technology Focus Center program.

	FY 2007	FY 2008	FY 2009
Molecular Photonics (MORPH)*	8.060	5.000	0.000

*Formerly Supermolecular Photonics Engineering.

(U) Large dendritic and other highly branched organic molecules offer great potential for active photonic applications. Three-dimensional molecular structures and shapes can be engineered to orient and immobilize optically active substituents to achieve much higher electro-optic activity than with traditional polymer systems. The ability to engineer molecular structure, shape, energy transport, and chemical composition offers the potential for distinct electronic energy level engineering without the traditional semiconductor crystal lattice. This will allow more freedom to tailor electromagnetic responses of individual molecules to achieve functionality not possible in semiconductors. Potential applications include: direct conversion of sunlight to power (“optical antenna”), inversion-less lasers and electromagnetically induced transparency (coherent

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organic emitters, and slow light materials), high performance photorefractive materials for signal processing and holographic memory, optical limiters and saturable absorbers as well as high performance modulators.

(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated a polymer-based signal modulator with far higher speed (20 gigahertz (GHz)) than semiconductor modulators of similar size while having comparable performance (impact on RF photonics).
- Demonstrated organic molecules with high optical limiting for sensor protection from laser threats (warfighter protection).

FY 2008 Plans:

- Demonstrate very high speed (100 gigahertz (GHz)) polymetric electro-optic (EO) modulator.
- Demonstrate organic materials for building ultra-high speed EO modulators.
- Develop tailored organic materials as high-efficiency optical limiters in regions of the spectrum relevant to military sensor protection.

	FY 2007	FY 2008	FY 2009
Photonics Technology Access Program (PTAP)	1.300	0.000	0.000

(U) The main goal of the Photonic Technology Access Program (PTAP) was to create a mechanism for providing the latest prototype optoelectronic devices and custom materials to systems researchers. The program sought to build bridges between the device and systems research community, the university and industrial community and the teaching and research community.

(U) Program Plans:

FY 2007 Accomplishments:

- Employed a broker-supplier user model that has been previously tried for integrated circuits and micro-electro-mechanical systems to implement the program.
- Evaluated the number of device/material transactions implemented between users and suppliers.

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	FY 2007	FY 2008	FY 2009
Quantum Entanglement Science and Technology (QuEST)	3.927	2.600	5.000

(U) The Quantum Entanglement Science and Technology (QuEST) program will explore the research necessary to create new technologies based on quantum information science. Technical challenges include loss of information due to quantum decoherence, limited communication distance due to signal attenuation, protocols, and larger numbers of quantum bits (Qubits) and their entanglement. A key challenge is to integrate improved single and entangled photon and electron sources and detectors into quantum computation and communication networks. Error correction codes, fault tolerant schemes, and longer decoherence times will address the loss of information. Expected impacts include highly secure communications, algorithms for optimization in logistics, highly precise measurements of time and position on the earth and in space, and new image and signal processing methods for target tracking.

(U) Program Plans:

FY 2007 Accomplishments:

- Initiated research in fundamentals of quantum information science, quantum algorithms and applications of small (several qubit) quantum systems.

FY 2008 Plans:

- Continue exploration of fundamental quantum systems.

FY 2009 Plans:

- Develop novel approaches to improving decoherence times.
- Devise full characterization and manipulation of entangled quantum systems.
- Formulate novel quantum algorithms.

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	FY 2007	FY 2008	FY 2009
N/MEMS Science and Focus Centers	9.302	9.432	13.282

(U) The goal of the N/MEMS Science and Focus Centers program is to support the development of an enhanced fundamental understanding of a number of important technical issues critical to the continuing advance of nanoelectromechanical systems (NEMS) and microelectromechanical systems (MEMS) technologies and their transition into military systems. The basic research work to be conducted under the program is responsive to recognized challenges in a comprehensive range of technical areas pertinent to future DoD needs. Industrial cost sharing is an important element of the overall effort.

(U) Program Plans:

FY 2007 Accomplishments:

– Developed a fundamental understanding of the behavior of materials interfaces and associated reliability.

FY 2008 Plans:

– Fabricate non-lithographic MEMS.
– Develop an understanding of fluidics on a nanoscale.

FY 2009 Plans:

– Develop MEMS enabled reconfigurable electronics.
– Develop ultra-high Q (energy ratio) nanoresonators.

	FY 2007	FY 2008	FY 2009
Semiconductor A1GaN Injection Lasers (SAIL)	0.000	1.049	3.168

(U) The objective of the Semiconductor AlGaN Injection Lasers (SAIL) program is to demonstrate lasers with ultraviolet emission in the wavelength range of 340 to 270 nanometers (nm). These lasers will be based on heterostructures of Aluminum Gallium Nitride (AlGaN). Such lasers do not exist at present. Once demonstrated, SAIL devices are expected to have applications in stand-off bio-defense, such as point detection of aerosolized bio-agents.

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(U) Program Plans:

FY 2008 Plans:

- Develop methods for preparing AlGaN with low density of dislocations.
- Demonstrate effective p-type doping in AlGaN with the aluminum nitride (AlN) content of 60%.

FY 2009 Plans:

- Fabricate injection lasers operating in the ultraviolet at 340 nm and 280 nm.
- Demonstrate stable and reliable operation of ultraviolet lasers at room temperature.

	FY 2007	FY 2008	FY 2009
Nanoscaled Architecture for Coherent Hyper-Optic Sources (NACHOS)	0.000	3.525	3.555

(U) The Nanoscaled Architecture for Coherent Hyper-Optic Sources (NACHOS) program will explore scaling rules for semiconductor laser sources. Such rules exist and are well understood in electronics but do not yet exist for photonic devices. Nanoscaled lasers would be useful in a wide range of applications, from close integration with electronics, on chip light sources, to single photon sources. The program idea is based on recent developments in heterostructured semiconductor nanowires (the gain medium), which establish the feasibility of forming lasers with diameters much smaller than the wavelength of light they produce. Simultaneously, advances in plasmonic structures, which support optical frequencies with X-ray like wavelength, make it possible to envision feedback structures (cavities) that are also shorter than the wavelength of light emitted from the cavity. The program goal will thus be to produce nanoscaled lasers with all three dimensions shorter than the wavelength of light. Important issues of beam shaping through antenna-like structures and powering via plasmonic structures will also be considered.

(U) Program Plans:

FY 2008 Plans:

- Develop defect-free nanowire-based heterostructures.
- Grow lithographically defined nanowire heterostructures.
- Use photonic bandgap structures for feedback and coupling of light.

FY 2009 Plans:

- Establish and validate models for nanophotonics.

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	FY 2007	FY 2008	FY 2009
Tip-Based Nanofabrication (TBN)	0.000	0.000	5.000

(U) The Tip-Based Nanofabrication (TBN) program will develop methods for precise, repeatable, manufacturing at the nanoscale, using Atomic Force Microscope (AFM) tips as tools. Confinement of extreme conditions (temperatures, fluxes, fields & forces) to the region within a few microns of the tip will enable heterogeneous integration of normally incompatible materials.

(U) Programs Plans:
FY 2009 Plans:
- Develop a new nanomanufacturing technology based on extreme fields and fluxes available in the region of a nanoprobe tip.
- Build unique nanometer-scale device structures.
- Demonstrate post-complementary metal-oxide-semiconductor (CMOS) local nanofabrication.

	FY 2007	FY 2008	FY 2009
Illinois Institute of Technology	0.000	1.040	0.000

(U) The Illinois Institute of Technology program will explore new approaches to advanced electronics technology.

(U) Program Plans:
FY2008 Plans:
- Initiate development of advanced electronics technologies.

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	FY 2007	FY 2008	FY 2009
Nanocrystal Source Display	0.000	1.200	0.000

(U) The objective of Nanocrystal Source Display program is to develop nanoscale crystals for display applications.

(U) Program Plans:
FY2008 Plans:
- Initiate nanocrystal development.

	FY 2007	FY 2008	FY 2009
Advanced Photonic Composites Research	0.000	3.253	0.000

(U) The objective of Advanced Photonic Composites Research is to develop advanced optical composites for defense applications.

(U) Program Plans:
FY 2008 Plans:
- Transition nano-engineered materials and composites into DoD relevant devices with a specific focus on advancing infrared detectors and energy harvesting structures.
- Develop and commercialize composite technology in integrated optics.

	FY 2007	FY 2008	FY 2009
Nanoscience Nanotechnology Institute	0.000	2.400	0.000

(U) The Nanoscience Nanotechnology Institute will explore new approaches to nanoscience research.

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(U) Program Plans:
FY 2008 Plans:
– Initiate nanoscience research.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Materials Sciences MS-01	31.091	48.832	48.733	47.679	57.603	58.509	61.693

(U) Mission Description:

(U) This project provides the fundamental research that underpins the development of advanced nanoscale and bio-molecular materials, devices and electronics for DoD applications.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Nanoscale/Biomolecular and MetaMaterials	12.029	16.500	17.500

(U) The research in this thrust area exploits advances in nanoscale and bio-molecular materials, including computationally based materials science, in order to develop unique microstructures and material properties. This includes efforts to develop the underlying physics for the behavior of materials whose properties have been engineered at the nanoscale (Metamaterials).

(U) Program Plans:

FY 2007 Accomplishments:

- Developed a cluster expansion method for material properties that achieved 10^6 reduction in the number of calculations.
- Developed an instantiation for quantum monte carlo calculations linear in the number of particles.
- Developed a new method for predicting material properties based upon linear combinations of atomic potentials.
- Demonstrated a laser driven, 1 billion electron volt electron beam.
- Designed composite nano-material structures and demonstrated processing capabilities for achieving improved optical and mechanical properties over existing infrared windows.
- Developed and applied new theory for multiple input multiple array radar systems that lead to 10x improvement in missed target detection while providing 10x reduction in search volume.

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– Demonstrated a new digital coding scheme to simultaneously exploit spatial, temporal, and polarization diversity that led to a 15x improvement in signal/clutter ratio in the Naval Research Laboratory Advanced Multi Function Radar System.

FY 2008 Plans:

– Predict and synthesize new thermoelectric materials with a figure of merit ZT > 5.
– Develop efficient computational methods that correctly predict the properties of excited electronic states.
– Demonstrate laser-initiated production of ultra violet (UV) light via harmonic generation.
– Achieve mid-wave infrared optical transmission comparable to that of spinel with mechanical properties comparable to those of sapphire.
– Demonstrate infrared optical transmission in 75mm disks.

FY 2009 Plans:

– Develop methods to connect theoretical materials to experimental methods to support verification of the predicted properties of the theory.
– Demonstrate interleaved production of electron beam and X-ray or UV light from laser-initiated processes.
– Demonstrate hemispherical and aerodynamic domes with decreased optical scatter, doubled mechanical strength, and doubled thermal shock capabilities over single crystal sapphire.
– Develop the capability to inexpensively mass manufacture large quantities of customized diatom-derived structures and materials to facilitate new and unprecedented designs of microwave components, unique sensors, and revolutionary biomimetic devices such as tissue scaffolding.

	FY 2007	FY 2008	FY 2009
Engineered Bio-Molecular Nano-Devices and Systems	3.112	3.032	10.733

(U) The Engineered Bio-Molecular Nano-Devices and Systems program seeks to develop and demonstrate engineered bio-molecular nano-scale devices that enable real time observation and analysis of bio-molecular signals, thus enabling single molecule sensitivity with the simultaneous exploitation of the temporal domain (i.e., stochastic sensing). Arrays of such devices will enable an order of magnitude (10 to 100X) reduction in the time required for analysis and identification of known and unknown (engineered) molecules. This program will also develop novel nanomaterials for exquisitely precise purification of materials, enabling such diverse applications as oxygen generation and desalination.

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(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated that a sensor element composed of a single protein molecule could be packaged and sustained for greater than one week, an order of magnitude improvement over the previous state-of-the-art.
- Demonstrated new sensor architecture that promises accurate detection of toxic agents while reducing false positive detections due to interferents present in the environment.

FY 2008 Plans:

- Demonstrate detection of nerve agents at established thresholds.
- Demonstrate acceptable false alarm signals in the presence of interferents.
- Begin design and prototyping of a multi-element (5) array of sensor elements.

FY 2009 Plans:

- Develop a 50-element array able to resolve mixtures of more than five components with a probability of detection >99% and false alarm rate of <1/1000.
- Design new nano-level circuit devices and adaptive/structural material systems via a priori topological mathematical computation.
- Develop new materials to replace silicon for ultra-dense and miniaturized electronic devices, and develop liquid state electronics.
- Develop new tunable materials that possess novel transport properties, such as mass and charge separation.

	FY 2007	FY 2008	FY 2009
Atomic Scale Materials and Devices	8.100	13.500	12.500

(U) This thrust examines the fundamental physics of materials at the atomic scale in order to develop new devices and capabilities. A major emphasis of this thrust is to provide the theoretical and experimental underpinnings of a new class of semiconductor electronics based on spin degree of freedom of the electron, in addition to (or in place of) the charge. In addition, this program will examine other novel classes of materials and phenomena such as plasmons or Bose-Einstein Condensates (BEC) that have the potential to provide new capabilities in the quantum regime, for example, GPS-independent navigation via atom interferometry.

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(U) Program Plans:

FY 2007 Accomplishments:

- Developed theory for achieving nonlinear effects and/or gain in plasmonic structures.
- Achieved 40,000 BEC atoms/pulse every five seconds with 1.2 second BEC lifetime, enabling a 10x improvement in measurement rate.
- Completed baseline design of cold-atom optical lattice experiments.

FY 2008 Plans:

- Develop potential applications of plasmonics for on-chip optoelectronic coupling.
- Demonstrate Rubidium atomic clock with line-width below 10 Hz (less than 10% natural line-width).
- Demonstrate high-throughput optical lattice systems for improved simulation time and stable frequency metrology.

FY 2009 Plans:

- Demonstrate, in a military relevant application, the advantage of plasmonics for exploiting the high information carrying capacity of optics with the size advantages of electronics.
- Demonstrate rotationally sensitive interferometer with sensitivity greater than 1 radian per earth rotation rate.
- Emulate 2-D Bose-Hubbard Model phase diagram in under 12 hours that confirms theoretical calculations.

	FY 2007	FY 2008	FY 2009
Surface Enhanced Raman Scattering (SERS) - Science and Technology	0.000	5.000	8.000

(U) The Surface Enhanced Raman Scattering (SERS) – Science and Technology program focuses on the fundamental technical challenges facing potential sensor performance with respect to their sensitivity, selectivity, enhancement factors and development. SERS nanoparticles have considerable potential for both chemical and biochemical sensing applications due to: (1) their potential large spectral enhancement factors, (2) the nature of spectral fingerprints that can be expected to yield low false alarm rates, and (3) the capability for detecting targeted molecules at useful stand-off ranges. This program seeks to identify and overcome the key scientific and technical challenges necessary for replacing existing sensors of chemical and biological warfare (CBW) agents with SERS-based sensing approaches.

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(U) Program Plans:

FY 2008 Plans:

- Develop understanding of nanoparticle shape and its effect on SERS enhancements; examine high quality resonators for SERS applications.

FY 2009 Plans:

- Develop methods to engineer nanoparticles with 1 nanometer feature sizes (separation) on a macroscale.

	FY 2007	FY 2008	FY 2009
Quantum Sensors	3.000	4.800	0.000

(U) The Quantum Sensors program is developing approaches to exploit non-classical effects called entanglement to improve the resolution and range of military sensors. Quantum sensors will retain the generally better propagation characteristics of long wavelength light while achieving the better spatial resolution of short wavelength radiation. Conventional classical sensors rely on light with shorter wavelengths, like blue light, to produce sharp images. As wavelengths increase, for example from blue to infrared, the classical resolution decreases. Quantum sensors will be able to retain high resolution as the wavelength increases using a non-classical effect called entanglement. Two broad classes of sensor are under consideration. Type I quantum sensors propagate entangled photons to a target and back to a detector, where quantum effects may enhance resolution. Type II quantum sensors propagate classical radiation to the target, and entangled photons are used within the detector to improve resolution. A third class of approach, based on ghost imaging, is also being explored. As the program transitions from the theoretical proof stage to the subsystem design stage in FY 2009 it will move to the Electronic Technology PE 0602716E, Project ELT-01.

(U) Program Plans:

FY 2007 Accomplishments:

- Commenced experimental measurements to determine whether non-classical quantum states can be propagated through the atmosphere.
- Developed theoretical paradigm for absorption by one class of entangled photon states.

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FY 2008 Plans:
- Continue studies of Type I, Type II, and ghost imaging sensor concepts to establish whether they are robust to military targets and environments.
- Complete experiments on outdoor propagation of non-classical states.

	FY 2007	FY 2008	FY 2009
Comparative Genomics for National Security Goals	1.650	1.000	0.000

(U) Program Plans:
FY 2007 Accomplishments:
- Verified new approaches for examining prognostic epidemiology using comparative genomics.

FY 2008 Plans:
- Continue to examine prognostic epidemiology using comparative genomics.

	FY 2007	FY 2008	FY 2009
Advanced Materials Research Institute	2.200	4.000	0.000

(U) Program Plans:
FY 2007 Accomplishments:
- This effort focused on the development and demonstration of hybrid sensors for chemical and/or biological agent detection for national security. In particular, sensors made from metal oxide nanoparticles and nanowires were explored.

FY 2008 Plans:
- Investigate use of nanoparticles and nanowires to improve chemical electron mobility and/or magnetic energy storage product relative to bulk materials.

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	FY 2007	FY 2008	FY 2009
Next Generation Protective Gear for Small Arms Threats	1.000	0.000	0.000

(U) Program Plans:
FY 2007 Accomplishments:
– Explored next generation protective gear for small arms threats.

	FY 2007	FY 2008	FY 2009
Alternative Futures at the Range-Complex Level for the Southwest U.S.	0.000	1.000	0.000

(U) Program Plans:
FY 2008 Plans:
– Explore alternative Range-Complex Level Futures in the Southwestern part of the U.S.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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