ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2007

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**

	COST (In Thousands)	FY 2006 Actual	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	49951	48575	39826	41017	41055	41483	42899	44337
140	HI-POWER MICROWAVE TEC	4860	5451	6154	6209	6275	6323	6462	6604
H15	GROUND COMBAT ID TECH	5297	5578	5974	7877	7960	8020	8196	8377
H16	S3I TECHNOLOGY	17030	16413	20607	19498	19209	19361	20291	21231
SA1	Sensors and Electronic Initiatives (CA)	13515	14093						
SA2	BIOTECHNOLOGY APPLIED RESEARCH	3499	3628	5503	5786	5911	6029	6162	6297
SA3	COMBAT IDENTIFICATION COMPONENT TECHNOLOGIES (CA)	5750	2176						
TS1	TACTICAL SPACE RESEARCH		1236	1588	1647	1700	1750	1788	1828

A. Mission Description and Budget Item Justification: The objective of this program is to research and evaluate technologies that will enhance the capabilities of the Future Force and, where feasible, exploit opportunities to enhance Current Force capabilities. Focus is on providing sensor, signal, and information processing technology for advanced reconnaissance, surveillance, and target acquisition (RSTA); ground-to-ground and air-to-ground combat identification (ID), fire control systems, fuzing, and guidance-integrated fuzing functions in future munitions; significantly improving the survivability, lethality, deployability, and sustainability of future tactical vehicles/platforms by devising high-power electronic components and technologies for compact, light-weight power and energy storage, power and energy conversion, and conditioning and radio frequency (RF)/microwave directed energy (DE) weapons. Project 140 funds research, development, and evaluation of RF weapon technology, high energy laser technology, and high power components. Project H15 funds research that will provide the ability for joint fires to locate, identify, track, and engage targets as necessary with the overall goal of increasing lethality and survivability through the reduction of fratricide. Project H16 funds studies that will provide the Soldier with decisive new capabilities to locate, identify, and engage battlefield targets in tactical and urban environments. In project SA2, the Army Research Laboratory in collaboration with the Institute for Collaborative Biotechnology (ICB) a University Affiliated Research Center (UARC) led by the University of California, Santa Barbara in partnership with California Institute of Technology and Massachusetts Institute of Technology and their industry partners conducts applied research focused on biological sensors and biological photovoltaic power generation. Work in SA2 will exploit breakthroughs in biotechnology basic research transitioning from the ICB to enable Future Force capabilities in sensors, electronics, and photonics. Projects SA1 and SA3 fund congressional special interest items. Project TS1 is a new project that funds research, development, and evaluation of space-based remote sensing, signal, and information processing technology in collaboration with other Department of Defense (DoD) and government agencies to support space force enhancement and space superiority advanced technology integration into Army battlefield operating systems.

Work in this program element (PE) is related to and fully coordinated with efforts in PE 0602307 (Advanced Weapons Technology), PE 0602705 (Electronics and Electronic Devices), PE 0602709 (Night Vision Technology), PE 0602782 (Command, Control, Communications Technology), PE 0603772 (Advanced Tactical Computer Science and Sensor Technology), PE 0603006 (Command, Control, Communications Advanced Technology), and PE 0603008 (Command Electronic Warfare Advanced Technology). The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed by the Army Research Laboratory and the Communications-Electronics Research, Development, and Engineering Center, Ft. Monmouth,

NJ, and US Army Space and Missile Defense Technical Center, Huntsville, AL.

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B. Program Change Summary	FY 2006	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2007)	51327	38428	39295	40792
Current BES/President's Budget (FY 2008/2009)	49951	48575	39826	41017
Total Adjustments	-1376	10147	531	225
Congressional Program Reductions		-5945		
Congressional Rescissions				
Congressional Increases		16450		
Reprogrammings	-1376	-358		
SBIR/STTR Transfer				
Adjustments to Budget Years			531	225

Eleven FY07 congressional adds totaling $15767 (after adjustment for Undistributed Congressional Reductions) were added to this PE.

($1055) Advanced Detection of Explosives (ACE) Program
($1870) Prometheus Spectrometer Sys & Thazer Free Elec Las
($1869) Center for Advanced Microelectronics Manufacturing
($1294) High Brightness Diode Source (HiBriDS)
($1438) Lighter-than-air Unmanned Veh w/Scalable payload
($1869) ONYX OPTICS - Adv Bonded Diamond for Optical Apps
($958) Roll-to-Roll (R2R) Microelectronics in Spt of FDI
($958) Single Crystal Chem Vapor Dep Diamond Lens Element
($1390) Vertical/Horizontal Integ of Space Tech & Apps
($958) Wearable Video Capture System
($2108) Network Enabled Combat Identification

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**140**

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
140 HI-POWER MICROWAVE TEC	4860	5451	6154	6209	6275	6323	6462	6604

A. Mission Description and Budget Item Justification: This project funds research and evaluation of traditional and non-traditional Radio Frequency (RF) and laser electronic attack. This includes traditional jammers, RF Directed Energy Weapon (DEW) technology as well as the high power components that will significantly enhance the survivability and lethality of Army platforms and related systems. The DEW effort studies both RF microwave and laser system capabilities and effects against various threats such as off- and on-route mines and electronically guided and fuzed missiles/munitions. Realizing DEW capabilities for diverse targets at a variety of lethality levels and operational ranges requires optimizing the DEW system including devising compact, high density power systems meeting stringent weight and volume restrictions. System optimization relies on determining the most effective DEW parameters and system components needed to defeat classes of selected targets; i.e., determining the desired DE effects drives the DEW component and system design, including power. Required power system components include power generation and storage, high-temperature/high power devices, power converters, and power conditioning. The ongoing DE effects and power component work is coordinated with and, as appropriate, leveraged by DEW and power/energy programs in the Air Force, Navy, High Energy Laser Joint Technology Office, Defense Threat Reduction Agency, national labs, university consortia, and relevant industry and foreign partners. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work on this project is performed by the Army Research Laboratory in coordination with the US Army Research, Development, and Engineering Command's Tank and Automotive Research, Development, and Engineering Center (TARDEC), the Armaments Research, Development, and Engineering Center, the Aviation and Missile Research, Development, and Engineering Center (AMRDEC) and the Communications and Electronics Research, Development, and Engineering Center (CERDEC).

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Research and evaluate materials and component structures that provide the higher energy density required by next generation Army systems such as electromagnetic armor, hybrid-vehicle propulsion electronics, directed energy sources, pulse power for Future Force systems, small unattended ground sensors, and Soldier systems. In FY06, investigated and matured silicon carbide (SiC) power modules for greater than (>) 20 kilowatt (kW) level power conversion at high temperature (90-150 degrees Celsius) for motor control, vehicle power bus, vehicle survivability, and lethality systems. Measured efficiency of SiC devices in converting beta and gamma energy into direct electrical current as power source for small unattended sensors. Modeled the generation and collection of the electron showers generated in SiC from radiation. Investigated path to more efficient Stirling engine through reduction of mass of individual engine components. Devised materials for higher energy primary and rechargeable power sources for the soldier. In FY07, mature high temperature SiC power modules for power conversion levels >100 kW. Design and build an isotope battery based on isotope material figures-of-merit, and SiC-conversion efficiencies. Measure efficiency of novel Stirling engine. In FY08, will mature development of high-temperature SiC power modules for operation at high temperature for power conversion levels >200 kW. Will investigate use of gallium-nitride (GaN) and diamond materials for use as direct energy converter in extended life batteries for unattended sensor and prognostics and diagnostics. Will model Stirling engine characteristics and optimize parameters for battery charging loads determined by CERDEC. Will investigate carbon-monoflourides alloys as anodes and continue work on high energy cathodes for Li-Air batteries. In FY09, will evaluate SiC power modules for operation at high temperature for power conversion levels >350 kW.	1313	1354	2416	2232

Research and mature novel solid-state laser concepts, architectures, and design components enabling High Energy Laser (HEL) technology for Army specific DEW applications. Exploit breakthroughs in laser technology and photonics basic research to meet the stringent weight/volume requirements for Future Force platforms. In FY06, investigated the most promising ceramic laser materials (Yb:Y2O3 and Yb:Sc2O3) for efficiency at room and cryogenic temperatures while fostering on-shore material development. Researched, designed, and fabricated efficient high-power laser based on highly concentrated neodymium-doped yttrium aluminum garnet (Nd:YAG) ceramics. Investigated diamond cooling technologies for advanced thermal management and beam quality improvement and transitioned these technologies to SiC for use as an optical heat sinking material. In FY07, investigate and evaluate the efficiency of the ultra-low quantum defect, high power "eye-safe" fiber laser (~1600 nm) with direct diode pumping by long-wavelength (InP) laser diodes (or surrogate narrowband fiber laser); conduct feasibility study of Tellurium Oxide (TeO2) as phase conjugate wavefront-correcting mirror for high power applications. In FY08, will evaluate composite ceramic laser materials to increase laser power; will evaluate volume Bragg grating based, spectral narrowing of diode pumps for high brightness pumping schemes. Will complete feasibility study of TeO2 for high power applications. In FY09, will implement a new approach to the thin disk laser architecture based on edge pumping of a composite doped-undoped gain element. Applied research will be conducted by ARL in close collaboration with domestic ceramic (and other) material vendors, university researchers, and major laser diode manufacturers.	1473	1798	2412	2449
Investigate, research, and evaluate technologies related to DEW technology, electronic warfare (EW) survivability/lethality, and supporting high power components to enhance the survivability/lethality of Army platforms. In FY06, collected, analyzed, and summarized RF effects susceptibility data on Radio Controlled (RC) threats and non RC controlled devices of interest to CERDEC. Designed and built threat neutralization system breadboard for robotic platform. Researched back-door, out-of-band coupling of RF energy into network components. In FY07, investigate integration of threat neutralization breadboard on countermine platforms and conduct lab/field experiment to show effectiveness. Investigate RF effects levels on threat mines of interest to CERDEC. Determine feasibility of RF DE countermine systems by identifying power/energy requirements. Design and if possible, build counter smart mine concept to show proof of principle and transition to CERDEC/PM Close Combat Systems. Investigate susceptibility profiles of network components to assess vulnerability of Future Force network. In FY08, will measure the RF susceptibility levels of threat sensors/communications of interest to CERDEC. Will use data to identify system design requirements for counter electronic system. Will build models to help predict the effective range of counter electronic system. Will investigate susceptibility profiles of wireless network components. In FY09, will design experimental counter electronic system and will conduct lab and/or field test to evaluate the capability. Will investigate feasibility of using RF DE to electronically attack air threats of interest to Air Defense Artillery Center and AMRDEC for Enhanced Area Air Defense. Will identify and acquire critical components of Unmanned Aerial Vehicles and evaluate failure levels. Will transition data and system design to AMRDEC for further evaluation. Will investigate susceptibility profiles for two Future Force systems.	2074	2218	1326	1528
Small Business Innovative Research/Small Business Technology Transfer Programs		81		
Total	4860	5451	6154	6209

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**H15**

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H15 GROUND COMBAT ID TECH	5297	5578	5974	7877	7960	8020	8196	8377

A. Mission Description and Budget Item Justification: This project researches and investigates emergent combat identification (CID) technologies for joint, allied, and coalition air-to-ground and ground-to-ground mounted, dismounted, forward observer, and forward air controller missions for the Future Force and, where feasible, exploit opportunities to enhance Current Force capabilities. Efforts research enabling technologies to demonstrate a common battlespace picture for joint coalition situation awareness, reduction of weight and cost of previously developed CID systems, and evaluation of multiband radio frequency (RF) tags as a CID enabler. This project researches embedded radio algorithm developments as well as Soldier RF Tag hardware for multiband and aerial platform interoperability. This project increases the survivability and lethality of Coalition Forces by providing fusion of battlefield sensor and situational awareness data to identify friend from foe, thereby, reducing fratricide incidents across the battlefield. Additionally, this program investigates cost-effective sensors for use in threat warning systems for enhanced battlefield situation awareness and target cueing for Army ground combat vehicles. Coordination will be accomplished with other services, allies, and coalition partners. MANPRINT will be addressed in all activities. Efforts in this program element (PE) are coordinated with PE 0603270 (EW Technology), PE 0602270 (EW Techniques), PE 0603772 (Advanced Tactical Computer Science and Sensor Technology), PE 0602783 (Computer and Software Technology), and PE 0602784 (Advanced Concepts and Simulation).

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed by the Communications-Electronics Research, Development, and Engineering Center, Fort Monmouth, NJ.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Combat Identification (CID) Technologies: This effort develops and evaluates potentially cost effective CID approaches that reduce fratricide, increase situational awareness (SA), and increase combat effectiveness of Soldier based and Brigade Combat Team (BCT) CID technologies. In FY06, identified the best approach for implementing triangulation techniques based on Global Position System (GPS) and signal time of arrival to identify the location of battlefield entities called Geometric Pairing (GP), RF Tag/Interrogator CID functionality, and crypto functions into application specific integrated circuits (ASICs). In FY07, design GP and RF Tag hardware for the ground Soldier to demonstrate dismounted integration concepts and technical performance characteristics; conduct first technical evaluation of GP situation awareness and RF Tag concepts. In FY08, will conduct final technical testing of representative models of GP and RF Tag technologies in a high fidelity lab environment and final technical testing of millimeter Wave (mmW) ID ASICs in a high fidelity lab facility; will complete regression tests of mmW ID ASICs to validate compliance with STANAG (NATO Standardization Agreement) 4579; will conduct virtual experiments with hardware in the loop for BCT ground-to-ground technologies. In FY09, will initiate study of integrated approach for net centric architecture for CID; will investigate embedding CID waveforms into FCS and JTRS; will investigate and explore promising technologies for providing foe and neutral identification; will initiate study of potential CID for dismounted Soldier mission area; will investigate tools for determining cost effectiveness of CID capabilities and coordinate with services, allies, and coalition partners for their participation. Related work is also accomplished under PE/Project 63270/K16.	1335	1592	1887	7877
Cueing Sensor: This effort develops low cost infrared sensors that detect rocket propelled grenades, anti-tank guided missiles, and tank fired kinetic energy and high energy anti-tank rounds and then cue active protection system for Army vehicles. In FY06, investigated	2140	2847	2900	

algorithms for on-the-move frame registration, clutter suppression, and specific threat classification for active protection threat cueing sensor; developed focal plane arrays (FPA) with required array uniformity, operability, sensitivity in the desired spectral bands. In FY07, develop cueing sensor algorithms and processing; perform live-fire test of prototype sensors and systems. In FY08, will optimize FPA design; enhance sensor, electronics, and algorithms for on-the-move environment. Related work is also accomplished under PE/Project: 62270/442; 63270/K15; 63772/243.				
Fusion Based Technologies: This effort develops an advanced knowledge generation capability to provide actionable intelligence enabling timely decision-making by commanders and timely action by Soldiers in the execution of operations. In FY06, investigated and evaluated fusion architectures, algorithms, representations, and data mining capabilities; initiated software generation in situation development; evaluated fusion capabilities by expanding to a moderate-sized set of reports (structured, semi-structured, and unstructured situational input); demonstrated 3000 reports/hr processed (scenario-specific performance, and sophisticated spatial/temporal reasoning); demonstrated data retrieval integrated with search engine. In FY07, demonstrate capabilities in identification and tracking of force aggregates in information noisy scenarios with realistic terrain characteristics and demonstrate initial capabilities for inferring enemy objectives/intent in conventional and asymmetric scenarios. In FY08, will develop expanded set of representations for different types of enemy tactics to handle more complex scenarios including the prediction of locations of specific types of asymmetric attacks using real data.	1822	1007	1187	
Small Business Innovative Research/Small Business Technology Transfer Programs		132		
Total	5297	5578	5974	7877

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**H16**

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H16 S3I TECHNOLOGY	17030	16413	20607	19498	19209	19361	20291	21231

A. Mission Description and Budget Item Justification: The objective of this project is to provide the future Soldier with decisive new capabilities to locate, identify, and engage battlefield targets in tactical and urban environments. This project is focused on applied research of advanced sensors, signal processing, and information technologies to enable these capabilities for the Future Force and other emerging thrusts. The ultimate impact and utility of this work will be to protect Soldiers and to greatly increase their lethality and range and speed of engagement. Emphasis is on solving critical Army-specific battlefield sensing and information management problems such as false targets, complex terrain (including urban applications), movement of sensors on military vehicles, etc. Cost reduction is a key focus. Significant areas of research include: low cost sensors designed to be employed in large numbers as unattended ground sensors (UGS) for force protection, homeland defense, minefield replacements, counter terrorism operations, and munitions; Tagging, Tracking, and Locating (TTL) of non-traditional targets; fusion of diverse sensors such as acoustic, seismic, magnetic including the Micro Electro Mechanical System (MEMS) magnetic flux concentrator, radar, infrared (IR), Forward Looking IR (FLIR), Laser Detection and Ranging (LADAR), visible imagers, etc.; low cost acoustic, seismic, and magnetic sensors that can passively detect and track battlefield targets such as tanks, helicopters, etc., and locate gun fire; sensor technologies for the detection and tracking of humans, especially in urban terrain; high performance multi-function radio frequency (RF) systems that allow target acquisition, combat identification (ID), active protection, surveillance, and communications systems consolidated into a single system, reducing system cost, and size; passive and active RF sensors capable of high-resolution imaging to detect targets hidden in foliage, smoke, and fog; ultra wideband radar work enabling buried mine detection and target imaging through dense foliage and greatly enhanced robotic mobility; aided/automatic target recognition (ATR) allowing sensors to autonomously locate and identify targets; Opto-Electronic (OE) interconnects and processors are being built to greatly speed the movement of information within and between electronic digital processing units to facilitate smart sensors, adaptive sensors, and sensor fusion; advanced battlefield sensor and information processing to conduct a dynamic and real time situational assessment to present a common picture of the battlespace focused on low echelon commanders; advanced information processing methods to provide automatic information technologies that utilize widely dispersed sensor and legacy information sources; sensor and eye protection against laser threats, and algorithms for acoustic sensors mounted on a Soldier's helmet to localize source of gunfire. Work is coordinated with outside organizations, particularly the Night Vision Electronic Sensors Directorate, other Research and Development Engineering Centers (RDECs), and the Defense Advanced Research Projects Agency (DARPA). This work is related to and fully coordinated with efforts funded in PE 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603001A (Warfighter Advanced Technology). The cited work is consistent with the Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work in this area is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Mature technologies for low-cost UGS to enhance persistent Army sensing capabilities. Research focus is based on opportunities and feedback from UGS used in OIF. A key focus is on detecting people. Investigate fusion algorithms using multi-modal sensing phenomenology including acoustic, seismic, magnetic, electric field (E-field), passive IR, and RF to increase probability of target detection and reduce false alarms. In FY06, evaluated multi-modal database and fusion algorithms using RF, magnetic, E-field, seismic, and acoustic sensor technologies required for human infrastructure detection. Investigated new force protection concepts using visible and IR imagery, adaptive classification, hyperspectral (HS), and change detection algorithms. Investigated the fusion of multi-band IR sensors for target detection. In FY07, devise and mature algorithms for low cost persistent sensing and change detection. Design biomimetic	4080	3330	3816	4696

acoustic sensing systems for a helmet mounting; evaluate low cost, high sensitivity magnetic sensor, and evaluate E-field sensor suitability for low cost UGS. Design and evaluate fusion algorithms for multi-band IR sensor target detection, integrate advanced multi-target tracking techniques for imagery to enhance force protection and adapt ATR methods for multimodal fusion. In FY08, will prepare 1st generation multi-modal algorithms for fielding in Army UGS systems; will evaluate use of HS technology, including band selection techniques for target detection; will create image enhancement algorithm toolbox to enable feasibility studies; will optimize and transition the high sensitivity magnetic sensor and extend advanced infrasonic algorithms to extract a larger class of transient events. In FY09, will evaluate the combination of advanced imaging sensor types for ATR such as polarimetric FLIR with LADAR; will extend autonomous acoustic sensing and processing algorithms to new platforms; will investigate use of magnetic and E-field sensors on vehicles.				
Investigate and mature hyper-modal sensor data fusion for detecting and classifying human infrastructure in urban operations such as machinery, RF emissions, chemicals, and computers in hidden and confined spaces such as tunnels, caves, sewers, and buildings. In FY06, investigated and evaluated hyper-modal sensor data fusion on a mobile platform for detecting and classifying human infrastructure presences such as machinery, RF emissions, chemicals, and computers in hidden and confined spaces such as tunnels, caves, sewers, and buildings. Actions included collection of hyper-modal co-registered sensor data and signatures in relevant environments, design of robust hyper-modal sensor fusion algorithms, and development of fusion algorithm criteria. In FY07, design detection algorithms and begin sensor fusion algorithm maturation for imagery. Evaluate a correlation matrix to establish relationships between sensor detection capabilities and relevant target signatures. Collect additional multimodal data. In FY08, will experimentally validate an integrated hyper-modal sensor testbed tailored for urban operations; will devise node-based algorithms for detecting human infrastructure and presence in hidden/confined spaces and will establish a database of co-registered, hyper-modal relevant signatures and features that are detectable with available sensor technologies. In FY09, will investigate the application of sensor fusion algorithms and sensor networks to new Army applications, such as force protection and homeland security applications.	3600	3510	3700	2072
Conduct applied research that will result in technology advances for clandestine TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are classified and in accordance with the Hostile Forces TTL Capabilities Development Document (HFTTL CDD) and the TTL Science and Technology Roadmap. This effort will directly support CERDEC's advanced research in clandestine TTL and will in turn be supported by basic research in TTL. In FY08 technologies to be researched and matured will be extremely wide ranging and may include but are not limited to microtechnology, Micro Electro Mechanical System (MEMS), nanotechnology, low-power chip based radar, birefringent taggants, LADAR, hyperspectral imaging, polarimetric imaging, biomimetics, and carbon nanotubes. Technologies that have the potential to be transitioned into advanced research of clandestine TTL will be identified and research to mature these areas will be conducted. In FY09 technologies selected for further exploration will begin to be matured. Multi-functional multi-device and algorithm implementations will be explored. Technologies that are of sufficient technology readiness will transition to advanced research.			1189	1397
Research, mature, and validate electro-optical techniques and components to protect sensors and eyes from threat laser sources on the battlefield; target redesign of optical devices and explore new nonlinear optical materials for protection. In FY06, investigated and evaluated magneto-optical and electro-optical switches for fast shuttering of optical systems. In FY07, design and evaluate multi-element magneto-optical switches and characterize response time. In FY08, will investigate large-area fast electro-optic shutter devices and evaluate nonlinear optical tandem limiters. In FY09, will evaluate demonstrator protection devices across the visible spectrum.	2338	2478	3078	2652
Mature technical underpinnings of ultra wideband (UWB) radar for several key Army concealed target detection technology requirements including landmine detection, through-the-wall sensing, and obstacle detection. Validate advanced computational electromagnetic algorithms and estimate performance of proposed radar systems as well as predict target signatures. Characterize target and clutter scattering behavior in support of advanced image formation and detection algorithm development. Transfer predictions and algorithms to	2989	2979	3809	3807

landmine detection, through-the-wall sensing, and robotic perception programs. In FY06, completed fabrication and evaluation of an advanced affordable (under $25K/unit) UWB radar in support of unmanned ground vehicle (UGV) perception requirements. In FY07, mature advanced through-the-wall imaging capabilities consistent with a randomized, distributed array implementation concept. In FY08, will examine techniques to combine radar data with other advanced perception sensors to improve obstacle detection on autonomous navigation systems. In FY09, will devise radar concepts and supporting algorithms to enable Army ground vehicles to survey the forward looking hemisphere for concealed targets including hidden personnel and large arms caches in buildings and various mine deployments.				
Mature Multi Function Radio Frequency System (MFRFS) for use on small ground and air vehicles and future Soldier technologies. Mature understanding of phenomenology for an integrated RF sensor that performs radio, radar, and control functions to allow communications, combat ID, target acquisition/track, active protection, and munition command guidance. Mature Aluminum-Gallium-Nitride based semiconductor Ultra Violet (UV) optoelectronics for covert line-of-sight and non-line-of-sight communications and for photoluminescent detection of bio-threats. In FY06, implemented and evaluated four channel MFRFS receiver design; evaluated close in active protection radar; and designed RF imaging and collision avoidance radar for robotic perception. Investigated long range detection and tracking waveform for kinetic energy projectiles. Transitioned UV emitters to the Edgewood Chemical and Biological Center with enhanced efficiency into Army bio-sensor R&D programs. In FY07, establish MFRFS radar model for use in analyzing the radar limitations in adverse environments and evaluate RF imaging and collision avoidance radar for robotic perception. Explore high-brightness active regions for LEDs and lasers operating at wavelengths below 300 nm for UV covert communications and bio-agent detection. In FY08 will evaluate communication functionality with MFRFS demonstration array and will investigate methods for increasing communication rates achievable with MFRFS hardware and explore integrated receiver/exciter design and develop methods for increasing frequency flexibility. Will investigate UV laser development in the 280 nm to 340 nm range. In FY09, will evaluate methods for detecting stationary dismounts using biometric signatures and develop waveforms and algorithms for implementing these techniques in MFRFS. Will investigate feasibility of solar-blind 280 nm avalanche photodiode.	1523	1553	2339	2270
Improve the lower echelon commander's (i.e. platoon) situational understanding in complex/urban terrain by maturing infrastructure and validating algorithms, filters and agent technologies to reduce cognitive load by fusing information. In FY06, improved asset discovery and control software framework and fusion algorithms that correlate/fuse the local picture from a suite of unattended ground sensors and highly mobile manned and semi-autonomous sensor nodes within an ad hoc networking environment. Software components will be transitioned to CERDEC for end-user evaluation within the Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance On-the-Move (C4ISR-OTM) experiment. In FY07, explore robotic asset management and control technologies in order to enable semi-autonomous assets with the ability to provide persistent surveillance. In FY08, will define robotic asset control technologies and investigate bio-inspired asset behavior algorithm as software components within a stimulation environment. Using an existing virtual stimulation environment, will define scenarios for evaluating algorithms prior to lab experimentation. In FY09, will conduct lab experiments in order establish a baseline for evaluating the effectiveness of bio-inspired asset management for providing persistent surveillance for detecting and monitoring activity within a limited activity dynamic urban scene. From this baseline, will devise and mature algorithms to scale to more complex scenes.	2500	2500	2676	2604
Small Business Innovative Research/Small Business Technology Transfer Programs		63		
Total	17030	16413	20607	19498

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**SA2**

COST (In Thousands)		FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
SA2	BIOTECHNOLOGY APPLIED RESEARCH	3499	3628	5503	5786	5911	6029	6162	6297

A. Mission Description and Budget Item Justification: The objective of this project is to transition maturing biotechnology research from the Army's Institute for Collaborative Biotechnologies (ICB), a University Affiliated Research Center (UARC). The ICB is led by the University of California, Santa Barbara (Santa Barbara, CA) in partnership with the California Institute of Technology (Pasadena, CA) and the Massachusetts Institute of Technology (Cambridge, MA). The ICB is focused on advancing the survivability of both the Soldier and weapons systems through fundamental breakthroughs in the area of biotechnology. This project will conduct applied research that transitions breakthroughs in biotechnology basic research from the ICB to enable revolutionary Future Force capabilities in sensors, electronics, photonics, and network science. Areas of applied research include bio-array sensors, biological, and bio-inspired power generation and storage, biomimetics, proteomics, genomics, network science, DNA research and development, control of protein, and gene expression. Efforts include designing and performing multi-scale dynamic and predictive modeling to understand biologically-inspired "sense and respond" systems (integrated system of sensor, information processing, and response mechanism) and their components. The Army Research Laboratory (ARL) and other Army laboratories, including the Natick Soldier Center (NSC) and Edgewood Chemical Biological Center (ECBC), in collaboration with the ICB industry partners will conduct applied research focused on biological sensors, biological, and bio-inspired materials, and biological and bio-inspired power generation and storage. This applied research effort will ensure that the basic science developed at the ICB is directed towards and transitioned to Army devices and systems. The in-house research program (~20%) will link the ICB research to Army requirements and enhance the transition of this technology into the Army. Most of the funding (~80%) is focused on competitively awarded joint projects led by an ICB Industrial partner in collaboration with an Army laboratory and an ICB faculty member to transition ICB research into the Army and industry. The projects are programmed for three years each and are reviewed annually. Projects are intended to cover the entire breadth of the ICB 6.1 program. The process of transformation requires revolutionary advances in performance of Army weapons systems, including improvements in engineered systems impacting Soldier survivability. The ICB will conduct unclassified basic scientific research in: sensors, electronics, information processing and the technical fundamentals enabling development of advanced capabilities in these application areas. The Army seeks to provide the interdisciplinary fundamental knowledge and technical capabilities to manipulate biological systems and components, and to exploit biologically derived products and processes for both the Soldier and engineered systems and platforms. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work in this project is performed by the Army Research Laboratory (ARL) in coordination with the Edgewood Chemical Biological Center (ECBC), Natick Soldier Center (NSC), and other Army laboratories.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Institute for Collaborative Biotechnologies: In FY06, investigated the use of the biologically-based and inspired sensors and materials to design and fabricate "sense and respond" system components; devised and experimentally validated a laboratory scale biological sensor, which will be more selective, compact, and provide a significantly reduced logistical burden. Evaluated and optimized microbes for use in microbial fuel cells. In FY07, identify biologically-based and inspired sensors and materials to design and fabricate "sense and respond" system components, investigate biologically-inspired control, and networking capability for these systems; evaluate the biological sensors in a relevant environment and transition to ECBC and/or NSC. Initiate fabrication of microbial fuel cells and optimize power output for low power sensor applications. Establish baseline methodologies for comparisons of novel molecular recognition elements (MREs) devised using rapid micro-fluidic screening and currently used antibodies. In FY08, will design biologically-based and inspired sensors and materials for "sense and respond" systems components and determine the feasibility of biologically inspired control and network	3499	3535	5503	5786

systems for these devices, investigate high-throughput screening of microbe, and fuel candidates for microbial fuel cells, waste reclamation, and bioremediation. Optimize and perform side-by-side comparison evaluation of novel MREs and standard antibody using baseline methodologies. In FY09, will optimize the design of biologically-based and inspired sensors and materials for "sense and respond" systems components and investigate incorporation of biologically-inspired control systems and networks in the "sense and respond" architecture, investigate bioelectronic properties of biologically-derived conductive nano-fibers. Establish supporting infrastructure to select MREs using novel micro-fluidic system in coordination with ECBC transition partners.				
Small Business Innovative Research/Small Business Technology Transfer Programs		93		
Total	3499	3628	5503	5786

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602120A - Sensors and Electronic Survivability**	**TS1**

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
TS1 TACTICAL SPACE RESEARCH		1236	1588	1647	1700	1750	1788	1828

A. Mission Description and Budget Item Justification: The objective of this new project is to research and evaluate space-based technologies that will enhance ground capabilities of the Future Force and where feasible, exploit opportunities to enhance the Current Force capabilities. Focus is on space-based remote sensor, signal, and information processing technology for space-to-ground applications for advanced intelligence, surveillance, and reconnaissance (ISR), battle command, control, and communications, target acquisition, position/navigation, threat warning, and space superiority technology for force protection. The space-based applied research leverages other DoD space science and technology to support space force enhancement cooperative satellite payload development for advanced technology integration into battlefield operating systems. This includes applied research in persistent intelligence, surveillance, and reconnaissance and dedicated communications for in theater high altitude long loiter and operationally responsive space payload applications. In addition, this project includes research and evaluation of ground-to-space superiority technologies against remote sensor and communications capabilities and space object identification and characterization. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work in this project is performed by the Space and Missile Defense Technical Center in Huntsville, AL.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
In FY07, will conduct research to leverage other DoD space science and technology, including high altitude long loiter, operationally responsive, space and small tactical satellite payload technologies for battlefield communication, and ISR applications. In FY08, will exploit tactical satellite and high altitude long loiter platform technologies that accommodate operationally responsive wideband communications and wide area surveillance for improved sensor, signal, and data processing payload capabilities. In FY 09, will continue research and evaluation of payload/platform technologies to provide a technology baseline for Army advanced space technology applications and/or other DoD space technology cooperative payload development.		1201	1588	1647
Small Business Innovative Research / Small Business Technology Transfer Programs		35		
Total		1236	1588	1647