Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*					R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	42.189	45.260	43.170	-	43.170	47.802	57.460	52.969	54.285	Continuing	Continuing
H15: *Ground Combat Id Tech*	-	2.033	2.181	2.328	-	2.328	2.330	4.384	4.456	4.536	Continuing	Continuing
H16: *S3I Technology*	-	19.699	20.726	20.808	-	20.808	21.198	21.382	21.370	21.755	Continuing	Continuing
SA2: *Biotechnology Applied Research*	-	5.321	4.852	4.037	-	4.037	4.059	4.491	3.372	3.795	Continuing	Continuing
TS1: *Tactical Space Research*	-	3.606	4.303	5.306	-	5.306	6.278	6.950	7.052	7.179	Continuing	Continuing
TS2: *Robotics Technology*	-	11.530	13.198	10.691	-	10.691	13.937	20.253	16.719	17.020	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

FY14 - Funding realigned to higher priority efforts

A. Mission Description and Budget Item Justification

This program element (PE) investigates designs and evaluates sensors and electronic components and software that enhance situational awareness, survivability, lethality, and autonomous mobility for tactical ground forces. Project H15 focuses on Combat Identification (CID) technologies, which include devices to locate, identify, track, and engage targets in the Joint fires environment. Project H16 investigates sensors, signal processing and information fusion technologies to increase target detection range and speed of engagement. Project SA2 conducts applied research on biological sensors and biologically derived electronics that exploits breakthroughs in biotechnology basic research 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. Project TS1 researches and evaluates space-based remote sensing, signal, and information processing software 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. Project TS2 focuses on advancing perception for autonomous ground mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and unique mobility for unmanned vehicles.

Work in this program element (PE) complements and is fully coordinated with efforts in PE 0602307A (Advanced Weapons Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603006A (Command, Control, Communications Advanced Technology), PE 0603008A (Command Electronic Warfare Advanced Technology),
PE 0603710A (Night Vision Advanced Technologies), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology),

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army	DATE: April 2013
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The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy

Work is performed by the Army Research Laboratory, Adelphi, MD and Aberdeen Proving Ground, MD; the Communications-Electronics Research, Development, and Engineering Center, Aberdeen Proving Ground, MD; and the US Army Space and Missile Defense Technical Center, Huntsville, AL.

B. Program Change Summary ($ in Millions)	FY 2012	FY 2013	FY 2014 Base	FY 2014 OCO	FY 2014 Total
Previous President's Budget	43.453	45.260	50.877	-	50.877
Current President's Budget	42.189	45.260	43.170	-	43.170
Total Adjustments	-1.264	0.000	-7.707	-	-7.707
• Congressional General Reductions	-0.068	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.823	-			
• Adjustments to Budget Years	-	-	-7.707	-	-7.707
• Other Adjustments 1	-0.373	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT H15: *Ground Combat Id Tech*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H15: *Ground Combat Id Tech*	-	2.033	2.181	2.328	-	2.328	2.330	4.384	4.456	4.536	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project conducts applied research and investigates emergent techniques, devices and software for combat identification (CID) of Joint, allied, and coalition forces, including air-to-ground and ground-to-ground for mounted, dismounted, forward observer, and forward air controller missions. Efforts include research to enable a common battlespace picture for Joint and coalition situation awareness and fusion efforts to increase the survivability and lethality of coalition forces by fusing battlefield sensor and situational awareness data to identify friend from foe.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier and Ground portfolios. Efforts in this project are complimentary of PE 0602270A (EW Techniques), PE 0603270A (EW Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work is performed by the Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Combat Identification (CID) Technologies	2.033	2.181	2.328
Description: This effort evaluates and enhances CID modeling and simulation tools, concepts, and algorithms to improve anti-fratricide and combatant/non-combatant identification capabilities. Soldier-to-Soldier CID algorithms that interoperate with non-traditional CID sensors (air and ground) are developed to increase situational awareness (SA), feed the common operating picture, and increase the combat effectiveness of Soldier and Brigade Combat Teams (BCTs). Work being accomplished under PE 0603270A/project K16 complements this effort.			
FY 2012 Accomplishments: Improved algorithms to deconflict, fuse and correlate warning receiver and blue force emitter data with DCGS-A, provided intelligence, surveillance and reconnaissance, based on initial user jury results; Investigated data transport requirements needed to support the generation of an enterprise-wide ground and air common operating picture that provides accurate and timely reporting of high value targets for enterprise-wide as well as organic platform SA for increased CID awareness.			
FY 2013 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT H15: *Ground Combat Id Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Evaluate tactical and emerging commercial communications, wireless personal area networks and position location information beaconing through modeling and simulation to assess their potential as components of a Soldier-to-Soldier CID capability; evaluate capacity of existing mobile/handheld platforms to perform CID display and training; investigate signature data from multiple sensor types (infrared, RF and other) to support non-cooperative CID technology development. ***FY 2014 Plans:*** Will design and integrate tactical and commercial communications, wireless personal area networks and position location beaconing for a Soldier-to-Soldier CID capability utilizing equipment that is already employed by Soldiers; design CID display and training tools to be implemented on existing mobile and handheld platforms being targeted by applicable programs of record.			
Accomplishments/Planned Programs Subtotals	2.033	2.181	2.328

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT H16: *S3I Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H16: *S3I Technology*	-	19.699	20.726	20.808	-	20.808	21.198	21.382	21.370	21.755	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project designs, investigates and evaluates advanced sensor components, signal processing, and information fusion algorithms that will provide the future Soldier decisive new capabilities to locate, identify, decide and engage battlefield targets in tactical environments. The ultimate impact and utility of this work will be to greatly increase the lethality, range, and speed of engagement of the Soldier. 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, and exploitation of multimodal sensors. Significant areas of research include: low cost sensors designed to be employed in large numbers of networked sensors for force protection, hostile fire defeat, homeland defense, counter terrorism operations, and munitions; fusion of disparate sensors such as non-imaging acoustic, seismic, electric-field (E-field), magnetic, radar; imaging infrared (IR), forward looking IR (FLIR), laser detection and ranging (LADAR), visible imagers; low cost acoustic, seismic, and magnetic sensors that can passively detect, classify, and track battlefield targets such as personnel, heavy/light vehicles, and helicopters. Other areas of research include sensing technologies for tagging, tracking, and locating (TTL) non-traditional targets as well as the location of direct and indirect fires and other hostile threats. Further areas of research include Ultraviolet (UV) optoelectronics for battlefield sensors, networked compact radar for vehicle and dismount identification and tracking; ultra wideband radar for buried and concealed threat detection, enhanced robotic mobility, stand-off characterization of infrastructure; and the detection, classification, and tracking of humans in urban terrain. Additional areas of research are aided/automatic target recognition (ATR) allowing sensors to autonomously locate and identify targets; 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; and advanced information processing methods to provide automatic information technologies that utilize widely dispersed sensor and legacy information sources.

This project supports Army science and technology efforts in the Command Control and Communications, Ground and Soldier portfolios. The work in this project complements efforts funded in PE 0601104A (University and Industry Research Centers), PE 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603001A (Warfighter Advanced Technology).

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this area is performed by the Army Research Laboratory (ARL), Adelphi, MD.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT H16: *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	5.790	4.014	5.590
Description: This effort evaluates and designs technologies for multi-modal low-cost networked sensors to enhance persistent sensing capabilities with increased probability of target detection and reduced false alarms. A key focus is on acoustic, seismic, magnetic, E-field, and passive RF with unique capabilities for Army & DoD applications such as technologies that enable detection of underground facilities. ***FY 2012 Accomplishments:*** Investigated new fusion techniques for enhanced discrimination between vehicles, humans and animals and developed algorithms for acquiring 360 degree situational awareness from multisensory wide-area persistent surveillance platforms; applied acoustic, seismic, magnetic, and E-field to subsurface anomaly detection and characterization; applied advanced transient event classification algorithms to fielded acoustic systems; and enhanced detection range and localization accuracy of airborne acoustic systems to include an unmanned aerial vehicle (UAV) with both acoustic and E-field sensors. ***FY 2013 Plans:*** Continue to investigate, design, and code new algorithms and assess sensor performance to enable faster identification and localization of transient/hostile threat events such as gunfire, explosions, weapon launches, etc. to enable rapid counter responses in urban environment and for base camps; and investigate, code new algorithms for fusing the output of multi-modal sensors to differentiate, with very high confidence, the presence of humans versus animals to reduce the costs for sensor deployment required for target classification. ***FY 2014 Plans:*** Will evaluate combination of co-located passive IR sensors to discriminate humans from animals with high confidence; investigate new algorithms to detect digging using seismic and magnetic sensors; develop and evaluate algorithms to fuse input from acoustic velocity sensors, electric-field charge detectors, narrow-band burn-product sensor and infrared flash detector to improve detection and classification of hostile threats such as gunfire, mortars, and rockets.			
Title: Networked Sensing and Data Fusion	5.057	5.650	6.022
Description: This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, RF emissions, chemicals and computers in hidden and confined spaces (i.e., tunnels, caves, sewers and buildings (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision making and (4) devise approaches for fusing results of processed outputs of multimodal sensors such as visible, IR and hyperspectral imagers, and acoustic, magnetic & E-field sensors. This effort is complementary with PE 0601104A/H50 and PE0601104A/J22.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Applied advanced fusion algorithms to multimodal sensors and systems; exploited magnetic and E-field fusion for equipment characterization, power line monitoring, and target localization; employed acoustic and seismic techniques to augment E-field subsurface imaging; enhanced sensing from airborne platforms with multi-modal sensors, cueing and fusion algorithms; and implemented fusion algorithms to discriminate humans versus other targets with high accuracy. ***FY 2013 Plans:*** Continue to develop and assess novel multi-modal sensing and processing algorithms for acquiring information on human activity; investigate and perform experiments in a realistic or simulated environment to evaluate FY12 distributed networking and interoperability algorithms and tools for coalition information sharing and decision making; and implement quality of information (QoI) based data discovery, collection and fusion techniques to extract desired information from large data sets. ***FY 2014 Plans:*** Will develop pattern of life algorithms and statistics to discriminate between potential threat activities and normal behavior; develop and evaluate fusion algorithms that correlates bearing information from multiple soldier-worn gunfire detection systems for localization of shooter with reduced errors and uncertainties; develop protocols and message formats to enable interoperability between disparate sensor systems; develop tools to understand value and quality of information based on data discovery, collection and fusion of large datasets; evaluate fusion of acoustic and E-field sensing systems to enable passive ranging of near-miss bullets based on wave propagation velocity differences; develop passive EM target detection and localization using multi-axis electric-field and magnetic field sensors.			
Title: Tagging Tracking and Locating (TTL)	1.553	2.072	2.189
Description: Conduct applied research to support advances in state-of-the-art clandestine TTL for non-traditional hostile forces and non-cooperative targets. Specific technical details related to this effort are classified. ***FY 2012 Accomplishments:*** Optimized and transitioned TTL technologies to CERDEC and implemented improvements to RF and IR Tags. ***FY 2013 Plans:*** Investigate alternate technologies including ultra violet (UV), infrared (IR), radio frequency (RF), and acoustic modalities for application to TTL; design advanced hyperspectral algorithms for locating and tracking targets of interest; develop advanced biometric techniques for locating and identifying humans of interest. ***FY 2014 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will investigate battery free tags for extending the operating life of tags; develop and extract signals from targets of interest using mechanical and electromechanical coupling methods combined with applicable sensing modalities.			
Title: Ultra Wideband Radar ***Description:*** Design technical underpinnings of ultra wideband (UWB) radar for several key Army concealed target detection technology requirements including landmine detection, sensing through-the-wall (STTW), and obstacle detection. Validate advanced computational electromagnetic algorithms, estimate performance improvements of proposed radar systems, and predict target signatures for advanced detection requirements. ***FY 2012 Accomplishments:*** Collected data with improved forward-looking UWB radar testbed to assess IED detection performance gains relating to the following areas: increased antenna height above ground, new antenna/balun design with enhanced low frequency content for better ground penetration, and polarimetric effects; and investigated techniques to utilize information embedded in low frequency radar data to develop an effective combination of interior building maps, moving target indication algorithms and RF Measurement & Signatures Intelligence technology. ***FY 2013 Plans:*** Complete FY12 assessments that combine electromagnetic models, rough surface models, measurement data and signal processing techniques to recommend forward looking radar parameters for optimized detection of IEDs to improve detection performance at increasing standoff distances; continue to investigate utilizing radar data to build interior structure maps as well as stationary target detection techniques using 3-D computer-generated radar images. ***FY 2014 Plans:*** Will develop techniques for combining UWB radar with complementary sensors (e.g., video, thermal IR) for improving probability of detection and confirmation of targets; investigate computational electromagnetic models of the radar signature of RF devices placed in a complex building environment.	3.341	2.114	2.529
Title: Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies ***Description:*** Design Networked Compact Radar for use on small ground and air vehicles and future Soldier technologies. Develop understanding of phenomenology for an integrated RF sensor that performs radio, radar, and control functions to allow communications, combat ID, and target acquisition/tracking,. Develop semiconductor-based ultraviolet (UV) optoelectronics for communications, water/air/surface purification, and detection and identification of biological threats. Conduct applied research in sensor and eye protection from laser threats. ***FY 2012 Accomplishments:***	1.291	4.115	1.544

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Developed new methods of moving target classification based on micro-doppler analysis; explored the phenomenology and image processing associated with sub-mmW imaging of human-borne IEDs and validated new sub-mmW / terahertz device technology; extended research on 230-275-nm optical sources including LEDs, lasers, and detectors. ***FY 2013 Plans:*** Assess the application of RF micro-Doppler algorithms to the remote sensing of human activities for counter-IED applications; investigate non-traditional radar modes in a compact radar device for force protection and surveillance; improve performance of UV lasers, LEDs, and detectors operating at wavelengths of 230-275-nanometers for enabling communications, water/air/surface purification, and detection and identification of biological threats; and investigate new optical limiting components for detecting emerging laser threats. ***FY 2014 Plans:*** Will create software and hardware architectures that enable compact radars to network with other unattended ground sensors for small unit force protection; evaluate nonlinear optical materials and tune their properties to optimize performance of the overall vision protection system; grow and characterize gallium nitride materials for extending the spectral range of UV lasers, LEDs, and detectors to wavelengths of 230-365-nanometers for enabling communications, water/air/surface purification, detection and identification of biological threats, and electro-optic countermeasures.			
Title: Adaptive Information Collection and Fusion (previously titled Information Fusion) ***Description:*** This effort develops network and processing infrastructure concepts, and validates algorithms to enable assets to dynamically modify their physical and information producing behaviors to adaptively operate within the dynamics and timelines of small unit decision makers. ***FY 2012 Accomplishments:*** Developed algorithms and enhanced applications directed to persistent surveillance, sensor management, and asset-to-asset taskings to minimize the cognitive workload of a lower echelon commander. ***FY 2013 Plans:*** Assess Cloud-based cellular architectures and explore implementation of decision support tools at the sensor level to more effectively support the collection and dissemination of information specifically tailored to the Soldiers cognitive requirements for more accurate decision making. ***FY 2014 Plans:*** Will evaluate decision-adaptive anomaly detection techniques as a means of filtering data at the sensor level to improve situation understanding for small unit decision makers and evaluate the impact of these techniques on data latency and situation	2.667	2.761	2.934

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
awareness; integrate these filtering algorithms into an autonomous collaborative collection framework and assess the impact on delay and situation awareness.			
Accomplishments/Planned Programs Subtotals	19.699	20.726	20.808

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
SA2: *Biotechnology Applied Research*	-	5.321	4.852	4.037	-	4.037	4.059	4.491	3.372	3.795	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project designs, develops and evaluates biotechnology with application to sensors, electronics, photonics, and network science. This project funds collaborative applied research and integration of government, academic and industry scientific research on biotechnology from PE 0601104/H05, Institute for Collaborative Biotechnologies (ICB) to advance innovative capabilities. 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.

The ICB is a collaborative effort led by the University of California, Santa Barbara (Santa Barbara, CA) in partnership with the California Institute of Technology (Pasadena, CA), the Massachusetts Institute of Technology (Cambridge, MA), the Army Laboratories and Research, Development and Engineering Centers, and the ICB industrial partners.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work is performed by the Army Research Laboratory, Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Biotechnology Applied Research	5.321	4.852	4.037
Description: This effort exploits breakthroughs in biotechnology basic research invented at the ICB to enable capabilities in sensors, electronics, photonics, and network science.			
FY 2012 Accomplishments: Designed/built hardware/software required to image single cells in 3D and collect initial 3D images; applied the lessons learned in microbial fuel cells to implement enhanced fermentation, environmental monitoring, and investigated waste water treatment; completed characterization and investigation of bacterial nanowires fabricated artificially from the naturally occurring proteins;			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
completed and validated algorithms for control of data displayed on crew stations based on neural processing; began two new start projects selected in FY11, "Biological Power Source for Unattended Ground Sensors" and "Biomimetic UAV-based System for Soldier Navigation and Situational Awareness." ***FY 2013 Plans:*** Complete the design and fabricate hardware and software required to image single cells in 3D to better understand the interactions between biological materials and inorganic surfaces; experimentally validate increased electron acceptors ability to improve fermentation for bioprocessing and monitoring systems; analyze wastewater treatment on increased laboratory scale to optimize bioremediation; characterize artificial biofilms doped with organic conductive structures for increased current density microbial fuel cells; evaluate bio-inspired algorithms for control of swarms of micro-unmanned aerial vehicles; evaluate yeast cell based electrodes and membranes in a microbial fuel cell for powering unattended ground sensors. ***FY 2014 Plans:*** Will improve bio-fuel cell electrode and membrane materials design, and validate for powering unattended ground sensors and other monitoring systems; complete and validate bio-inspired algorithms for control of swarms of micro-unmanned aerial vehicles; evaluate the use of a virus to template electrode materials to design improved batteries for small-scale, unmanned aerial vehicles; evaluate protein capture agents and synthetic bio-molecules as materials to improve stability, affinity for overall environmental tolerance.			
Accomplishments/Planned Programs Subtotals	5.321	4.852	4.037

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	3.606	4.303	5.306	-	5.306	6.278	6.950	7.052	7.179	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project researches and evaluates technologies for space-based, high altitude, and cyberspace applications for Army tactical ground forces. Applied research efforts include the design and development of sensors and electronic components, communications, signal and information processing, target acquisition, position/ navigation, and threat warning within space and high altitude environments as well as the design and development of technologies and analytical tools for cyber risk assessment and mitigation in acquisition systems. The applied research and technology evaluations conducted under this Project leverage other DoD space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

This project supports Army science and technology efforts in the Command, Control, Communications, and Intelligence (C3I) portfolio.

Work in this project complements and is fully coordinated with PE 0603006A (Space Applications Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the US Army Space and Missile Defense Command (SMDC) in Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Tactical Space Research	2.636	3.292	4.242
Description: This effort designs, develops, and evaluates space-based technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies allow for the rapid integration and development of tactical payloads in support of responsive space environments.			
FY 2012 Accomplishments: Continued development of advanced power technologies for use in space satellite applications; continued component development for small satellite electro-optical/infrared (EO/IR) sensors; developed L-Band communications components for insertion into a small satellite software defined radio.			
FY 2013 Plans:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Design and develop optics, processor, and gimbal systems component technologies for small satellite Electro-Optical (EO) video subsystems, small satellite deployable arrays, and small satellite constellation enablers. ***FY 2014 Plans:*** Will design and develop tracking system and antenna pointing component technologies for small satellites; develop orbit planning and analysis tools to support small satellite constellation concept of operation feasibility studies; research and develop propulsion concepts for small satellite station keeping and maneuvering.			
Title: Space and Analysis Lab ***Description:*** This effort provides an in-house capability to design and conduct analytic evaluations of space, high altitude, and cyberspace technologies. ***FY 2012 Accomplishments:*** Implemented the design of the Space Analysis Lab to stand up an in-house capability to support component development and system integration for ground demonstrations and evaluation of space, high altitude, and cyberspace technology applications. ***FY 2013 Plans:*** Design payload ground systems to monitor health and status of small satellite systems during flight operations. ***FY 2014 Plans:*** Will design and implement a communications satellite testbed to conduct and evaluate nanosatellite assembly, payload integration, ground testing and preflight checkout; improve ground station capabilities within the lab to support on-orbit communications and imagery nanosatellite demonstrations.	0.970	1.011	1.064
Accomplishments/Planned Programs Subtotals	3.606	4.303	5.306

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT TS2: *Robotics Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	11.530	13.198	10.691	-	10.691	13.937	20.253	16.719	17.020	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project designs, evaluates, and investigates autonomous technologies to enable robotics to assist military missions. Technical efforts are focused on advancing perception for autonomous ground mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and improved mobility for unmanned vehicles of scales from micro-systems through tactical vehicles. The project provides the underpinning research of the Robotics Collaborative Technology Alliance (CTA), a cooperative arrangement with industry and academia to conduct a concerted, collaborative effort advancing key enabling robotic technologies required for future unmanned systems. This project sustains Army science and technology efforts supporting the Ground portfolio.

This project leverages basic research conducted under PE 0601102A, project T63 and PE 0601104A, project H09 and transitions knowledge and emerging technologies to PE 0603005A (Combat Vehicle Advanced Technology) for maturation and demonstration.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas, and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL) at the Aberdeen Proving Ground, MD, and the Robotics Collaborative Technology Alliance consisting of: Boston Dynamics, Carnegie Mellon University, Florida A&M University, General Dynamics Robotics Systems, Jet Propulsion Laboratory, QinetiQ North America, University of Central Florida, and University of Pennsylvania.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Robotics CTA	7.311	5.925	8.323
Description: Conduct applied research to provide essential capabilities for advanced perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility for unmanned systems to conduct multiple military missions for a full range of robots from man-portable to larger systems. Research focuses on new sensor and sensor processing algorithms for rapid detection and classification of objects in cluttered and unknown environments, enabling autonomous mobility and intelligent tactical behavior by future unmanned systems; implementing adaptive control strategies that will enable unmanned systems to display intelligent tactical behavior, formulation of control strategies that will facilitate use of unmanned systems in			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT TS2: *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects. ***FY 2012 Accomplishments:*** Enabled lower cost sensory capability for smaller unmanned systems; examined issues of trust in automation and developed a common mental picture between soldier and unmanned system; and examined mid- and long- range scene recognition to facilitate tactical behavior in unmanned systems. ***FY 2013 Plans:*** Design algorithms to enable both improved comprehension of the sensed environment by small unmanned systems and adaptability in planning and execution of tactical behaviors; and investigate concepts for more efficient locomotion by small, legged unmanned systems to improve mobility. ***FY 2014 Plans:*** Will continue to design perception and intelligence algorithms that will permit unmanned systems to team with soldiers in moderately complex environments and conduct missions; will instantiate learning algorithms to enable robots to continually learn from experience and recognize intent of other agents; will focus on the implementation of hybrid cognitive/metric architecture to minimize the workload placed upon soldier, including implementation of non-traditional control techniques; and will implement concepts for manipulation of objects and improved ground mobility for complex and constrained environments.			
Title: Perception and Intelligent Control ***Description:*** Advance perception and intelligent control technologies required to achieve autonomous tactical behaviors and other objective capabilities for future unmanned vehicles of multiple size scales and to transition this technology to advanced development programs being conducted under PE 0603005A (Combat Vehicle and Automotive Advanced Technology) project 515 (Robotic Ground Systems) for integration into test bed systems. ***FY 2012 Accomplishments:*** Conducted applied research for improved shared understanding of tactical environment between soldier and unmanned systems. ***FY 2013 Plans:*** Investigate FY12 learned understanding of tactical environment between soldier and unmanned systems for improving autonomous tactical behaviors and validate technologies in collaboration with CTA efforts; investigate and evaluate the state-of-the-art in intelligent control and focus on the technology gaps. ***FY 2014 Plans:***	3.013	7.273	2.368

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602120A: *Sensors and Electronic Survivability*	PROJECT TS2: *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will implement algorithms for perception of the local environment employing a hybrid cognitive/metric architecture; will incorporate advanced algorithms for whole body manipulation on to testbed platforms; will implement novel approaches to mobility in complex and constrained environments; and will assess performance of algorithms in an integrated context.			
Title: Autonomous Robotics - Component Maturation ***Description:*** Matures component technologies on unmanned ground vehicle test beds by conducting extensive field evaluation and technology characterization to establish improved capability for near autonomous UGVs. Conduct regular, periodic evaluation at Ft. Indiantown Gap, PA, and other military facilities that will stress the technology in complex environments to further focus CTA sponsored research, assess performance, and provide the opportunity for US Army Training and Doctrine Command to engage in the early development of the tactics, techniques, and procedures required for successful utilization of unmanned systems in future conflicts. Work is done collaboratively with industry, academia and other government agencies to include Tank and Automotive Research, Development, and Engineering Center (TARDEC) to support future transitions of knowledge and emerging technologies. ***FY 2012 Accomplishments:*** Conduct initial assessments to establish baseline capability for unmanned systems to understand terrain and behaviors.	1.206	0.000	0.000
Accomplishments/Planned Programs Subtotals	11.530	13.198	10.691

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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