Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army											Date: February 2016	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*							
COST ($ in Millions)	**Prior Years**	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**Cost To Complete**	**Total Cost**
Total Program Element	-	45.792	58.374	36.109	-	36.109	32.972	33.341	33.288	35.230	-	-
H16: *S3I Technology*	-	17.936	21.168	19.599	-	19.599	15.610	16.698	16.304	17.897	-	-
SA1: *Sensors and Electronic Initiatives (CA)*	-	12.750	20.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
SA2: *Biotechnology Applied Research*	-	2.767	2.972	1.361	-	1.361	1.680	1.605	1.647	1.690	-	-
TS1: *Tactical Space Research*	-	4.593	5.808	6.702	-	6.702	7.026	7.072	7.213	7.357	-	-
TS2: *Robotics Technology*	-	7.746	8.426	8.447	-	8.447	8.656	7.966	8.124	8.286	-	-

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 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),

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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army					Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602120A *I Sensors and Electronic Survivability*			
B. Program Change Summary ($ in Millions)	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	46.258	38.374	38.448	-	38.448
Current President's Budget	45.792	58.374	36.109	-	36.109
Total Adjustments	-0.466	20.000	-2.339	-	-2.339
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	20.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.466	-			
• Adjustments to Budget Years	-	-	-2.339	-	-2.339

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Force Protection Radar Development*	5.000	-
Congressional Add: *Cyberspace security*	7.750	-
Congressional Add: *Program Increase*	-	12.500
Congressional Add: *Space and High Altitude Assets Survivability*	-	7.500
Congressional Add Subtotals for Project: SA1	12.750	20.000
Congressional Add Totals for all Projects	12.750	20.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) H16 / *S3I Technology*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H16: *S3I Technology*	-	17.936	21.168	19.599	-	19.599	15.610	16.698	16.304	17.897	-	-

A. Mission Description and Budget Item Justification

This project designs, investigates, evaluates and characterizes advanced sensor components, signal processing, and information fusion algorithms that will provide the future Soldier decisive new capabilities to locate, identify, decide and make decisions about 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 as 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 field, 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; protection of sensors (including Soldier's eyes) from battlefield laser threats; 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), Program Element (PE) 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603001A (Warfighter Advanced Technology). The networked sensing and data fusion efforts performed in this project complement efforts funded in PE 0601104A/Project H50 (Network Sciences CTA) and PE0601104A/Project J22 (Network Science and Technology Research Center CTA).

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	5.539	5.435	4.675

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Description: This effort designs and characterizes 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 field, electric field, and passive radio frequency (RF) with unique capabilities for Army and DoD applications that enable detection of underground facilities. ***FY 2015 Accomplishments:*** Exploited multimodal sensing, fusion, and sensor processing to detect and locate diverse threats using static and mobile sensors and networked systems; enhanced sensors and algorithms to provide persistent surveillance and actionable information; and exploited target features and mitigated environmental interference to enhance ISR capabilities. ***FY 2016 Plans:*** Develop advanced acoustic, magnetic- and electric-field sensors and arrays to detect and locate threats in complex environments; implement algorithms to mitigate effects of acoustic propagation channel and signature modifications to optimize transient classification of mortar, rocket, gunfire and explosive events; apply electric and magnetic field phasor processing to detect and classify equipment and power events; and develop methods for detecting and classifying humans and human activities with multimodal image, video, and text data. ***FY 2017 Plans:*** Will develop sensor and processing algorithms to acoustically detect, track, and classify transients, vehicles, unmanned aerial systems (UAS), and infrasound sources, and integrate wind noise reduction and propagation error correction; develop electric- and magnetic-field phase measurements to extract target signatures in complex environments; develop sensors and methods to characterize device signatures and power events; and develop multi-modal processing algorithms to reliably detect targets in complex environments and under diverse environmental conditions.			
Title: Networked Sensing and Data Fusion	4.843	5.474	5.506
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, such as tunnels, caves, sewers, and buildings, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors such as visible, IR, and hyperspectral imagers, and acoustic, magnetic, and electric field sensors. This effort complements efforts funded in PE 0601104A/H50 (Network Sciences CTA) and PE0601104A/J22 (Network Science and Technology Research Center CTA). ***FY 2015 Accomplishments:***			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Implemented anomaly detection algorithms by fusing the output of social network with disparate multimodal sensors to determine patterns of behavior; enhanced acoustic, magnetic and electric field sensors and algorithms to detect, classify, and localize hostile transient threat events such as mortars, rockets, gunfire, and moving ground/air vehicles, to include UAS; and mitigated background noise resulting from mobile sensor systems in complex environments. ***FY 2016 Plans:*** Expand tools to improve search capabilities of relevant social media data to fuse with sensor data; expand interoperability for sensor plug-and-play capabilities and quick integration across unmanned sensors; design algorithms that will exploit electric and magnetic field sensor fusion for electrical power event monitoring; and design detection, tracking and cueing methodologies for counter-unmanned aerial system (C-UAS) using fusion of acoustic, passive RF, and imaging modalities. ***FY 2017 Plans:*** Will research holistic approaches to networked sensor/data fusion by exploiting signatures in support of anti-personnel landmine alternatives (APL-A); research personnel and ground vehicle classification and anomaly determination algorithms using multi-modal sensors for robust, high confidence reports; research automatic human and vehicle activity classification in full motion video (FMV) and Wide Area Motion Imagery (WAMI); investigate a collaborative sensor environment to enhance data collection and collaborative design of fusion algorithms with the Army Cold Regions Research and Engineering Laboratory and the Air Force Research Laboratory.			
Title: Ultra Wideband (UWB) Radar ***Description:*** This effort examines the technical underpinnings of UWB radar for several key Army concealed target detection requirements, including landmine and improvised explosive device (IED) detection, sensing through-the-wall, and obstacle detection. This research uses a combination of advanced computational electromagnetic algorithms, radar measurements, and advanced signal processing techniques to define the performance boundaries of state-of-the-art airborne and ground-based UWB radar for concealed target detection. ***FY 2015 Accomplishments:*** Assessed performance of UWB radar with complementary sensor techniques and technologies and compared to the current target detection capabilities and performance metrics; and investigated computational electromagnetic models to address new target deployments. ***FY 2016 Plans:*** Investigate utility of combining forward looking radar with electro-optical/infrared (EO/IR) sensor to improve detection and reduce false alarms for standoff detection of explosive hazards; incorporate stereo visible cameras to provide three-dimensional	2.913	2.892	1.794

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
reconstruction of the environment that can be fused with radar image formation algorithms; and investigate and validate disturbed earth computational UWB forward-looking radar models. ***FY 2017 Plans:*** Will collect and assess new UWB stepped-frequency, radar standoff explosive hazard detection data sets to address radio frequency interference, clutter mitigation, and self-interference in relevant environments; combine and assess data with electro-optic/IR standoff detection sensor data sets to further reduce false-alarms associated with explosive hazard threat deployments; exploit two-dimensional (2D) and three-dimensional (3D) reconstruction of the environment across standoff sensors and algorithms for improved performance; and develop exploitation algorithms for detection and discrimination of explosive hazards relating to forward-looking standoff radar.			
Title: Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies	3.083	3.854	3.757
Description: This effort investigates RF networking technology in support of integrated RF systems for use on ground, air, and Soldier platforms to support radio, radar, and control functions to allow communications, combat identification, and target acquisition/tracking. Research also focuses on semiconductor-based ultraviolet UV optoelectronics for communications, water/air/surface purification, and detection and identification of biological threats, and novel materials and high-speed switching technology for sensor and eye protection. ***FY 2015 Accomplishments:*** Grew and characterized wide bandgap semiconductor materials and developed device designs to extend the spectral range of UV lasers, Light Emitting Diodes (LEDs), and detectors to wavelengths from 200 to 365 nanometers to enable water/air/surface purification and the detection and identification of biological threats; investigated different materials and characterized solutions for eye and sensor protection against ultra-short pulses and near-IR high power threats. ***FY 2016 Plans:*** Study and characterize non-linear optical materials (including two novel platinum bipyridine complexes and several iridium dyes) for eye and camera protection on mounted ground vehicle platforms and investigate active long wavelength protection filters for uncooled infrared cameras and focal plane arrays to reduce their vulnerability to damage and dazzle. ***FY 2017 Plans:*** Will develop exploitation algorithms for detection and discrimination of explosive hazards relating to forward-looking standoff radar, design distributed and decentralized algorithms using consensus methods of networked sensors for a moving ground vehicle, and determine the improvement in ground vehicle tracking accuracy and efficiency versus conventional centralized approaches; research advanced active protection techniques and new non-linear optical materials based on results for bipyridine and iridium dye experiments, to increase protection against laser-induced damage of eyes and cameras in wavelength ranges from visible through shortwave IR; perform studies and create UV sources (e.g., light-emitting diodes and lasers) with output			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
power greater than 20 mW in the wavelength range of 200-290 nm, and photodetectors with single-photon detection capability across the UV spectral range for Army applications including water sterilization, non-line-of-sight communications, and chemical-biological detection.			
Title: Multi-Mode Air Defense Radar ***Description:*** This research supports the current and future technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging RF spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments. ***FY 2015 Accomplishments:*** Investigated current and emerging technologies, across a broad RF spectrum, which may limit the performance of current air defense radar systems; modified existing physics-based electromagnetic modeling techniques to assess performance and identify critical areas of research; and examined performance in contested environments and research techniques to mitigate performance limitations. ***FY 2016 Plans:*** Model air targets to investigate multiband architectures, alternative spectrum configurations, and broadband apertures; investigate spectrum sensing algorithms specific to air defense radar bands (e.g., L-band thru X-band and beyond); and investigate novel tracking algorithms for rockets, artillery, and mortar targets for next generation air defense radar. ***FY 2017 Plans:*** Will design and characterize multiband elements with integrated front-end radar components including the amplifier and mixer; validate electromagnetic models of both target and physical phenomenology; extract radar architecture and circuit requirements from assessments and simulations; and emulate cognitive algorithms for electronic protection in a contested RF environment.	1.558	3.513	3.867
Accomplishments/Planned Programs Subtotals	17.936	21.168	19.599

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) SA1 / *Sensors and Electronic Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	12.750	20.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016
Congressional Add: Force Protection Radar Development ***FY 2015 Accomplishments:*** Congressional interest item for Force Protection Radar Development	5.000	-
Congressional Add: Cyberspace security ***FY 2015 Accomplishments:*** Congressional interest funding for cyberspace security research	7.750	-
Congressional Add: Program Increase ***FY 2016 Plans:*** This is a Congressional Interest Item	-	12.500
Congressional Add: Space and High Altitude Assets Survivability ***FY 2016 Plans:*** This is a Congressional Interest Item	-	7.500
Congressional Adds Subtotals	12.750	20.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army											Date: February 2016	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*				Project (Number/Name) SA2 / *Biotechnology Applied Research*			
COST ($ in Millions)	**Prior Years**	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**Cost To Complete**	**Total Cost**
SA2: *Biotechnology Applied Research*	-	2.767	2.972	1.361	-	1.361	1.680	1.605	1.647	1.690	-	-

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 Program Element (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, deoxyribonucleic acid (DNA) research and development, and 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 (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Biotechnology Applied Research	2.767	2.972	1.361
Description: This effort exploits breakthroughs in biotechnology basic research accomplished at the ICB to enable new capabilities in sensors, electronics, photonics, and network science.			
FY 2015 Accomplishments: Investigated performance limits of hybrid biofuel cells for powering unattended ground sensors or other remote, stand-alone monitoring systems; studied interface technologies using bio-assembled materials for small-scale batteries on unmanned aerial vehicles (UAVs); and developed and studied rapid bio-based screening, selection, and production processes for recognition and targeting of emerging threats to the Soldier.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** SA2 / *Biotechnology Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Test hybrid biofuel cells; develop and test assays with advanced protein capture agents to validate capability to rapidly respond to emerging threats; evaluate bio-inspired algorithms for control applications including decision support tools to unburden UAV operators; and conduct field evaluation of combined bio-inspired algorithms for distributed mobile gunfire detection. ***FY 2017 Plans:*** Will evaluate microbial communities for the generation of fuel for bio-hybrid fuel cells that can accept multiple types of fuel; develop, integrate, and assess pairs of advanced capture agents for threat materials and evaluate assays to validate capability to rapidly respond to emerging threats; evaluate bio-inspired algorithms for control applications including decision support tools for mounted soldiers; develop experimental platforms to evaluate bio-inspired protocols to unburden the cognitive load on UAV operators; and complete analysis of combined bio-inspired algorithms for distributed mobile gunfire detection.			
Accomplishments/Planned Programs Subtotals	2.767	2.972	1.361

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) TS1 / *Tactical Space Research*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	4.593	5.808	6.702	-	6.702	7.026	7.072	7.213	7.357	-	-

A. Mission Description and Budget Item Justification

This project researches and evaluates technologies for space-based and high altitude 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. The applied research and technology evaluations conducted under this Project leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

Work in this project complements and is fully coordinated with Program Element (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 Army Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT) in Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Tactical Space Research	3.621	4.787	5.664
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. Work related to standard Army networks is done in coordination with the Communications-Electronics Research Development and Engineering Center (CERDEC) and Army Cyber Center of Excellence.			
FY 2015 Accomplishments: Developed payload deployer subsystem for affordable launch vehicle; designed and developed advanced attitude determination and control and propulsion subsystems for nanosatellites to change orbits in flight.			
FY 2016 Plans: Investigate and develop network hardware and software interfaces and information dissemination architecture that allows Software Defined Radio (SDR) and imagery payloads to be controlled from any node and products distributed to tactical ground units; develop follow-on small satellite antenna and guidance, navigation, and control (GNC) components that have less mass, are more accurate, and are more power efficient; and investigate technologies and explore collaboration opportunities with other Services and Agencies for small satellite affordable launch capabilities.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Will design and develop small satellite components to support the Army's Warfighter Information Network – Tactical (WIN-T); develop data processing algorithms and network integration interfaces to improve Army tracking and locating capabilities for ground objects of interest; investigate satellite-to-satellite communications components to reduce forward-deployed ground control station requirements by enabling control of beyond-line-of-sight satellites and continue to explore collaboration opportunities with other Services and Agencies for small satellite affordable launch capabilities.			
Title: Space and Analysis Lab ***Description:*** This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies. ***FY 2015 Accomplishments:*** Validated performance of Hardware In The Loop nanosatellite attitude control, to include attitude control software, device integration, and in-flight simulation of commanded motion. ***FY 2016 Plans:*** Develop components for follow-on small satellite designs, to include propulsion and distributed aperture imager components. ***FY 2017 Plans:*** Will continue small satellite design and assess capabilities through the use of in-house distributed bench assessment and Hardware In The Loop capabilities.	0.972	1.021	1.038
Accomplishments/Planned Programs Subtotals	4.593	5.808	6.702

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) TS2 / *Robotics Technology*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	7.746	8.426	8.447	-	8.447	8.656	7.966	8.124	8.286	-	-

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 and air mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and improved mobility for unmanned vehicles of scales from micro-systems through tactical combat 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. The Robotics CTA research is funded in Program Element (PE) 0601104A/Project H09.

This project sustains Army science and technology efforts supporting the Air and Ground Maneuver portfolios.

This project leverages basic research conducted under PE 0601102A/Project T63 (Robotics Autonomy, Manipulation and Portability) and PE 0601104A/Project H09 (Robotics CTA) and transitions knowledge and emerging technologies to PE 0603005A (Combat Vehicle and Automotive 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 Carnegie Mellon University, Florida State 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 2015	FY 2016	FY 2017
Title: Robotics CTA	3.487	3.790	3.811
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 populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects.			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Incorporated perception and intelligence algorithms into effective teaming of humans and robots as part of a mixed team to successfully conduct missions; conducted technology assessments of components and integrated systems to determine performance and technology maturity levels; and implemented perception and reasoning skills with technology test beds employing unique mobility modes (e.g., legs, and manipulation skills) to assess technology performance levels. ***FY 2016 Plans:*** Instantiate enhanced hybrid cognitive architecture on robots to explore teaming behaviors including natural modes of communication and control in the context of a mixed small unit; incorporate mechanisms and software to permit robots to effectively perform basic manipulation skills; integrate resultant technology into test bed platforms to assess technology maturity. The hybrid architecture permits command and communication to be at a natural or abstract level similar to a Soldier issuing a command (e.g., open the third door on the right) to a subordinate. ***FY 2017 Plans:*** Will incorporate advanced algorithms for reasoning, learning, and multi-modal communication between human and robot into existing architecture and conduct virtual and live experiments to determine limits of performance; expand implantation of the architecture for whole body manipulation that efficiently utilizes interaction with objects in an environment to mimic capabilities of biological systems.			
Title: Perception and Intelligent Control	4.259	4.636	4.636
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 2015 Accomplishments:*** Developed the perceptual and reasoning capabilities necessary to enable an unmanned system to deduce the intent of actions/ activity; and explored and implemented on test bed platforms the mechanisms and control algorithms that will enable autonomous unmanned systems to dexterously manipulate objects and maneuver through complex terrain, with an emphasis on increased efficiency. ***FY 2016 Plans:*** Continue extension of perceptual, reasoning, and learning techniques for unmanned systems to enable creation of a common, though not necessarily equivalent, mental model of the surrounding world facilitating planning and execution of tasks, as well			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
as communication with human teammates; and conduct experiments focused upon establishing technology maturity and performance gaps. ***FY 2017 Plans:*** Will incorporate initial perceptual, reasoning, and learning capabilities into a comprehensive architecture and conduct both virtual and live experiments; explore concepts for whole body manipulation and hybrid mobility modes in simulation and live experimentation; instantiate intelligent control architecture into appropriate virtual environment and on appropriate surrogate unmanned air and ground systems; and explore initial behaviors for manned-unmanned teaming and for manipulation of objects by unmanned air and ground systems.			
Accomplishments/Planned Programs Subtotals	7.746	8.426	8.447

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A