Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
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*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	83.581	80.849	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	164.430
H16: *S3I Technology*	-	19.872	19.419	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.291
SA1: *Sensors and Electronic Initiatives (CA)*	-	45.500	48.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	94.000
SA2: *Biotechnology Applied Research*	-	1.635	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.635
TS1: *Tactical Space Research*	-	6.797	3.495	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.292
TS2: *Robotics Technology*	-	9.777	9.435	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.212

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is being realigned, with continuity of effort realigned to the following PEs:
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602146A Network C3I Technology
* PE 0602148A Future Vertical Lift
* PE 0602150A Air and Missile Defense Technology

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 H16 investigates sensors, signal processing and information fusion technologies to increase target detection range and speed of engagement. Project SA1 (Congressional Interest Item) focuses on the design and development of Assured Positioning, Navigation, and Timing, and Robust Communications technologies for the Warfighter in disadvantaged/degraded environments. 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 0603710A (Night Vision Advanced Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology),

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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*

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

Work in this PE is performed by the Army Futures Command.

All FY 2020 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	35.730	32.366	31.106	-	31.106
Current President's Budget	83.581	80.849	0.000	-	0.000
Total Adjustments	47.851	48.483	-31.106	-	-31.106
• Congressional General Reductions	-0.013	-0.017			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	45.500	48.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.000	-			
• SBIR/STTR Transfer	-0.636	-			
• Adjustments to Budget Years	-	-	-31.106	-	-31.106

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Advanced Space Data Exp & Integ*	7.500	9.500
Congressional Add: *Agile Manufacturing Materials Processing*	23.000	15.000
Congressional Add: *Tactical Space-Small Sat Tech Dev*	15.000	20.000
Congressional Add: *Open Campus Initiative*	-	4.000
Congressional Add Subtotals for Project: SA1	45.500	48.500
Congressional Add Totals for all Projects	45.500	48.500

Change Summary Explanation

FY18 increase related to $45.500 million of Congressional Add funding
FY19 increase related to $48.500 million of Congressional Add funding.
FY20 decrease related to Science and Technology financial restructuring.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
H16: *S3I Technology*	-	19.872	19.419	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.291

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology Project:
* Project BI2 Sensor Protection Technology
PE 0602146A Network C3I Technology Projects:
* Project AP5 Electronic Warfare Technology
* Project AR1 Robust, Resilient and Intelligent C3I Technology
PE 0602148A Future Vertical Lift Project:
* Project AL8 Holistic Situational Awareness and Dec Making Tech
PE 0602150A Air and Missile Defense Technology Project:
* Project AD5 Next Generation Fires Radar Technology

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, 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 networked sensors for force protection, hostile fire defeat, homeland defense, counter terrorism operations, munitions, and fusion of disparate sensors (e.g., acoustic, seismic, electric-field (E-field), magnetic field) to 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 and 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), advanced battlefield sensor and information processing to conduct a dynamic and real time situational assessment to present a common picture of the battle space focused on low echelon commanders; protection of sensors, especially human eyes, from battlefield laser threats; and advanced computational methods to provide automatic information technologies from widely dispersed sensor and legacy information sources for improved situational awareness.

This Project supports Army Science and Technology efforts in the Command Control and Communications, Ground, and Soldier portfolios. The sensor-related 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 Technology), and PE 0603001A (Warfighter Advanced Technology). The networked sensing and data fusion efforts performed in this Project

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

complement efforts funded in PE 0601104A (University and Industry Research Centers) / Project H50 (Network Sciences CTA) and PE 0601104A (University and Industry Research Centers) / Project J15 (Network Science ITA).

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

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	6.996	6.169	-
Description: This effort designs and characterizes technologies for multi-modal (acoustic, seismic, infrasound, electric and magnetic (E/H) field, and passive radio frequency (RF)), low-cost networked sensors to enhance persistent sensing capabilities for increased probability of target detection and reduced false alarms. These combined sensors have unique capabilities that enable detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions. ***FY 2019 Plans:*** Develop robust, low-cost acoustic sensors with 1 to 10000 Hz frequency response to detect and locate Army-relevant target signals in environments of interest; focus on sensor miniaturization and small arrays; will develop novel wind noise reduction techniques that are necessary for successful particle-velocity sensor operation in complex military scenarios and on mobile platforms; develop new tools to calibrate and characterize quasi-static E/H field sensors for long-wavelength applications, such as power-line sensing, anomaly detection, and low-frequency positioning/navigation/timing; develop novel detection, classification, and identification algorithms for new classes of targets; characterize and assess technologies and sensing modalities that can detect and identify improvised explosive threats, detect their components, and mitigate their delivery platforms; and develop and integrate automated multi-modal detection, tracking, classification and decision support tools for deployment on low resource tactical platforms, ground stations and sensors. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, Intelligent C3I Technology) as part of financial restructure in support of Army Modernization Priorities.			
Title: Networked Sensing and Data Fusion	5.137	4.547	-
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, (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, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors.			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
FY 2019 Plans: Develop focused infrasonic classification methods and integrate them with long-range sound propagation models to increase classification accuracy; develop algorithms to provide automated tipping and cueing at each sensor array for incorporation into the analyst?s common operating picture; develop tools for creating and visualizing a multi-sensor 3-dimensional (3D) common operating picture for real-time data geo-registration and fusion of heterogeneous data from multiple aerial and ground-based passive and active imaging sensors for increased situational awareness; develop tools for multimodal biometrics and human activity recognition using unconstrained video; explore scene representation models for optimized, real time implementation; develop theory for inference and subjective networks that benchmark performance against other uncertain reasoning methods; develop higher level fusion of event tracking from sensor and social media data in uncertain environments via subjective logic Bayesian networks; and develop robust capability for communications, sensors and data management and information fusion for a large network of ground sensors. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, Intelligent C3I Technology) as part of financial restructure in support of Army Modernization Priorities.			
Title: RF Sensing for Concealed/Low-Signature Threat Detection (previously Ultra Wideband (UWB) Radar) ***Description:*** This effort develops the technical underpinnings of ultra-wideband (UWB) radar and other active and passive RF sensing modalities for several key Army concealed and low-signature target detection requirements, including landmine and improvised explosive device (IED) detection, sensing through-the-wall, foliage penetration, unmanned aerial system (UAS) detection, other electronic threat detection, and obstacle avoidance for autonomous navigation. This research uses a combination of advanced computational electromagnetic models and algorithms, radar measurements, active and passive RF sensing technologies, and advanced signal processing techniques to define the performance boundaries of state-of-the-art airborne and ground-based UWB radar and other RF sensing modalities for concealed and low-signature target detection and classification. ***FY 2019 Plans:*** Reduce sensor size with on-board signal processing for automated detection and tracking; investigate the benefits of cooperative RF sensing in complex environments; and will assess the processing constraints introduced by distributed sensing. ***FY 2019 to FY 2020 Increase/Decrease Statement:***	2.713	2.967	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AP5 (Electronic Warfare Technology) and PE 0602148A (Future Vertical Lift Technology) / Project AL8 (Holistic Situational Awareness and Dec Making Tech) as part of financial restructure in support of Army Modernization Priorities.			
Title: Laser Protection Technologies (previously Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies) ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats including high-power continuous wave and ultrashort (femto-second) pulsed lasers. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive organic and inorganic optical limiter materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active man-made material-based solutions will be investigated for uncooled sensors in the long-wave IR (LWIR). Vulnerability of sensors and optical sensor systems will be studied against high-power and ultrashort pulsed laser threats to determine protection requirements. ***FY 2019 Plans:*** Improve multi-chromophore solid-state optical limiter based on previous experimental results; investigate femtosecond limiter concepts in the mid-wave infrared; and conduct experiments to validate high power continuous wave laser protection concepts. These combined efforts will enable transmission of low light intensities, while blocking laser radiation with excessively high irradiance hence preventing sensor damage. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY20 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI2 (Sensor Protection Technology) as part of financial restructure in support of Army Modernization Priorities.	4.957	5.054	-
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 2019 Plans:***	0.069	0.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
Adapt front end RF technologies for next generation fires radars. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602150A (Air and Missile Defense Technology) / Project AD5 (Next Generation Fires Radar Technology) as part of financial restructure in support of Army Modernization Priorities.			
Title: FY 2019 SBIR / STTR Transfer ***Description:*** FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer	-	0.182	-
Accomplishments/Planned Programs Subtotals	19.872	19.419	-

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 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	45.500	48.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	94.000

Note

Congressional add

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019
Congressional Add: Advanced Space Data Exp & Integ ***FY 2018 Accomplishments:*** Advanced Space Data Exp & Integ ***FY 2019 Plans:*** Advanced Space Data Exp & Integ	7.500	9.500
Congressional Add: Agile Manufacturing Materials Processing ***FY 2018 Accomplishments:*** Agile Manufacturing Materials Processing ***FY 2019 Plans:*** Agile Manufacturing Materials Processing	23.000	15.000
Congressional Add: Tactical Space-Small Sat Tech Dev ***FY 2018 Accomplishments:*** Tactical Space-Small Sat Tech Dev ***FY 2019 Plans:*** Tactical Space-Small Sat Tech Dev	15.000	20.000
Congressional Add: Open Campus Initiative ***FY 2019 Plans:*** Open Campus Initiative	-	4.000
Congressional Adds Subtotals	45.500	48.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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)*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
SA2: *Biotechnology Applied Research*	-	1.635	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.635

Note

This Project was completed in Fiscal Year (FY) 2018.

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) 0601104A (University and Industry Research Centers) / Project H05 (Institute for Collaborative Biotechnologies) 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 Institute for Collaborative Biotechnologies (ICB) University Affiliated Research Center (UARC) 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 Under Secretary of Defense, Research and Engineering priority focus areas.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Biotechnology Applied Research ***Description:*** This effort exploits breakthroughs in biotechnology basic research accomplished at the ICB UARC to enable new capabilities in sensors, electronics, photonics, and network science.	1.635	-	-
Accomplishments/Planned Programs Subtotals	1.635	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** SA2 / *Biotechnology Applied Research*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	6.797	3.495	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.292

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602146A Network C3I Technology Project:
* Project AO5 Tag Track and Locate Small Satellites Technology

A. Mission Description and Budget Item Justification

This Project researches, evaluates, and adapts 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 for 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 PE 0603006A (Command, Control, Communications Advanced Technology).

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

Work in this Project is performed by the United States Army Space and Missile Defense Command/Army Forces Strategic Command in Huntsville, AL.

FY20 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Tactical Space Research	5.681	2.289	-
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 2019 Plans: Refine tag, track and locate capabilities for ground objects of interest, advance space-based data exploitation technologies and components, space-based signal detection/processing/dissemination technologies, and software algorithms to enable cohesive exploitation from single or multiple small satellite platforms. Design and refine small satellite/payload components focused on			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
the improvement of warfighter tag, track, and location capabilities to include planning for tasking, processing, exploitation, and dissemination. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY20 funds realigned to PE 0602146A (Network C3I Technology) / Project AO5 (Tag, Track and Locate Small Satellites Technology) as part of financial restructure in support of Army Modernization Priorities.			
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 2019 Plans:*** Develop in-house research capabilities for small satellite/payload and component design, development and validation for tactical spacecraft; and assess new technologies for spacecraft components. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY20 funds realigned to PE 0602146A (Network C3I Technology) / Project AO5 (Tag, Track and Locate Small Satellites Technology) as part of financial restructure in support of Army Modernization Priorities.	1.116	1.127	-
Title: FY 2019 SBIR / STTR Transfer ***Description:*** FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer	-	0.079	-
Accomplishments/Planned Programs Subtotals	6.797	3.495	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	9.777	9.435	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.212

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology Project:
* Project BF8 Artificial Intelligence & Machine Learning Tech

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 PE0601104A (University and Industry Research Centers) / Project H09 (Robotics CTA).

This Project leverages basic research conducted under PE 0601102A (Defense Research Sciences) / Project T63 (Robotics Autonomy, Manipulation and Portability Rsh) and PE 0601104A (University and Industry Research Centers / 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 Under Secretary of Defense for Research and Engineering focus areas, and the Army Modernization Strategy. The Ground Portfolio technology investments are improving logistics throughput and surge capability supporting maneuver forces (Leader-Follower technology) and allow experimentation with manned and unmanned teams to develop the advantages that inform/protect the maneuver force.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Robotics CTA	3.675	3.208	-
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 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects. ***FY 2019 Plans:*** Demonstrate cognitive architecture with the integrated capabilities of perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility. A limbed robot employing dynamic locomotion solely through electromotive rotary actuators will be assessed with the Robotics CTA cognitive architecture for autonomous capability. Perception and intelligence for a dynamic limbed platform will be demonstrated to show its capacity for teaming in an optempo scenario. Whole body manipulation will be employed in conjunction with the cognitive architecture to demonstrate the ability to perform environment interactions autonomously in ad hoc scenarios. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure in support of Army Modernization Priorities.			
Title: Perception and Intelligent Control ***Description:*** Advance perception and intelligent control technologies required to achieve autonomous tactical behaviors, based on the environment, 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 2019 Plans:*** Integrate a map-based and an ontology focused World Model to provide a more complete architecture for reasoning and understanding the environment. Cognitive approaches to perception will be implemented on robotic platforms and methods for artificial intelligence assessment will be employed to ensure future unmanned systems can offer transparency in their cognitive processes. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure in support of Army Modernization Priorities.	4.640	4.509	-
Title: Ground Robotic Vehicle Mobility and Propulsion Technology ***Description:*** Advance the speed and agility of unmanned vehicles in complex three-dimensional environments through exploration of advanced and unconventional mobility and propulsion technologies integrated with innovative application of perceptual and reasoning capabilities. Ground robotic platforms may have legs, may be able to climb or may even be robots	1.462	1.418	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
restricted to small confined spaces. Research will focus on developing actuation mechanism that intelligently achieve movement while minimizing the use of energy to ensure longer range and endurance of the system. ***FY 2019 Plans:*** Explore novel mechanics and perception/proprioception technology to enable robust, resilient, and self-sustaining mobility of ground vehicle platforms. Research will be conducted in embedded and inherent sensing, actuation, control of complex structural dynamics, and cognitive/perceptual architectures. Embedded and inherent sensing will also be investigated as a technique to enable locally-controlled reflexive and intuitive behaviors. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure ins support of Army Modernization Priorities.			
Title: FY 2019 SBIR / STTR Transfer ***Description:*** FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer	-	0.300	-
Accomplishments/Planned Programs Subtotals	9.777	9.435	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A