Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	110.712	127.164	87.877	-	87.877	89.591	91.085	93.028	94.756	0.000	694.213
AB4: *Army Research Centers*	-	0.000	26.150	23.268	-	23.268	23.719	24.185	24.416	24.417	0.000	146.155
AB7: *Army Collaborative Research and Tech Alliances*	-	0.000	42.863	46.859	-	46.859	47.802	48.382	48.898	50.424	0.000	285.228
AB8: *Army Educational Outreach Program*	-	0.000	10.466	10.664	-	10.664	10.883	11.101	12.214	12.337	0.000	67.665
AC6: *International Science and Technology*	-	0.000	6.685	7.086	-	7.086	7.187	7.417	7.500	7.578	0.000	43.453
EA6: *Cyber Collaborative Research Alliance*	-	4.701	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.701
F17: *Neuroergonomics Collaborative Technology Alliance*	-	4.542	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.542
FF5: *Distributed Collaborative Intelligent Systems CTA*	-	5.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.600
FF7: *Internet of Battlefield Things CTA*	-	4.021	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.021
H04: *HBCU/MI Programs*	-	1.538	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.538
H05: *Institute For Collaborative Biotechnologies*	-	5.773	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.773
H09: *Robotics CTA*	-	4.080	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.080
H50: *Network Sciences Cta*	-	5.608	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.608
H59: *International Tech Centers*	-	6.345	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.345
H73: *Automotive Research Center (ARC)*	-	3.192	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.192
J08: *Institute For Creative Technologies (ICT)*	-	6.196	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.196

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army													Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601104A *I University and Industry Research Centers*								
J12: *Institute For Soldier Nanotechnology (ISN)*	-	5.773	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.773
J13: *UNIVERSITY AND INDUSTRY INITIATIVES (CA)*	-	22.000	41.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	63.000
J14: *Army Educational Outreach Program*	-	9.883	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.883
J15: *Network Sciences ITA*	-	3.955	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.955
J17: *Vertical Lift Research Center Of Excellence*	-	3.080	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.080
VS2: *Multi-Scale Materials Modeling Centers*	-	8.423	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.423
VS3: *Center For Quantum Science Research*	-	6.002	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.002

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to several new Projects in the following PEs:
* 0601104A University and Industry Research Centers
* 0601121A Cyber Collaborative Research Alliance

A. Mission Description and Budget Item Justification

This PE fosters university and industry based research to provide a scientific foundation for enabling technologies for future force capabilities. Broadly, the work in this PE falls into the categories of Collaborative Technology Alliances / Collaborative Research Alliances (CTAs/CRAs), University Centers of Excellence (COE), University Affiliated Research Centers (UARCs), Army-sponsored educational outreach, and Army investments at international academic and industrial partners. The Army formed CTAs to leverage large investments by the commercial sector in basic research areas that are of great interest to the Army. CTAs are industry-led partnerships between industry, academia, and the Army Futures Command to incorporate the practicality of industry, the expansion of the boundaries of knowledge from universities, and Army scientists to shape, mature, and transition technology relevant to the Army mission. CRAs are academia-led partnerships, which leverage the cutting-edge innovation found in the academic environment. The COEs focus on expanding the frontiers of knowledge in research areas where the Army has enduring needs, and couples state-of-the-art research programs at academic institutions with broad-based graduate education programs to increase the supply of scientists and engineers in automotive and rotary wing technology. Also included are Army Educational Outreach Program (AEOP) and activities to stimulate interest in science, math, and technology among middle and high school students. This PE includes support for basic research at three Army UARCs, which have been created to exploit opportunities to advance new capabilities through a sustained long- term multidisciplinary effort. The Institute for Soldier Nanotechnologies focuses on Soldier protection by emphasizing revolutionary materials research for advanced Soldier protection and survivability. The Institute for Collaborative Biotechnologies focuses on enabling network centric-technologies, and broadening the Army's use of biotechnology for the development of bio-inspired materials, sensors, and information processing. The Institute for Creative Technologies is a partnership with academia and the entertainment and gaming industries to leverage innovative research and concepts for

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601104A *I University and Industry Research Centers*

training and simulation. Examples of specific research of mutual interest to the entertainment industry and the Army are technologies for realistic immersion in synthetic environments, networked simulation, standards for interoperability, and tools for creating simulated environments. This PE also includes the Historically Black Colleges and Universities and Minority Institution (HBCU/MI) Centers of Excellence that address critical research areas for Army Transformation.

FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

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

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	114.003	86.164	87.621	-	87.621
Current President's Budget	110.712	127.164	87.877	-	87.877
Total Adjustments	-3.291	41.000	0.256	-	0.256
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	41.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.291	-			
• Adjustments to Budget Years	-	-	0.256	-	0.256

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: J13: *UNIVERSITY AND INDUSTRY INITIATIVES (CA)*		
Congressional Add: *Congressional Program Increase - University and Industry Research Centers - Army Artificial Intelligence Innovation Institute*	7.000	20.000
Congressional Add: *Congressional Program Increase - University and Industry Research Centers - Bioenabled Materials*	1.000	4.000
Congressional Add: *Congressional Program Increase - University and Industry Research Centers - Improved Machine Intelligence Through Understanding*	2.000	-
Congressional Add: *Congressional Program increase - Materials in Extreme Dynamic Environments*	10.000	5.000
Congressional Add: *Congressional Program Increase - university assisted hypervelocity testing*	2.000	2.000
Congressional Add: *Catalyst*	-	10.000
Congressional Add Subtotals for Project: J13	22.000	41.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add Totals for all Projects	22.000	41.000

Change Summary Explanation

FY20 increase related to $41.000 million of Congressional Add funding.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*				Project (Number/Name) AB4 / *Army Research Centers*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AB4: *Army Research Centers*	-	0.000	26.150	23.268	-	23.268	23.719	24.185	24.416	24.417	0.000	146.155

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0601104A University and Industry Research Centers
* Project H04 HBCU/MI Programs
* Project H05 Institute For Collaborative Biotechnologies
* Project H73 Automotive Research Center
* Project J08 Institute For Creative Technologies
* Project J12 Institute For Soldier Nanotechnology
* Project J17 Vertical Lift Research Center of Excellence

A. Mission Description and Budget Item Justification

This Project encompasses The Partnered Research Initiative (PRI) which supports Army's research partnerships with Historically Black Colleges and Universities and Minority Institutions (HBCU/MI), University Affiliated Research Centers (UARCs), and Army Centers of Excellence (COEs). The PRI Program was established as the next phase of what was previously known as Partnership in Research Transition (PIRT) Program that ended in FY16. The focus of the PRI Program is to advance innovative basic research leading to potential technology development in areas of strategic importance to the Army by bringing competitively selected HBCUs and Minority-Serving Institutions (MIs) research teams into existing Army Futures Command Collaborative Research Alliances (CRAs) and Collaborative Technology Alliances (CTAs). The CTAs and CRAs are large collaborative centers focused on developing and transitioning research in Army critical areas. Army UARCs have been created to exploit opportunities to advance new capabilities through a sustained long- term multidisciplinary effort. The Institute for Soldier Nanotechnologies focuses on Soldier protection by emphasizing revolutionary materials research for advanced Soldier protection and survivability. The Institute for Collaborative Biotechnologies focuses on enabling network centric-technologies, and broadening the Army's use of biotechnology for the development of bio-inspired materials, sensors, and information processing. The Institute for Creative Technologies is a partnership with academia and the entertainment and gaming industries to leverage innovative research and concepts for training and simulation. Examples of specific research of mutual interest to the entertainment industry and the Army are technologies for realistic immersion in synthetic environments, networked simulation, standards for interoperability, and tools for creating simulated environments. The COEs focus on expanding the frontiers of knowledge in research areas where the Army has enduring needs, and couples state-of-the-art research programs at academic institutions with broad-based graduate education programs to increase the supply of scientists and engineers in automotive and rotary wing technology.

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

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB4 / *Army Research Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Centers of Excellence for Battlefield Capability Enhancements (BCE)	-	1.431	1.671
Description: The PRI Program was established as the next phase of what was previously known as PIRT Program that ended in FY16. The focus of the PRI Program is to advance innovative basic research leading to potential technology development in areas of strategic importance to the Army by bringing competitively selected HBCUs and MIs research teams into existing Army Futures Command CRAs and CTAs. The CRAs and CTAs are large collaborative centers focused on developing and transitioning research in Army critical areas. ***FY 2020 Plans:*** New Mexico Institute of Mining and Technology is in collaboration with Multiscale Modeling of Electronic Materials (MSME) CRA by investigating how Uncertainty Quantification techniques and Optimization algorithms can be used to complete the pipeline for robust design of nanoparticles; City College of New York is contributing to Cognition and Neuroergonomics (CaN) CTA by focusing on measuring the relevance of peripheral stimuli to neural reliability via experiments in combined electroencephalogram and eye-tracking during passive free viewing of films; University of Texas at El Paso is in collaboration with Cyber Security CRA by designing and running behavioral game theory experiments on group decision making; and North Carolina Agricultural & Technical State University is contributing to Materials in Extreme Dynamic Environments (MEDE) CRA with experiments to understand the effects of loading conditions such as temperature (from ambient to 773 Kelvin) and strain rate (from quasi-static to ultra-high) and their coupled effects on the mechanical properties and microstructure evolution of magnesium alloys. ***FY 2021 Plans:*** The PRI Program will continue in its second multi-year phase, supporting Army's research partnerships with HBCU/MI via collaborations with UARCs. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Institute for Collaborative Biotechnologies	-	5.146	4.753
Description: This effort performs sustained multidisciplinary basic research supporting technology to provide the Army with bio-inspired materials and biomolecular sensor platforms. ***FY 2020 Plans:*** Continue to support projects and seedlings started in FY19 in systems and synthetic biology and bio-enabled materials. These efforts include synthetic biology tools for novel thermal bioswitches, field-programmable molecular circuits, biological thermoelectric gels, and novel photochromic materials for load bearing. ***FY 2021 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB4 / *Army Research Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will create a new generalizable platform using synthetic biology to engineer materials with novel optical and electronic properties that are impossible to produce using non-biological routes; create a platform to build genetic circuits in Magnetospirillum and G. hansenii to control the primary structure and spatial arrangement of composite nanomaterials; investigate control of the shape, composition, and supermolecular assembly of composite metal nanocrystals integrated into silica structures and investigate organic polymers as conductors. In the long term, these efforts are expected to translate solutions from biological systems into high-performance technologies, materials, and systems for the Army. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to the Artificial Intelligence Hub in PE 0601104A / AB7.			
Title: Institute for Creative Technologies	-	6.372	4.701
Description: This effort focuses on the basic research of Immersive Environments and spans a number of key areas to include virtual humans, three-dimensional (3D) sound and visual media to achieve more efficient and affordable training, modeling, simulation, and application solutions and tools. Research includes: investigation of techniques and methods to address the rapid development of synthetic environments and the study of perception and cognition to help direct the development of new technologies and techniques that evoke more realistic responses from users; auditory aspects of immersion to provide the sound stimulus for increasing the realism for military training and simulation devices; new computational techniques in graphics for achieving real-time photo-realistic rendering of physical and synthetic environments for training and simulations; innovative methods for automatically generating animations and gestures for virtual humans based on what is being communicated; new technologies for scanning real people and rapidly generating virtual humans which look like these people significantly reducing the time, expense, and effort required to develop virtual humans and virtual environments; methods and techniques for creating autonomous virtual human computer-generated characters that look, communicate, and behave like real people, use verbal and non-verbal communication, exhibit emotions, model their own beliefs, desires, and intentions as well as those of others, and reason using advanced artificial intelligence; and methods and techniques for improving the perception, communication, understanding, and responsiveness of virtual humans when interacting with live humans and explore how people relate to virtual humans. ***FY 2020 Plans:*** Use learning science and social simulations to understand and develop the human dimension of immersive environments and its complement to the physical dimensions of synthetic immersive environments, as well as the mixed reality live-synthetic training environment. Define accurate articulation and behavior of virtual entities that will include the use of machine learning and artificial intelligence. Use social simulations and cognitive network techniques to understand the critical human interactions that are necessary for effective virtual humans to replicate accurate training scenarios. ***FY 2021 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB4 / *Army Research Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will explore deep learning in the context of creating virtual assistants and immersive environments for synthetic training; automatically create 3-D models of humans from a few photographs, currently an arduous manual task, as well as realistic behavioral models of humans, such as speaking patterns and behavioral gestures, when interacting in groups; conduct studies to understand human intent and state of mind from video for potential applications in coaching and after-action reports; investigate explainable models of Reinforcement Learning that could form the basis of transparent artificial intelligent systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to the Artificial Intelligence Hub in PE 0601104A / AB7.			
Title: Institute for Soldier Nanotechnologies ***Description:*** This effort investigates Nanomaterials and Nanotechnologies for Soldier Application focused on light-weight, multifunctional nanostructured fibers and materials. ***FY 2020 Plans:*** Advance high-fidelity 3D dynamical modeling for simulation of durability, fracture, and failure of materials under blast to create resilient structural materials. Advance the use of nanooptoelectronics and novel light-matter interactions for optical sensing and energy. Through nanoscience, advance next generation electronics including two-dimensional systems, photonic integrated circuits for ultra-low power electrons, and electromagnetic pulse-resistant circuits. ***FY 2021 Plans:*** Will determine if packed granular particles of shape memory ceramic materials can dissipate energy through inter-particle friction and intra-particle martensitic phase transformations for application to vibrational damping, and synthesis of novel mechano-optic, electro-optic, and thermo-optic fibers. In the long term, this work may enable high bandwidth communications and reflectivity management of Soldier clothing and platforms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to the Artificial Intelligence Hub in PE 0601104A / AB7.	-	5.800	5.410
Title: Vertical Lift Research Center of Excellence (VLRCOE) ***Description:*** VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology to supplement a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations. ***FY 2020 Plans:***	-	3.051	3.313

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB4 / *Army Research Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Implement year four of VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology to conduct a robust experimental and analytic basic research program in broad rotorcraft technologies areas relevant to future vertical lift to include high-performing composite materials to enable extremely light-weight rotor and airframe structures, aeromechanics of high-speed compound rotors and multi-rotor interactions, enhanced damping for high-speed rigid rotors. Following the annual review at the three rotorcraft Centers, adjust technical directions of the research tasks as necessary to ensure that the research remains relevant to the Army's Science and Technology goals. ***FY 2021 Plans:*** Will complete the final year of the current VLRCOE technology interchange agreements with the Georgia Institute of Technology, the Penn State University, and the University of Maryland; conduct fundamental experimental measurements and analysis of Future Vertical Lift relevant configurations such as coaxial rotors and winged compound; identify new research thrust areas of interest to Army Aviation, such as autonomy and teaming; solicit proposals for a new Center of Excellence program that provides a robust experimental and analytic basic research program coupled with a vertical lift focused education program. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Automotive Research Center (ARC) ***Description:*** The ARC is an U.S. Army Center of Excellence for Modeling and Simulation of ground vehicles. The Center relies on the collaboration of researchers from multiple universities and disciplines to bridge fundamental technology gaps in five research thrust areas of strategic importance to the Army: mobility, human factors and man-machine integration, lightweight structure and materials, power and energy, and design integration. A major integrative focus of these five areas are autonomy and manned-unmanned teaming. ***FY 2020 Plans:*** Conduct advanced modeling and simulation research on autonomy and mobility problems for ground vehicles. Topics include teleoperated, semi-, fully-, and multiple autonomous vehicle operation and control, high fidelity operational evaluations of autonomy related technologies, high performance terramechanics models, machine learning, robotic trust, etc. Research optimal power generation storage and distribution for autonomous vehicles expanding in application for drone and electric vehicles in support of the third offset strategy. ***FY 2021 Plans:*** Will continue to conduct advanced modeling and simulation research for ground vehicles focusing on autonomy and mobility problems. Topics will include: teleoperated, semi-, fully-, and multiple autonomous vehicle operation and control, high fidelity operational evaluations of autonomy-related technologies, perception in degraded sensor environments, machine learning, robotic	-	3.163	3.420

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB4 / *Army Research Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
trust, high performance terramechanics models, ground vehicle power generation, storage, and distribution models, and the usage of modeling and simulation techniques to shorten the vehicle/technology/capabilities development for future combat vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	1.187	-
Accomplishments/Planned Programs Subtotals	-	26.150	23.268

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) AB7 / *Army Collaborative Research and Tech Alliances*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AB7: *Army Collaborative Research and Tech Alliances*	-	0.000	42.863	46.859	-	46.859	47.802	48.382	48.898	50.424	0.000	285.228

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0601104A University and Industry Research Centers
* Project F17 Neuroergonomics Collaborative Technology Alliance
* Project FF5 Distributed Collaborative Intelligent Systems CTA
* Project FF7 Internet of Battlefield Things CTA
* Project H05 Institute For Collaborative Biotechnologies
* Project J15 Network Sciences ITA
* Project VS2 Multi-Scale Materials Modeling Centers
* Project VS3 Center For Quantum Science Research

A. Mission Description and Budget Item Justification

This Project supports the Army Collaborative Research Alliances (CRAs) and Collaborative Technology Alliances (CTAs). CTAs and CRAs are partnerships between Army laboratories and centers, private industry, and academia that focus on the rapid transition of innovative technologies to the Warfighter to enable the Army's Future Force. The collaboration between industry, academia and the government is a key element of the alliance concept as each member brings with it a distinctly different approach to research. Academia is known for its cutting-edge innovation; the industrial partners are able to leverage existing research results for transition and to deal with technology bottlenecks; the Army Futures Command researchers keep the program oriented toward solving complex Army technology problems. This approach enables an Alliance to bring together world class research and development talent and focus it on Army-specific technology objectives for application to Army needs. The topics covered by CRAs and CTAs include cyber security (funded in PE 0601121A (Cyber Collaborative Research Alliance)), the internet of battlefield things, distributed and collaborative intelligent systems technology, neuroergonomics and neuroscience, advanced materials, exploitation of quantum effects, and machine learning and artificial intelligence.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Internet of Battlefield Things CTA (IoBT CTA)	-	5.804	6.074
Description: The IoBT CTA seeks to gain fundamental understanding of Internet of Things (IoT) phenomena and its performance in tactical environments, ranging from sparse, remote settings to complex, dense urban environments. Research will address			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
intelligent resourcing and influence in complex, constrained and uncertain networks (demand from massive numbers of dynamically connected devices, limited and unpredictable connectivity, shared civilian networks, computation at or near the device), heterogeneous sensing and actuation devices (efficient, smart devices with self-organizing/preservation/directing capabilities), and variable and unreliable provenance and dynamisms of information and device signals. ***FY 2020 Plans:*** Establish theories and insights leading to scalable composition and management of heterogeneous networks of small sensing and/or actuation devices to enable secure information-driven awareness; build the theoretical foundations, models, and methods for autonomic complex systems that deliver adaptive cyber-physical capabilities and services; create scientific principles, theories, and methods for predictive processing, analytics, and anomaly detection given heterogeneous and varied autonomic, sensing, and actuation data that may be sparse and voluminous. ***FY 2021 Plans:*** Will investigate methods for Dynamic and Autonomous Composition that enable automatic and transparent cooperation between intelligent devices through Deep Learning and Satisfiability Modulo Convex (SMC) optimizations; explore computational methods provide artificial intelligence algorithmic bounding and guarantees, as well as provide resilience to threats and adversarial activities through quantified machine learning (ML) such as deep learning algorithms that provide quantified uncertainty in responses for use in automated processes; create theories and methods for distributed learning and inference that can support collective intelligence through progressive machine learning and continuous learning, such as Zero Shot algorithms that combine deep learning with classifiers and semantic projection. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Distributed Analytics and Information Science International Technology Alliance (ITA) ***Description:*** This research will address the fundamental science underpinning the complex information network issues that are vital to future United States (US) / United Kingdom (UK) coalition military operations and to fully exploit the joint development of emerging technologies necessary to enable coalition operations. These efforts provide enhanced ability to perform adaptive, goal-driven, semantically-aware, distributed analytics for situational understanding in coalition operations. ***FY 2020 Plans:*** Model distributed, dynamic, secure coalition communication/information infrastructures that support distributed analytics to derive situational understanding; create techniques for dynamic self-configuring services "on demand" based on mission needs, context	-	3.935	4.233

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and resource constraints; model underlying distributed analytics and situational understanding that supports dynamic coalition operations involving complex multi-actor situations. ***FY 2021 Plans:*** Will investigate theories, models, and techniques for content-based software defined networking, policy-based secure coalition information infrastructures, composability of adaptive distributed coalition data services, dynamic context-aware information processing services, distributed processing and analytics to derive situational understanding, and complex adaptive human systems in the context of ad-hoc coalition operations at the tactical-edge. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Materials in Extreme Dynamic Environments and Multiscale Multidisciplinary Modeling of Electronic Material CRA ***Description:*** Research will focus on two-way multiscale modeling for predicting performance and designing materials; investigating analytical and theoretical analyses to effectively define the interface physics across length scales; advancing experimental capabilities for verification and validation of multiscale physics; and modeling and strategies for the synthesis of high loading rate tolerant materials. The multiscale modeling capability will be applied across multiple disciplines to facilitate revolutionary advances in materials for coupled environments (electromagnetic, high rate, high pressure, and other extreme environments). ***FY 2020 Plans:*** Implement and integrate basic science tools into a proof-of-concept multiphysics, multiscale capability for Materials by Design that crosses the three electronic materials classes and applications that 1) works across a variety of computational platforms from the desktop to large-scale distributed computing as the problem dictates; 2) allows for uncertainty quantification at scale and moving up and down the scales; and 3) allows assessment of reliability of simulation-predicted outcomes. Initiate a predictive framework that demonstrates a materials-by-design paradigm suitable for Army applications. Establish a process that rigorously limits the path in the multiscale space that must be understood for multiscale materials design. Create newly designed metal, ceramic and composite systems for critical armor applications. Validate and transition integrated codes for multiscale materials design in each of our chosen material systems, coupling aspects of processing, experiments and modeling with respect to the application space. ***FY 2021 Plans:*** Will conduct iterative research through the materials-by-design paradigm to create newly designed metal, ceramic and composites systems for armor applications; continue to investigate multiscale models to enable the transition of software codes and tools to improve armor design codes for the selected material systems; study integrative multi-mechanism models using canonical experiments; use synthesis and processing to control the critical mechanisms which determine the material performance in high strain rate extreme environments; generalize the integrative models based on these mechanisms, thus enabling the materials-	-	8.522	8.680

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
by-design paradigm to be applied to other materials within the same class; investigate physics-informed machine learning for multiscale/multi-physics modeling for the advancement of electrochemical and electro-optical materials devices for sensing, energy and power applications; study extending multiscale modeling to optoelectronic and electrochemical materials and devices to explore physics based materials by design. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Distributed Collaborative Intelligent Systems Technology CTA ***Description:*** Establish the underpinning science to extend the reach, situational awareness, and operational effectiveness of intelligent system and soldier teams against dynamic threats in complex and contested environments and provide technical and operational superiority through fast, intelligent, resilient, and collaborative behaviors. Research efforts will enable distributed systems to engage in complex, time-varying, and contested environments to accomplish Army missions by leveraging a mix of online adaptation and system-wide resilience. ***FY 2020 Plans:*** Establish the fundamental underpinnings of hierarchical, composable, and adaptable learning for collaborative multi-agent networks; distributed learning, inference and planning; resource aware perception-action-communication loops; autonomous and heterogeneous team formation and tasking; robotic team interaction with human teammates; adaptive and on-line learning for robust behaviors in complex and contested environments; scalable control for distributed heterogeneous multi-agent manned-unmanned teams; resilient situational awareness, communications, and autonomous behaviors in the face of failure and adversarial actions. ***FY 2021 Plans:*** Will conduct fundamental research to investigate scalable methods for heterogeneous multi-agent autonomous maneuver through complex environments; explore methods for resource-constrained coordination and local and global situational awareness and understanding between multi-agent heterogeneous team members; investigate techniques for increased resiliency of multi-agent teams to adapt to large changes in state and situational understanding; investigate approaches that will enable multi-agent heterogeneous teams to react to and adapt to adversarial behaviors and operations in contested environments; conduct research to increase understanding of team formation, tasking, and control in collaborative heterogeneous human/multi-agent teams. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.	-	5.914	6.295
Title: Neurosciences CRA	-	0.438	0.654

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort performs multidisciplinary basic research in the area of neuroscience through collaboration with the University of California at Santa Barbara. ***FY 2020 Plans:*** Establish an understanding of the effect of fatigue and stress on cognition and on decision making and identify neural indicators/ biomarkers for optimal decision making; create neuro-engineering techniques to make inferences about human?s cognitive and attentional states that are particularly relevant to challenges faced by the Soldier. ***FY 2021 Plans:*** Will identify neural biomarkers that correspond to individual differences in spatial and navigational abilities, thereby testing specific predictions about the structural and functional correlates of different skills; investigate training paradigms to improve navigational abilities, testing the hypothesis that training involving making explicit predictions about upcoming locations when learning a novel environment will improve performance; determine how brain structure and function changes with training, testing the hypothesis that prediction training will increase intrinsic connectivity between prefrontal cortex and hippocampus and will lead to structural changes in white matter and diffusivity. If successful, these studies may enable new training techniques to enhance navigational skills. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Fund change reflects planned lifecycle of this effort.			
Title: Center for Exploitation of Quantum Effects ***Description:*** This work supports needed quantum information science basic research at the Army Futures Command for next generation capabilities in security, decision aids, sensing, and position, navigation, and timing (PNT) for Army dominance on the future battlefield. ***FY 2020 Plans:*** Establish methods for efficient light-matter interaction, including the use of optical cavities and materials suitable for nanophotonic integration; understand unique topological photonic materials for quantum state protection; and study quantum algorithms and measurement techniques and quantum frequency conversion in atomic and solid-state defect systems to improve quantum sensors. ***FY 2021 Plans:*** Will investigate, through experiment and theory: approaches for manipulating quantum systems with strong atom-light interaction; nanophotonic materials that protect quantum information from perturbations; optimization techniques for quantum algorithms and	-	2.784	3.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
non-classical measurement that beats classical limits. Will identify solid-state materials and excitation pathways in atoms that optimize response to electric and magnetic fields. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Fund change reflects planned lifecycle of this effort.			
Title: Neuroergonomics CTA ***Description:*** By utilizing fundamental principles that underlie Soldier neurocognitive performance, this effort provides individualized and adaptive technologies that enhance Soldier-agent interaction. ***FY 2020 Plans:*** Identify the potential for human behavior and neurophysiological data to be used to dynamically inform an AI agent trained to learn personalized navigation polices in operationally-relevant tasks; will create sensing hardware and signal processing algorithms to enable the acquisition and interpretation of neural activity during ambulation. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This efforts ends in FY20.	-	1.084	-
Title: Identification and characterization of team-level processes for enhancing performance of heterogeneous Soldier-Agent teams CRA ***Description:*** By developing and validating theoretical principles of human-agent team states and processes, this effort defines methods for exploiting individual dynamics and variability to improve team-level properties and performance. ***FY 2020 Plans:*** Create novel metrics of team-level states that account for specific roles and characteristics of both humans and intelligent agents as they cooperate to perform complex tasks; uncover fundamental relationships between team-level and individualized states and how changes in these states affect team performance over time. ***FY 2021 Plans:*** Will execute multiple focused lines of research prioritizing discovery and operationalization of the relationships between individual dynamics and team-level states and processes in human-autonomy teams; investigate novel metrics of team-level states and processes in human-autonomy teams that impact team effectiveness, accounting for specific roles and characteristics of humans and intelligent agents cooperatively performing complex tasks; and explore advancements in dynamic models linking individual and team states. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	3.314	4.933

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Planned program progression.			
Title: Army Artificial Intelligence Innovation Institute (A2I2) ***Description:*** This effort coordinates, conducts, and accelerates basic research to address Army-specific challenges, with a focus on advancing artificial intelligence (AI) and ML capabilities for autonomous maneuver in multi-domain operations (MDO). A broad-spectrum of AI capabilities are critical to the integration of operations in the contested environment including human-agent teaming for faster and more informed decisions, multi-domain Command, Control, Communications, and Computers (C4) that is resilient to Cyber Electromagnetic Activities (CEMA), and AI enabled cyber security that is robust to enemy deception. The Army Futures Command (AFC) will leverage its existing High Performance Computing (HPC) and network infrastructure, along with its regional laboratory extensions to enable basic research on AI that is open, with top-tier universities, small & large commercial businesses, and established Department of Defense industrial partners. The A2I2 creates an accessible database of heterogeneous data, a repository of AI and ML algorithms and software tools, and military-relevant challenge problems. ***FY 2020 Plans:*** Establish challenge problems on autonomous ground maneuver in complex off-road terrain as well as intelligent perception in complex urban terrain; will progressively increase problem complexity (from simple to complex terrain and from single to multiple agents), and steadily increase generality of the AI deceptive actions (from both the Move and Perception standpoints) in order to enable Robotic Autonomous Systems (RAS) that can still maneuver intelligently without human control despite adversarial interference; and begin data collection efforts to provide initial data base for learning algorithms. ***FY 2021 Plans:*** Will further investigate the underpinning science to extend the reach, situational awareness, and operational effectiveness of Intelligent System/Soldier teams against dynamic threats in complex and contested environments; research will working to explain how diverse, embodied agents collectively sense, infer, reason, plan, and execute in collaboration with Soldiers and in the face of a peer adversary. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work continues in Artificial Intelligence Hub.	-	9.121	7.470
Title: Artificial Intelligence Hub ***Description:*** The AI Hub is located at Carnegie Mellon University as a consortium of industry, government, and academia focused on building and optimizing the Army's AI and ML initiatives with the goal of accelerating the fielding of capability. The AI Hub will utilize the A2I2 data and AI/ML algorithms and software tools to investigate AI and ML capabilities to address the Army's unique problems. The AI Hub will focus on research into AI technologies for future application to Army-relevant areas such as	-	-	5.520

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB7 / *Army Collaborative Research and Tech Alliances*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
predictive maintenance, operations for intelligence in support of Long Range Precision Fires, human relations/talent management; and autonomous threat recognition. ***FY 2021 Plans:*** Investigate AI and ML models for: identifying emerging trends in helicopter maintenance records and/or on-board flight and/or vibration data; autonomous collection, integration, and analysis of information from myriad sensors/systems to rapidly produce actionable intelligence and facilitate targeting; branching models which align Army personnel talent with branch needs; AI that raises the level and number of tasks that can be executed autonomously or semi-autonomously by vehicles in the fleet. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Continues work from Army Artificial Intelligence Innovation Institute (A2I2).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	1.947	-
Accomplishments/Planned Programs Subtotals	-	42.863	46.859

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) AB8 / *Army Educational Outreach Program*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AB8: *Army Educational Outreach Program*	-	0.000	10.466	10.664	-	10.664	10.883	11.101	12.214	12.337	0.000	67.665

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0601104A University and Industry Research Centers
* Project J14 Army Educational Outreach Program

A. Mission Description and Budget Item Justification

This Project supports science, technology, engineering, and mathematics (STEM) activities that encourage elementary/middle/high school and undergraduate youths to develop an interest in and pursue education and employment in the STEM fields. These activities are coordinated within the Army Educational Outreach Program (AEOP) that links and networks appropriate components to derive the best synergies to present the Army to a larger pool of technical talent and to provide students with Army-unique practical experiences at Army laboratories, centers, and institutes and expose them to Department of Defense careers. AEOP increases interest and involvement of students and teachers across the nation in STEM at all proficiency levels and backgrounds to include under-represented and economically disadvantaged groups through exposure to Army sponsored research, education, competitions, internships, and practical experiences. This Project utilizes Army STEM assets to contribute to a STEM literate citizenry as well as enhances the national pool of science and engineering personnel that in turn supports defense industry and Army laboratory and research, development, and engineering center needs.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: AEOP Coop Agreement	-	10.156	10.354
Description: The Army Educational Outreach Program Cooperative Agreement encompasses a cohesive and coordinated portfolio of STEM education experiences to develop, enhance, and reward students in pursuit of STEM education. This activity supports a strong partnership with government, academia and industry to leverage assets and provide a broader and deeper STEM experience for students and teachers to address the Department's, and the nation's, challenge of acquiring clearable STEM literate talent in positions throughout the workforce and in the industrial base. These activities include Army-sponsored research, education, competitions, apprenticeships, internships, and practical experiences designed to engage and guide students and teachers in Army sponsored STEM programs. AEOP has targeted efforts to reach and engage underserved communities in STEM initiatives to build the pool of diverse STEM competitive talent.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AB8 / *Army Educational Outreach Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Continue Army sponsorship of students and STEM education opportunities; provide incentives in STEM competitions that include scholarships, experiences and mentorships as well as expose students to DoD career opportunities; streamline processes, leverage funding and build educational partnerships; and perform annual comprehensive reviews and educational assessments to support future decisions and best practices. ***FY 2021 Plans:*** Will continue Army sponsorship of students and STEM education opportunities; provide incentives in STEM competitions that include scholarships, experiences and mentorships as well as expose students to DoD career opportunities; streamline processes, leverage funding and build educational partnerships; and will perform annual comprehensive reviews and educational assessments to support future decisions and best practices. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: West Point Cadet Program ***Description:*** The West Point Cadet Research Program provides West Point Cadets an opportunity to work on Army research projects alongside Army and industry scientists and engineers during the summer. ***FY 2020 Plans:*** Conduct West Point cadet research internship program to enhance cadet training through field experience in Army research labs and engineering centers. Between 40 and 60 cadets are to intern for a period of 3 to 6 weeks. ***FY 2021 Plans:*** Will conduct West Point cadet research internship program to enhance cadet training through field experience in Army research labs and engineering centers. Between 40 and 60 cadets will intern for a period of 3 to 6 weeks.	-	0.310	0.310
Accomplishments/Planned Programs Subtotals	-	10.466	10.664

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) AC6 / *International Science and Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AC6: *International Science and Technology*	-	0.000	6.685	7.086	-	7.086	7.187	7.417	7.500	7.578	0.000	43.453

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0601104A University and Industry Research Centers
* Project H59 International Tech Centers

A. Mission Description and Budget Item Justification

This Project funds the International Technology Centers (ITCs) and the Foreign Technology (and Science) Assessment Support (FTAS) program. The nine ITCs located in North America, South America, Asia, and Europe support the Army's goals of providing the best technology in the world to our Warfighters by leveraging the Science and Technology (S&T) investments of our international partners. The ITCs perform identification and evaluation of international technology programs to assess their potential impact on the Army's S&T investment strategy. ITC 'technology finds' are submitted to various Army S&T organizations for evaluation and consideration for further research and development. Highly promising research will be awarded seed funding by the ITC through a grant, contract, or cooperative agreement. The FTAS program also builds upon the technology finds submitted by the ITCs. In some cases the find is truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. In such cases, the FTAS program can provide initial resources (seed money) to determine the appropriateness of these technology areas identified as having potential relevance to the Army. These efforts will provide information useful in making early assessments of the technology's potential contributions to the Army's S&T strategy.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: International Technology Centers	-	4.374	4.556
Description: The nine ITCs located in North America, South America, Asia, and Europe support the Army's goals of providing the best technology in the world to our Warfighters by leveraging the S&T investments of our international partners. The ITCs perform identification and evaluation of international technology programs to assess their potential impact on the Army's S&T investment strategy. ITC 'technology finds' are submitted to various Army S&T organizations for evaluation and consideration for further research and development through avenues such as the FTAS Program. Highly promising research is awarded seed funding by the ITC through a grant, contract, or cooperative agreement - typically to a foreign university.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AC6 / *International Science and Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
The ITCs continue to seek out foreign science and technology within their geographic areas of responsibility that may have United States (US) Army interest and applicability, In accordance with the Army S&T Strategy, ITCs connect foreign researchers with US Army scientists and engineers, and ultimately fund promising research through a grant, contract, or cooperative agreement. They also continue to enhance and refine technology search capabilities using customer feedback to focus on mid- and long-term capabilities. ***FY 2021 Plans:*** Will continue to seek out promising foreign science and technology solutions within geographic areas of responsibility that may have interest and applicability to the U.S. Army?s research and development efforts in support of the Army?s Modernization Priorities. In accordance with the Army S&T Strategy and the Combat Capabilities Development Command (CCDC) Global Engagement Plan, the ITCs will seek-out and connect foreign researchers with U.S. Army scientists and engineers, with the explicit intent to fund promising and relevant research through a grant, contract, or cooperative agreement. Will also continue to enhance and refine technology search capabilities using customer feedback to focus on mid- and long-term capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope.			
Title: Foreign Technology (& Science) Assessment Support ***Description:*** The FTAS program serves as a catalyst for the US Army Futures Command to assess potentially game-changing technologies discovered in friendly foreign nations by the US Army International ITCs which may meet future Army needs. The technology finds can often times be truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. These efforts will provide information useful in making early assessments of a technology's potential contributions to the Army's S&T strategy. ***FY 2020 Plans:*** Solicit proposals and assess scientific quality of candidate projects by utilizing US Army Senior Scientist Corps expertise.)provide seed funding for approved proposals to US Army laboratories to develop and/or assess these technology areas identified by the Army?s ITCs. ***FY 2021 Plans:*** Will solicit proposals and assess scientific quality of candidate projects by utilizing U.S. Army Senior Scientist Corps expertise. Provide seed funding for approved proposals to U.S. Army laboratories to develop and/or assess technology areas identified by the Army?s ITCs. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	2.057	2.530

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** AC6 / *International Science and Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Increase in funding supports additional proposals.			
Title: FY 2020 SBIR/STTR Transfer	-	0.254	-
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	6.685	7.086

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) EA6 / *Cyber Collaborative Research Alliance*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
EA6: *Cyber Collaborative Research Alliance*	-	4.701	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.701

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601121A Cyber Collaborative Research Alliance
* Project CB5 Cyber Collaborative Research Alliance

A. Mission Description and Budget Item Justification

This Project fosters research performed through the Cyber Security (CSEC) Collaborative Research Alliance (CRA), a competitively selected consortium, formed to advance the theoretical foundations of cyber science in the context of Army networks. This CRA consists of academia, industry and government researchers working jointly with the objective of developing a fundamental understanding of cyber phenomena so that fundamental laws, theories, and theoretically grounded and empirically validated models can be applied to a broad range of Army domains, applications, and environments. This research focuses on three interrelated aspects of cyber security and is conducted using a trans-disciplinary approach that takes into account the human element of the network. The three aspects of cyber that are addressed are: 1) vulnerabilities and risks of cyber networks to malicious activities, 2) anticipating, detecting, and analyzing malicious activities, and 3) agile cyber maneuver to thwart and defeat malicious activities. Overarching goals of cyber security are to significantly decrease the adversary's return on investment when considering cyber attack on Army networks, and minimizing the impact on (Army) network performance related to implementing cyber security. The CRA research creates a framework that effectively integrates the knowledge of cyber assets and potential adversary capabilities and approaches, and provides defense mechanisms that dynamically adjust to changes related to mission, assets, vulnerability state, and defense mechanisms.

Work in this Project supports key Army needs and provides the technical underpinnings to PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Cyber Security Collaborative Research Alliance	4.701	-	-
Description: The CSEC CRA supports basic research to enable capabilities for rapid development and adaptation of cyber tools for dynamically assessing cyber risks, detecting hostile activities on friendly networks, and supporting agile maneuver in cyber space in spite of the continuous evolution and emergence of novel threats.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** EA6 / *Cyber Collaborative Research Alliance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Accomplishments/Planned Programs Subtotals	4.701	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) F17 / *Neuroergonomics Collaborative Technology Alliance*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
F17: *Neuroergonomics Collaborative Technology Alliance*	-	4.542	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.542

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project fosters research through the Cognition and Neuroergonomics Collaborative Technology Alliance (CTA), a competitively selected industry and university consortium, to leverage world-class research in support of future force and Army transformation needs. Escalating levels of complexity and uncertainty on the current and future battlefield present conditions which have never existed before now. Solution strategies and approaches must be developed or tailored. The emerging field of neuroergonomics, which seeks to understand the brain at work and to leverage that understanding to optimize system design, offers tremendous potential for providing the solutions needed to meet the needs of Army forces in the future. This CTA addresses the solution strategies and approaches needed to design systems to fully exploit investments in revolutionary technological advances in areas such as robotics, microelectronics, and computer and network information systems. These technologies present significant opportunities to enhance Army mission capabilities, but impose significant burdens on the human brain, which will ultimately limit Soldier-system effectiveness, sustainability, and survivability. The technical barriers associated with this project include: immature knowledge base to guide the neuroergonomic approach to human-system integration; inadequate capabilities to sense and extract information about brain activity in dynamic, operational environments; lack of valid measures to robustly and uniquely characterize operationally-relevant cognitive performance; lack of techniques for integrating advanced understandings of brain activity into systems designs, including real-time use of measures of cognitive behavior as system inputs and the capability to account for individual differences in maximizing Soldier-system performance. This CTA conducts an intensive and accelerated program to formulate, validate, and transition basic research findings through multi-dimensional approaches focused in three areas: understanding fundamental principles underlying Soldier neurocognitive performance in operational environments, advancing computational approaches for the analysis and interpretation of neural functioning, and fundamental advancement in neurotechnologies that enhance Soldier-system interactions and performance.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Neurocognitive performance in operational environments	1.735	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** F17 / *Neuroergonomics Collaborative Technology Alliance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort is intended to understand fundamental principles underlying Soldier neurocognitive performance in operational environments.			
Title: Computational neural analysis ***Description:*** This effort advances computational approaches for the analysis and interpretation of neural functioning.	1.303	-	-
Title: Neurotechnologies ***Description:*** This effort provides a fundamental advancement in neurotechnologies that enhance Soldier-system interactions and performance.	1.504	-	-
Accomplishments/Planned Programs Subtotals	4.542	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) FF5 / *Distributed Collaborative Intelligent Systems CTA*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
FF5: *Distributed Collaborative Intelligent Systems CTA*	-	5.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.600

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project fosters basic research through the highly Distributed and Collaborative Intelligent Systems and Technology (DCIST) Collaborative Research Alliance (CRA), a competitively selected university consortium which leverages world-class research necessary to address future force and Army Transformation needs. The CRA links a broad range of government technology agencies, as well as industrial and academic partners with the Army Futures Command. The DCIST CRA focuses on systems with a large number of heterogeneous intelligent agents, including Soldiers that can be distributed over large areas and are required to move through contested environments and against peer capabilities at op-tempo. To meet these goals innovative research is performed in three main technical areas: distributed intelligence, large heterogeneous group control, and adaptive and resilient behaviors. The payoff to the warfighter will be extended reach, situational awareness, and operational effectiveness against dynamic threats in contested environments, and technical and operational superiority through intelligent, resilient and collaborative behaviors of Soldiers and intelligent systems. The CRA facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, and to make available to the Alliance state-of-the-art facilities and equipment at the participating organizations.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Distributed Collaborative Intelligent Systems Technology	5.600	-	-
Description: Extend reach, situational awareness, and operational effectiveness against dynamic threats in contested environments through intelligent, resilient and collaborative behaviors of heterogeneous teams of Soldiers, intelligent systems, smart sensors, and knowledge sources.			
Accomplishments/Planned Programs Subtotals	5.600	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** FF5 / *Distributed Collaborative Intelligent Systems CTA*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) FF7 / *Internet of Battlefield Things CTA*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
FF7: *Internet of Battlefield Things CTA*	-	4.021	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.021

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project will foster research performed through the Internet of Battlefield Things (IoBT) Collaborative Research Alliance (CRA), a competitively selected consortium formed to advance the theoretical foundations of the Internet of Things in the context of Army Operations. The CRA will comprise academia, industry and government researchers working jointly with the objective of developing a fundamental understanding of phenomena of Internet of Things (IoT) and cyber-physical systems in tactically relevant environments. The CRA will facilitate collaboration across organizations to provide multi-disciplinary perspectives on basic research challenges, as well as the use of state-of-the-art facilities and equipment at the participating organizations. This research focuses on three interrelated aspects of pervasive and converged cyber- physical complex information systems and is conducted using a trans-disciplinary approach that takes into account the information-theoretic and human elements of Army IoBT interactions. The three aspects of the emergent Internet of Battlefield Things topical areas addressed are: 1) dynamic discovery and adaptation of cyber- physical devices, networks, and information sources, 2) resilient re-purposing and re-tasking of devices and information capabilities, and 3) algorithmic, distributed and centralized information-stream processing. Overarching goals of the basic research on Army IoBT are to investigate foundational cross-cutting theories and methods leading towards a science of heterogeneous, self-adapting, complex cyber-physical systems. This research will lead to optimized real-time adversarial situation estimates in information-enabled warfare and greatly enhance the speed and precision for complex military operations involving converged sensing, communications, and resilient actuation.

Work in this Project builds fundamental knowledge for and accelerates the transition of communications and networks technology to PE 0602783A (Computer and Software Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Internet of Battlefield Things Collaborative Research Alliance	4.021	-	-
Description: The Internet of Battlefield Things (IoBT) CRA seeks to gain fundamental understanding of IoT phenomena and its performance in tactical environments, ranging from sparse, remote settings to complex, dense urban environments. To enable an			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** FF7 / *Internet of Battlefield Things CTA*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
IoBT capability, research needs to address intelligent resourcing and influence in complex, constrained and uncertain networks (demand from massive numbers of dynamically connected devices, limited and unpredictable connectivity, shared civilian networks, computation at or near the device), heterogeneous sensing and actuation devices (efficient, smart devices with self-organizing/preservation/directing capabilities), and variable, and unreliable provenance and dynamisms of information and device signals.			
Accomplishments/Planned Programs Subtotals	4.021	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H04 / *HBCU/MI Programs*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H04: *HBCU/MI Programs*	-	1.538	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.538

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers

A. Mission Description and Budget Item Justification

This Project supports basic research through the Partnered Research Initiative (PRI), the Army's research initiative focused on partnerships with Historically Black Colleges and Universities and Minority Institutions (HBCU/MI). The PRI Program was established as the next phase of what was previously known as Partnership in Research Transition (PIRT) Program that ended in FY16. The focus of this effort is to enhance programs and capabilities of high-interest scientific and engineering disciplines through innovative research performed in collaboration with Collaborative Technology Alliances and Collaborative Research Alliances (CTA/CRAs). The CTA/CRAs work with Army, industry, and other academic partners to transition research to technology demonstration. In addition, the Centers of Excellence (CoEs) and CTA/CRA partnerships provide opportunities to recruit, educate, and train outstanding students and post-doctoral researchers in science and technology areas relevant to the Army.

Work performed in this Project supports key Army needs and is coordinated with one or more Projects in PE 0601104A (University and Industry Research Centers).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Centers of Excellence for Battlefield Capability Enhancements	1.538	-	-
Description: Four PRI efforts from HBCUs/MIs joined the CTA/CRA consortia in early FY17: New Mexico Institute of Mining and Technology will collaborate with Multiscale Modeling of Electronic Materials (MSME) CRA by investigating how Uncertainty Quantification techniques and Optimization algorithms can be used to complete the pipeline for robust design of nanoparticles; City College of New York will contribute to Cognition and Neuroergonomics (CaN) CTA by focusing on measuring the relevance of peripheral stimuli to neural reliability via experiments in combined electroencephalogram (EEG) and eye-tracking during passive free viewing of films; University of Texas at El Paso will collaborate with Cyber Security CRA by designing and running behavioral game theory experiments on group decision making; and North Carolina Agricultural & Technical State University will contribute to Materials in Extreme Dynamic Environments (MEDE) CRA with experiments to understand the effects of loading conditions			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H04 / *HBCU/MI Programs*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
such as temperature (from ambient to 773 Kelvin) and strain rate (from quasi-static to ultra-high) and their coupled effects on the mechanical properties and microstructure evolution of magnesium alloys.			
Accomplishments/Planned Programs Subtotals	1.538	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H05 / *Institute For Collaborative Biotechnologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H05: *Institute For Collaborative Biotechnologies*	-	5.773	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.773

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project supports research at the Army's Institute for Collaborative Biotechnologies (ICB), led by the University of California-Santa Barbara, and two major supporting partners, the California Institute of Technology and the Massachusetts Institute of Technology. The ICB was established as a University Affiliated Research Center (UARC) to support leveraging biotechnology for: advanced sensors; new electronic, magnetic, and optical materials; and information processing and bioinspired network analysis. The objective is to perform sustained multidisciplinary basic research supporting technology to provide the Army with biomolecular sensor platforms with unprecedented sensitivity, reliability, and durability; higher-order arrays of functional electronic and optoelectronic components capable of self-assembly and with multi-functions; and new biological means to process, integrate, and network information. These sensor platforms will incorporate proteomics (large scale study of proteins) technology, Deoxyribonucleic Acid (DNA) sequence identification and detection tools, and the capability for recognition of viral pathogens. A second ICB objective is to educate and train outstanding students and post-doctoral researchers in revolutionary areas of science to support Army Transformation. The ICB has many industrial partners, such as International Business Machine (IBM) and Science Applications International Corporation (SAIC), and has strong collaborations with Argonne, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, and Sandia National Laboratories, the Army's Institute for Soldier Nanotechnologies, the Institute for Creative Technologies, and Army Medical Research and Materiel Command (MRMC) laboratories.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Institute for Collaborative Biotechnologies ***Description:*** Perform sustained multidisciplinary basic research supporting technology to provide the Army with bio-inspired materials and biomolecular sensor platforms.	5.139	-	-
Title: Neuroscience	0.634	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H05 / *Institute For Collaborative Biotechnologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Perform multidisciplinary basic research in the area of neuroscience.			
Accomplishments/Planned Programs Subtotals	5.773	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H09 / *Robotics CTA*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H09: *Robotics CTA*	-	4.080	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.080

Note

This Project concludes after Fiscal Year (FY) 2019.

A. Mission Description and Budget Item Justification

This Project supports a collaborative effort between the competitively selected industry and university consortium, the Robotics Collaborative Technology Alliance (CTA), and the Army Futures Command for the purpose of leveraging world-class research in support of the future force and Army transformation needs. This Project conducts basic research in areas that will expand the capabilities of intelligent mobile robotic systems for military applications with a focus on enhanced, innate intelligence, ultimately approaching that of a dog or other intelligent animal, to permit unmanned systems to function as productive members of a military team. Research is conducted in machine perception, including the exploration of sensor phenomenology, and the investigation of basic machine vision algorithms enabling future unmanned systems to better understand their local environment for enhanced mobility and tactical performance; intelligent control, including the advancement of artificial intelligence techniques for robot behaviors permitting future systems to autonomously adapt, and alter their behavior to dynamic tactical situations; understanding the interaction of humans with machines focusing upon intuitive control by Soldiers to minimize cognitive burden; dexterous manipulation of the environment by unmanned systems; and unique modes of mobility to enable unmanned systems to seamlessly navigate complex or highly constrained three dimensional environments. The program will conduct both analytic and validation studies.

Work in this Project builds fundamental knowledge for and complements the companion applied technology program, Program Element (PE) 0602120A, Project TS2 (Robotics).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Autonomous Systems	4.080	-	-
Description: Explore opportunities enabling revolutionary, autonomous, and highly mobile systems for the future force. Research focuses on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations.			
Accomplishments/Planned Programs Subtotals	4.080	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H09 / *Robotics CTA*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H50 / *Network Sciences Cta*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H50: *Network Sciences Cta*	-	5.608	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.608

Note

This Project concludes after Fiscal Year (FY) 2019.

A. Mission Description and Budget Item Justification

This Project supports a competitively selected university and industry consortium, the Network Sciences Collaborative Technology Alliance (NS CTA), formed to leverage commercial research investments to provide solutions to Army's requirements for robust, survivable, and highly mobile wireless communications networks, while meeting the Army's needs for a state-of-the-art wireless mobile communications networks for command-on-the-move. The NS CTA performs foundational, cross-cutting network science research leading to: a fundamental understanding of the interplay and common underlying science among social/cognitive, information, and communications networks; determination of how processes and parameters in one network affect and are affected by those in other networks; and prediction and control of the individual and composite behavior of these complex interacting networks. This research will lead to optimized human performance in network-enabled warfare and greatly enhanced speed and precision for complex military operations. The CTA facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, as well as the use of state-of-the-art facilities and equipment at the participating organizations. Many of the results of the NS CTA provide a foundation for the Internet of Battlefield Things Collaborative Research Alliance that began in FY18.

Work in this Project builds fundamental knowledge for and accelerates the transition of communications and networks technology to Program Element (PE) 0602783A (Computer and Software Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Network Sciences Collaborative Technology Alliance	5.608	-	-
Description: The Network Sciences CTA focuses on four major research areas: Information Networks, Communication Networks, Social/Cognitive Networks, and Interdisciplinary Research to develop a fundamental understanding of the ways that information, social/cognitive, and communications networks can be designed, composed, and controlled to dramatically increase mission effectiveness and ultimately enable humans to effectively exploit information for timely decision-making. Information Networks research develops the fundamental understanding of autonomous network activities and its linkage to the physical and human domains as related to human decision making within the networked command and control (C2) structure. Social/Cognitive Networks research is developing the fundamental understanding of the interplay of the various aspects of the social and cognitive networks with information and communications. Communications Networks research is developing the foundational techniques to model, analyze, predict, and control the behavior of secure tactical communication networks as an enabler for information and C2			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H50 / *Network Sciences Cta*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
networks. Integration is focused on achieving an integrated Information Networks, Social/Cognitive Networks, Communications Networks research program that significantly enhances the fundamental understanding of the underlying science of networks.			
Accomplishments/Planned Programs Subtotals	5.608	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H59 / *International Tech Centers*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H59: *International Tech Centers*	-	6.345	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.345

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AC6 International Science and Technology

A. Mission Description and Budget Item Justification

This Project funds the International Technology Centers (ITCs) and the Foreign Technology (and Science) Assessment Support (FTAS) program.

The nine ITCs located in in North America, South America, Asia, and Europe support the Army's goals of providing the best technology in the world to our Warfighters by leveraging the Science and Technology (S&T) investments of our international partners. The ITCs perform identification and evaluation of international technology programs to assess their potential impact on the Army's S&T investment strategy. ITC 'technology finds' are submitted to various Army S&T organizations for evaluation and consideration for further research and development. Highly promising research will be awarded seed funding by the ITC through a grant, contract, or cooperative agreement. The FTAS program also builds upon the "technology finds" submitted by the ITCs. In some cases the technology is truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. In such cases, the FTAS program can provide initial resources (seed money) to determine the appropriateness of these technology areas identified as having potential relevance to the Army. These efforts will provide information useful in making early assessments of the technology's potential contributions to the Army's S&T strategy.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: International Technology Centers	4.311	-	-
Description: This effort funds the technology search function of the ITCs. Research and/ or technologies that have possible interest to the Army are disseminated to the Army research enterprise. Review of these technologies by the research community provides useful information in making early assessments of the technology's potential contributions to the Army's S&T strategy. Highly promising international basic research will be provided seed funding by the ITC for further evaluation through a grant, contract, or cooperative agreement, typically to a university.			
Title: Foreign Technology (and Science) Assessment Support	2.034	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H59 / *International Tech Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort funds the FTAS program. The FTAS program builds upon the ?technology finds? submitted by the ITCs. In some cases a technology is truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. In such cases, the FTAS program can provide initial resources (seed money) to determine the appropriateness of technology areas identified to meet Army needs. These efforts will provide information useful in making early assessments of the technology's potential contributions to the Army's S&T strategy.			
Accomplishments/Planned Programs Subtotals	6.345	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) H73 / *Automotive Research Center (ARC)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H73: *Automotive Research Center (ARC)*	-	3.192	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.192

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers

A. Mission Description and Budget Item Justification

This Project fosters basic research in novel, high payoff technologies that can be integrated into Army ground platforms. The Center of Excellence for Automotive Research is part of the basic research component of the Army Futures Command. The Center of Excellence for Automotive Research is an innovative university/ industry/government consortium leveraging commercial technology for potential application in Army vehicle systems through ongoing and new programs in automotive research, resulting in significant cost savings and performance enhancing technological opportunities. The research performed in this Project contributes to formulating and establishing the basic scientific and engineering principles for these technologies.

Work in this Project complements and is fully coordinated with work under PE 0602601A (Combat Vehicle and Automotive Technology). Selected university partners include: University of Michigan, Virginia Tech, Wayne State University, University of Iowa, Oakland University, and Clemson University. Key industry partners include all major United States automotive manufacturers and suppliers. The Automotive Research Center (ARC) formulates and evaluates advanced automotive technologies and advances state-of-the-art modeling and simulation for the Army's future ground vehicle platforms.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Automotive Research Center	3.192	-	-
Description: The ARC is an United States (US) Army Center of Excellence for Modeling and Simulation of ground vehicles. The Center relies on the collaboration of researchers from multiple universities and disciplines in order to bridge fundamental technology gaps in five research thrust areas of strategic importance to the Army, associated with conversion and management of power and energy within vehicles, mobility and survivability of the complete vehicle system, including the human occupants, and vehicle integration/optimization.			
Accomplishments/Planned Programs Subtotals	3.192	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** H73 / *Automotive Research Center (ARC)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J08 / *Institute For Creative Technologies (ICT)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J08: *Institute For Creative Technologies (ICT)*	-	6.196	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.196

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers

A. Mission Description and Budget Item Justification

This Project supports simulation and training technology research at the Army's Institute for Creative Technologies (ICT) at the University of Southern California. The ICT was established as a University Affiliated Research Center (UARC) to support Army training and readiness through research into simulation, mixed and virtual reality, artificial intelligence, computer graphics, and learning sciences. ICT applies the results of this research and proves its value in Army relevant applications such as training, mission rehearsal, leadership development, cultural awareness, negotiation, health and medical, and distance learning. The ICT actively performs research and engages industry and academic institutions internationally to incorporate the latest research results and hardware and software into its research program and application development and exploit dual-use technology. The ICT serves as a means for the military to learn about, benefit from, and facilitate the transfer of applicable technologies into military systems. In addition the ICT works with creative talent from the entertainment industry to advance and leverage techniques and capabilities and adapt concepts of story and character to increase the degree of participant immersion in synthetic environments in order to improve the realism and usefulness of these experiences. In developing a true synthesis of the creativity, research, technology, and capability of industry and the research and development community, the ICT is revolutionizing capabilities for the Army by making it more effective in terms of cost, time, range of experiences and the quality of the result and by producing research and applications that will benefit the Army of the 21st century.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Immersive Environments	2.452	-	-
Description: Conduct basic research in immersive environments, to include virtual humans, three-dimensional (3D) sound and visual media, to achieve more efficient and affordable training, modeling, simulation and application solutions and tools. Research includes investigation of techniques and methods to address the rapid development of synthetic environments and the study of perception and cognition to help direct the development of new technologies and techniques that evoke more realistic responses			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** J08 / *Institute For Creative Technologies (ICT)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
from users. Perform research into auditory aspects of immersion to provide the sound stimulus for increasing the realism for military training and simulation devices.			
Title: Graphics and Animations ***Description:*** Conduct basic research to identify new computational techniques in graphics for achieving real-time photo-realistic rendering of physical and synthetic environments for training and simulations. Research innovative methods for automatically generating animations and gestures for virtual humans based on what is being communicated. Research new technologies for scanning real people and rapidly generating virtual humans which look like these people significantly reducing the time, expense and effort required to develop virtual humans and virtual environments.	1.211	-	-
Title: Techniques and Human-Virtual Human Interaction ***Description:*** Basic research to investigate methods and techniques for creating virtual human computer-generated characters that look, communicate and behave like real people, meaning the virtual humans will be autonomous, use verbal and non-verbal communication, exhibit emotions, model their own beliefs, desires and intentions as well as those of others, and reason using advanced artificial intelligence. Investigate methods and techniques for improving the perception, communication, understanding, and responsiveness of virtual humans when interacting with live humans and explore how people relate to virtual humans.	2.533	-	-
Accomplishments/Planned Programs Subtotals	6.196	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J12 / *Institute For Soldier Nanotechnology (ISN)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J12: *Institute For Soldier Nanotechnology (ISN)*	-	5.773	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.773

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers

A. Mission Description and Budget Item Justification

This Project supports sustained multidisciplinary research at the Army's Institute for Soldier Nanotechnologies (ISN) at the Massachusetts Institute of Technology. The ISN was established as a University Affiliated Research Center (UARC) to support research to devise nanotechnology-based solutions for the Soldier. The ISN emphasizes revolutionary materials research for advanced Soldier protection and survivability. The ISN works in close collaboration with the United States (US) Army Futures Command as well as several major industrial partners, including Raytheon and DuPont, in pursuit of its goals. This Project emphasizes revolutionary materials research toward an advanced uniform concept. The future uniform will integrate a wide range of functionality, including ballistic protection, responsive passive cooling and insulating, screening of chemical and biological agents, biomedical monitoring, performance enhancement, and extremities protection. The objective is to lighten the Soldier's load through system integration and multifunctional devices while increasing survivability. The new technologies will be compatible with other Soldier requirements, including Soldier performance, limited power generation, integrated sensors, communication and display technologies, weapons systems, and expected extremes of temperature, humidity, storage lifetimes, damage, and spoilage.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Nanomaterials and Nanotechnologies for Soldier Application ***Description:*** Nanomaterials research efforts focus on light-weight, multifunctional nanostructured fibers and materials.	5.773	-	-
Accomplishments/Planned Programs Subtotals	5.773	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** J12 / *Institute For Soldier Nanotechnology (ISN)*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J13 / *UNIVERSITY AND INDUSTRY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J13: *UNIVERSITY AND INDUSTRY INITIATIVES (CA)*	-	22.000	41.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	63.000

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for University and Industry Initiatives.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Congressional Program Increase - University and Industry Research Centers - Army Artificial Intelligence Innovation Institute ***FY 2019 Accomplishments:*** Congressional Program Increase - University and Industry Research Centers - Army Artificial Intelligence Innovation Institute ***FY 2020 Plans:*** Congressional Program Increase - University and Industry Research Centers - Army Artificial Intelligence Innovation Institute	7.000	20.000
Congressional Add: Congressional Program Increase - University and Industry Research Centers - Bioenabled Materials ***FY 2019 Accomplishments:*** Congressional Program Increase - University and Industry Research Centers - Bioenabled Materials ***FY 2020 Plans:*** Congressional Program Increase - University and Industry Research Centers - Bioenabled Materials	1.000	4.000
Congressional Add: Congressional Program Increase - University and Industry Research Centers - Improved Machine Intelligence Through Understanding ***FY 2019 Accomplishments:*** Congressional Program Increase - University and Industry Research Centers - Improved Machine Intelligence Through Understanding	2.000	-
Congressional Add: Congressional Program increase - Materials in Extreme Dynamic Environments	10.000	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** J13 / *UNIVERSITY AND INDUSTRY INITIATIVES (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
FY 2019 Accomplishments: Congressional Program increase - Materials in Extreme Dynamic Environments ***FY 2020 Plans:*** Congressional Program increase - Materials in Extreme Dynamic Environments		
Congressional Add: Congressional Program Increase - university assisted hypervelocity testing ***FY 2019 Accomplishments:*** Congressional Program Increase - university assisted hypervelocity testing ***FY 2020 Plans:*** Congressional Program Increase - university assisted hypervelocity testing	2.000	2.000
Congressional Add: Catalyst ***FY 2020 Plans:*** Catalyst	-	10.000
Congressional Adds Subtotals	22.000	41.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J14 / *Army Educational Outreach Program*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J14: *Army Educational Outreach Program*	-	9.883	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.883

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB8 Army Educational Outreach Program

A. Mission Description and Budget Item Justification

This Project supports science, technology, engineering, and mathematics (STEM) activities that encourage elementary/middle/high school and undergraduate youths to develop an interest in and pursue education in the STEM fields to support the Army, and the nations, growing dependence on STEM skills. These activities are coordinated within the Army Educational Outreach Program (AEOP) that links and networks appropriate components to derive the best synergies to present the Army to a larger pool of technical talent and to provide students with Army-unique practical experiences at Army laboratories, centers, and institutes and expose them to DoD careers. AEOP increases interest and involvement of students and teachers across the nation in STEM at all proficiency levels and backgrounds to include under-represented and economically disadvantaged groups through exposure to Army sponsored research, education, competitions, internships, and practical experiences. This Project utilizes Army STEM assets to contribute to a STEM literate citizenry as well as enhances the national pool of science and engineering personnel that in turn supports defense industry and Army laboratory and research, development, and engineering center needs.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Educational Outreach and Workforce Development ***Description:*** This effort aims to broaden STEM competencies through various outreach and workforce development initiatives at participating Army labs and research centers.	1.924	-	-
Title: Army Educational Outreach Program Cooperative Agreement ***Description:*** The Army Educational Outreach Program Cooperative Agreement encompasses a variety of outreach activities under AEOP that includes a comprehensive evaluation and assessment component, a holistic marketing strategy, and an alumni management element. Collectively, this activity supports a strategic partnership with government, academia and industry to address the shortfall of clearable STEM skilled talent preparing for the workforce with a concentration on leveraged partnerships/investments, quality program capabilities with qualitative and quantitative data support, and evidence-based program	7.709	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** J14 / *Army Educational Outreach Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
management. These activities include Army-sponsored research, education, competitions, internships and practical experiences designed to engage and guide students and teachers in Army sponsored STEM programs. AEOP has targeted efforts to reach and engage underserved and underrepresented communities in STEM initiatives to build the pool of diverse STEM competitive talent. Outcomes are reported annually online at https://www.usaeop.com/about/our-impact/.			
Title: West Point Cadet Research ***Description:*** The West Point Cadet Research Program provides 40 to 60 West Point Cadets an opportunity to work on Army research projects alongside Army and industry scientists and engineers for a period of 3 to 6 weeks during the summer.	0.250	-	-
Accomplishments/Planned Programs Subtotals	9.883	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J15 / *Network Sciences ITA*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J15: *Network Sciences ITA*	-	3.955	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.955

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project supports research at a competitively selected United States (US)/United Kingdom (UK) government, university, and industry consortium established to perform fundamental network and information science investigations in the areas of network theory, system-of-systems security, sensor processing and delivery, and distributed coalition planning and decision making. The focus is on enhancing distributed, secure, and flexible decision-making to improve coalition operations, and developing the scientific foundations for complex and dynamic networked systems-of-systems to support the complex human, social, and technical interactions anticipated in future coalition operations with the emphasis on integration of multiple technical disciplines in an international arena. The US Army and the UK Ministry of Defense (MOD) established the jointly funded and managed US and UK consortium, known as the International Technology Alliance (ITA) on Network and Information Sciences, in FY06.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Distributed Analytics and Information Science for U.S./U.K. Coalition Operations Information	3.955	-	-
Description: This research will address the fundamental science underpinning the complex information network issues that are vital to future US/UK coalition military operations and to fully exploit the joint development of emerging technologies necessary to enable coalition operations. These efforts provide enhanced ability to perform adaptive, goal-driven, semantically-aware, distributed analytics for situational understanding in coalition operations.			
Accomplishments/Planned Programs Subtotals	3.955	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** J15 / *Network Sciences ITA*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) J17 / *Vertical Lift Research Center Of Excellence*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
J17: *Vertical Lift Research Center Of Excellence*	-	3.080	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.080

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB4 Army Research Centers

A. Mission Description and Budget Item Justification

This Project fosters research to provide vertical lift capability and engineering expertise for the Army. The focus of the Vertical Lift Research Center of Excellence (VLRCOE) is to couple state-of-the-art research programs with broad-based graduate education programs at academic institutions with the goal of increasing the supply of scientists and engineers who can contribute to Army Transformation. Work will provide research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing vehicles.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Vertical Lift Research Center of Excellence	3.080	-	-
Description: VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology to supplement a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations.			
Accomplishments/Planned Programs Subtotals	3.080	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) VS2 / *Multi-Scale Materials Modeling Centers*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
VS2: *Multi-Scale Materials Modeling Centers*	-	8.423	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.423

Note

In Fiscal Year (FY) 2020, this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project supports two competitively awarded Collaborative Research Alliances (CRAs) to provide the Army with next generation multi-functional materials for ballistic and electronic applications and to address the extreme challenges associated with understanding and modeling materials subject to Army operational environments. The Materials in Extreme Dynamic Environments consortium, led by Johns Hopkins University partnered with CalTech, Rutgers University, and University of Delaware, focuses on understanding materials under high strain rates. The Multiscale Multidisciplinary Modeling of Electronic Materials consortium, led by University of Utah partnered with Boston University and Rensselaer Polytechnic Institute, focuses on microscale properties to design macroscale behavior for electronics. Research at both CRAs will address the modeling and experimental challenges associated with developing multidisciplinary physics simulations across multiple length scales for materials to include: a limited ability to relate materials chemistry, structure, and defects to materials response and failure under extreme conditions; an inadequate ability to predict the roles of materials structure, processing, and properties on performance in relevant extreme environments and designs; and the lack of experimental capabilities to quantify multiscale response and failure of materials under extreme conditions.

Work in this Project supports key Army needs and is coordinated with work performed in PE 0601102A (Defense Research Sciences) / Project H44 (Adv Sensor Research) and H42 (Materials and Mechanics).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Collaborative Research Alliances in Materials in Extreme Dynamic Environments and Multiscale Multidisciplinary Modeling of Electronic Materials.	8.423	-	-
Description: Research will focus on the following areas: two-way multiscale modeling for predicting performance and designing materials, investigating analytical and theoretical analyses to effectively define the interface physics across length scales; advancing experimental capabilities for verification and validation of multiscale physics; and modeling and strategies for the synthesis of high loading rate tolerant materials so that all of the latter lead to the development of a comprehensive set of			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** VS2 / *Multi-Scale Materials Modeling Centers*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
metrics that define high loading rate tolerant material systems. The multiscale modeling capability will be applied across multiple disciplines to facilitate revolutionary advances in materials for coupled environments (electromagnetic, high rate, high pressure and other extreme environments).			
Accomplishments/Planned Programs Subtotals	8.423	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / *University and Industry Research Centers*	Project (Number/Name) VS3 / *Center For Quantum Science Research*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
VS3: *Center For Quantum Science Research*	-	6.002	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.002

Note

In Fiscal Year (FY) 2020, this Project was realigned to:
Program Element (PE) 0601104A University and Industry Research Centers
* Project AB7 Army Collaborative Research and Tech Alliances

A. Mission Description and Budget Item Justification

This Project supports an extramural research consortium, which will bring together a critical mass of preeminent university and industry researchers to explore and develop critical emerging concepts in Quantum Information Science (QIS). The focus will be on establishing a first of its kind, multi-site distributed quantum network based on quantum memories. The Center for Distributed Quantum Information will study and demonstrate both the physical backbone and network layer for a robust quantum information network that will provide secure and tamper-proof communications and exponentially greater information processing capabilities for the future Army. The Center for Distributed Quantum Information will perform collaborative research with Army in-house scientists and engineers to help accelerate the transition of the research. In addition to providing the required expertise and critical mass to the effort, the consortium will also bring together a broad but unified multi-disciplinary research team needed to accelerate progress in the field of quantum information sciences.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Center for Distributed Quantum Information	6.002	-	-
Description: This work supports critical quantum science basic research at the United States (US) Army Futures Command exploiting quantum effects to greatly enhance computing, communications, imaging, sensing, and security, ensuring Army dominance on the future battlefield.			
Accomplishments/Planned Programs Subtotals	6.002	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601104A / *University and Industry Research Centers*	**Project (Number/Name)** VS3 / *Center For Quantum Science Research*

D. Acquisition Strategy

N/A