Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	0.000	219.047	-	219.047	230.179	231.056	236.043	258.720	0.000	1,175.045
BF1: *Autonomous Ground Resupply Tech*	-	0.000	0.000	11.301	-	11.301	11.029	0.000	0.000	0.000	0.000	22.330
BF3: *Combat Vehicle Robotics Tech*	-	0.000	0.000	11.658	-	11.658	9.191	19.473	21.926	22.236	0.000	84.484
BF6: *Crew Augmentation and Optimization Tech*	-	0.000	0.000	23.027	-	23.027	23.132	23.381	23.891	24.339	0.000	117.770
BF8: *Artificial Intelligence & Machine Learning Tech*	-	0.000	0.000	18.651	-	18.651	18.938	19.246	31.852	58.094	0.000	146.781
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	0.000	0.000	15.283	-	15.283	16.554	19.440	13.250	13.398	0.000	77.925
BG2: *Modeling and Simulation for MUMT Technology*	-	0.000	0.000	3.966	-	3.966	4.060	7.525	7.767	7.853	0.000	31.171
BG6: *Advanced Concepts for Active Defense Technology*	-	0.000	0.000	53.469	-	53.469	55.437	51.645	56.306	56.586	0.000	273.443
BG8: *Obscuration Technology*	-	0.000	0.000	4.070	-	4.070	2.622	2.677	2.731	2.761	0.000	14.861
BH2: *C4ISR Modular Autonomy Technology*	-	0.000	0.000	4.874	-	4.874	5.153	2.701	2.755	2.786	0.000	18.269
BH5: *Platform Electrification and Mobility Tech*	-	0.000	0.000	10.024	-	10.024	12.810	12.897	7.012	4.080	0.000	46.823
BH7: *Enhanced VETRONICS Technology*	-	0.000	0.000	3.603	-	3.603	3.675	3.751	6.155	6.223	0.000	23.407
BH9: *Protection for Autonomous Systems Tech*	-	0.000	0.000	2.548	-	2.548	2.000	3.500	3.570	3.609	0.000	15.227
BI2: *Sensor Protection Technology*	-	0.000	0.000	10.584	-	10.584	11.499	11.786	12.033	12.178	0.000	58.080
BI4: *Materials Application and Integration Tech*	-	0.000	0.000	8.313	-	8.313	9.561	9.730	9.921	10.023	0.000	47.548

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army													Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*								
BI6: *All-Electric Combat Powertrain Technology**	-	0.000	0.000	0.000	-	0.000	5.946	5.297	6.763	6.524	0.000	24.530
BI9: *Vehicle System Security Technology*	-	0.000	0.000	2.951	-	2.951	2.530	2.426	2.285	2.127	0.000	12.319
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	0.000	0.000	4.990	-	4.990	5.458	5.567	5.678	5.742	0.000	27.435
BJ3: *Hydrogen Based Combat System Technology*	-	0.000	0.000	7.127	-	7.127	6.180	4.599	3.655	2.899	0.000	24.460
BJ7: *Detection of Explosive Hazards Technology*	-	0.000	0.000	11.882	-	11.882	12.115	12.326	10.717	10.837	0.000	57.877
BJ9: *Autonomous Mobility Tech*	-	0.000	0.000	3.060	-	3.060	2.500	4.000	0.000	0.000	0.000	9.560
BK2: *Virtual Prototyping Technology*	-	0.000	0.000	5.426	-	5.426	5.426	5.300	5.426	5.155	0.000	26.733
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	0.000	0.000	1.050	-	1.050	3.450	2.850	1.770	0.892	0.000	10.012
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	0.000	0.000	1.190	-	1.190	0.913	0.939	0.580	0.378	0.000	4.000

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2020

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602120A Sensors and Electronic Survivability
* 0602308A Advanced Concepts and Simulation
* 0602601A Combat Vehicle and Automotive Technology
* 0602618A Ballistics Technology
* 0602622A Chemical, Smoke and Equipment Defeating Technology
* 0602624A Weapons and Munitions Technology
* 0602705A Electronics and Electronic Devices
* 0602709A Night Vision Technology
* 0602712A Countermine Systems
* 0602716A Human Factors Engineering Technology
* 0602783A Computer and Software Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602145A *I Next Generation Combat Vehicle Technology*

* 0602784A Military Engineering Technology

The following Projects within this PE are new starts:
* Project BJ9 Autonomous Mobility Tech
* Project BK2 Virtual Prototyping Technology
* Project BK3 Next Gen Intelligent Fire Control (NG-IFC) Tech
* Project BK5 Adv Direct In-Direct Armament Sys (ADIDAS) Tech

A. Mission Description and Budget Item Justification

This PE executes research for the Army's modernization priority for the Next Generation of Combat Vehicles. This PE researches, designs, and evaluates combat vehicle technologies that enable the Army to have a smarter, faster, more lethal, more precise, more protected, and more adaptable force. The focus is on building upon the foundational vehicle architectures to support the Next Generation of Combat Vehicles, to include autonomy architecture, power architecture, vehicle electronic architecture, physical architecture, lethality architecture and vehicle protection architecture. The research conducted will provide technologies to enable leap ahead capabilities for manned, optionally manned and unmanned vehicles that deliver decisive lethality.

Work in this PE complements PE 0602141A (Lethality Technology), PE 0602144A (Ground Technology), PE 0602146A (Network C3I Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603116A (Lethality Advanced Technology), PE 0603119A (Ground Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), and PE 0603463A (Network C3I Advanced Technology).

Work in this PE will transition to PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

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

Work is performed by the United States Army Futures Command and United States Army Engineer Research and Development Center.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army					Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602145A *I Next Generation Combat Vehicle Technology*		
B. Program Change Summary ($ in Millions)	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	219.047	-	219.047
Total Adjustments	0.000	0.000	219.047	-	219.047
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	219.047	-	219.047

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*				Project (Number/Name) BF1 / *Autonomous Ground Resupply Tech*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
BF1: *Autonomous Ground Resupply Tech*	-	0.000	0.000	11.301	-	11.301	11.029	0.000	0.000	0.000	0.000	22.330

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology)
* Project H91 Ground Vehicle Technology
PE 0602784 Military Engineering Technology:
* Project T40 Mob/Wpns Eff Tech

A. Mission Description and Budget Item Justification

Autonomous Ground Resupply (AGR) will design and develop modeling and simulation tools and advanced software behaviors to inform future ground supply distribution system requirements across multiple levels of strategic and tactical sustainment operations. The modeling and simulation software tools will be incorporated into a suite of products designed to support every phase of AGR and used to develop and refine AGR concepts, test vehicle designs, evaluate design changes, determine technology performance, and predict outcomes in a wide variety of terrain, weather, and environmental conditions. The effort will utilize the modeling and simulation software tools to design, develop and mature software; and conduct experiments to increase future autonomy capabilities. The work under this Project will transition to the Leader/Follower Program of Record. The architecture and safety work under this Project also lays the groundwork for Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command and the United States Army Engineer Research and Development Center.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Software for Autonomous Systems	-	-	9.801
Description: Develop and implement advanced system behaviors to address Leader Follower capabilities, including algorithms for dynamic route planning, world modeling that feature system cues and collaboration to minimize the cognitive load placed on soldiers managing groups of unmanned systems.			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF1 / *Autonomous Ground Resupply Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
FY 2020 Plans: Will develop advanced software behaviors to address Leader Follower capabilities; including the integration of trailers (forward and reverse), convoy reverse capabilities, and convoy formations. Will investigate and develop new advanced convoy behaviors to enable autonomous convoy operations. Will develop algorithms for dynamic route planning and world modeling that feature system cues and collaboration to minimize the cognitive load placed on soldiers managing groups of unmanned systems. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) and PE 0602784 (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure.			
Title: Autonomous System Modeling and Simulations ***Description:*** This effort matures a real-time, hardware-in-the-loop simulation environment for rapid autonomous system design and development and for robust autonomy algorithm development; investigates novel analyses methods for Modeling and Simulation enhanced demonstrations of autonomous ground vehicles to include adverse environmental conditions. ***FY 2020 Plans:*** Will mature simulation environments and will improve algorithms to predict autonomous vehicle system performance in adverse environmental conditions; will provide improved analytical tools to investigate the benefits of autonomous ground resupply and optimize sensor configurations for autonomous maneuver. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) and PE 0602784 (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure.	-	-	1.500
Accomplishments/Planned Programs Subtotals	-	-	11.301

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF1 / *Autonomous Ground Resupply Tech*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BF3 / *Combat Vehicle Robotics Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF3: *Combat Vehicle Robotics Tech*	-	0.000	0.000	11.658	-	11.658	9.191	19.473	21.926	22.236	0.000	84.484

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project H91 Ground Vehicle Technology.

A. Mission Description and Budget Item Justification

This Project designs, develops, and evaluates a variety of innovative technologies that enable scalable integration of multi-domain robotic and autonomous system capabilities teamed within Army formations supporting all combat warfighting functions (close combat, reconnaissance, targeting and acquisition, etc.). This Project focus areas include autonomous architecture, autonomous behaviors and perception, and soldier machine Interface.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and transitions to PE 0604017A (Robotics Development).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Autonomous Behaviors and Perception	-	-	5.230
Description: This effort contributes to the Army's Modernization Priority for Next Generation Combat Vehicle (NGCV) Robotic Autonomous Strategy (RAS) to advance the mobility performance of autonomous systems within complex environments/ operations to allow for the completion of mission goals in separate and teaming configurations at varying levels of autonomy.			
FY 2020 Plans: Will develop the semi-autonomous on-road and off-road mobility technology to focus on the rules of the road and begin to establish behaviors for tactical formations and operationally relevant speeds. Will develop algorithms and capabilities for obstacle			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF3 / *Combat Vehicle Robotics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
detection/avoidance, mounted/dismounted following, dynamic route planning, manned/unmanned teaming, and individual/ coordinated learning and environmental modeling. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Title: Autonomous Architecture ***Description:*** This effort contributes to the Army's NGCV RAS to implement an open autonomous architecture for an inclusive military library of behaviors that are non-proprietary and in a modular format to allow for design and development of payloads across the enterprise. This effort builds upon architecture activities under the autonomous ground resupply activity, further expanding the Autonomous Ground Vehicle Robotics Architecture for increased complexity of military maneuvers. ***FY 2020 Plans:*** Will develop a set of guidelines to enable the robotics community to fulfill the Army?s NGCV RAS commonality objectives with an affordable means to deliver advanced capability to the Warfighter by utilizing architectural best practices and standards. Will develop military repositories and an ecosystem for the sharing of robotic vehicle software to help reduce the cost of developing software for autonomous robotic platforms and increase the overall reliability, security, maturity, and interoperability of the software. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.	-	-	2.150
Title: Human Robotic Interaction ***Description:*** This effort contributes to the NGCV RAS to implement a focused approach to deliver optimized unmanned system and manned-unmanned system team performance through reduced cognitive burden for the Soldier while maintaining real-time unmanned system status/activity, overall mission effectiveness, and predictive capability of the system's intended activity. ***FY 2020 Plans:*** Will design and develop a multi-vehicle asset control approach that will have the capability to interface with multiple robotic assets on an interface either at a command mission planning level or directly to each asset that will allow for multi-user connection with different levels of authority. Will investigate multi-modal communications interface techniques for soldier interaction that will have	-	-	4.278

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF3 / *Combat Vehicle Robotics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
the capability to interface with a robotic asset with multiple modes of communication either separately or all combined into one multi-modal mission command system. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	11.658

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BF6 / *Crew Augmentation and Optimization Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF6: *Crew Augmentation and Optimization Tech*	-	0.000	0.000	23.027	-	23.027	23.132	23.381	23.891	24.339	0.000	117.770

Note

In Fiscal Year (FY(2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project H91 Ground Vehicle Technology
PE 0602716A Human Factors Engineering Technology:
* Project H70 Human Fact Eng Sys Dev
PE 0602308A Advanced Concepts and Simulation
* Project C90 Advanced Distributed Simulation

A. Mission Description and Budget Item Justification

This Project performs the applied research to design capabilities for reduced vehicle crew sizes to successfully operate a larger number of closed-hatch manned and remote unmanned vehicles in a complex multi-domain operations environment. This Project will enable future crews to perform complex missions with increasingly sophisticated technologies, and in increasingly complex, dynamic socio-technical environments. The applied research will provide the fundamental technologies to enable integrated performance-improving Learning - Warfighter Machine Interfaces (WMIs) that are scalable to multiple crew hardware and functional configurations; reconfigurable frameworks and simulation for concept experimentation and exploration; and team-centered dynamic tasking by machine intelligence to effectively utilize full capabilities of crew and technologies. The research will generate soldier-informed data, reports, and analysis to support operational use in future vehicles; and soldier experimentation and assessment of technical concepts in simulation and in-field WMIs. The capabilities created by this research will lead to increased overall crew and team performance; improved soldier safety due to fewer soldier per vehicle, closed-hatch operations, and improved standoff from effective control; and vehicles that can effectively perform across multiple domains of battle.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Crew Station / Closed Hatch Operations	-	-	4.118

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF6 / *Crew Augmentation and Optimization Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: This effort focuses on crew size reduction and crew stations tailored to mission and soldier needs through the utilization of emerging human-interaction technologies, automations, machine intelligence and the provision of cohesive domain personalization to permit soldiers to achieve leap-ahead performance beyond today's constrained ground vehicle environment. ***FY 2020 Plans:*** Will develop baseline crew station technology for a seven soldier vehicle in both Manned Fighting Vehicle and Infantry Carrier Vehicle configurations to optimize task effectiveness, investigate and adapt helmet mounted display functionality for ground vehicle applications and incorporate rudimentary driving automations to validate utility of artificial intelligence as a soldier task enabler. Will assess motion effects on crew station utilizing motion based simulation. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.			
Title: Crew Understanding Agents ***Description:*** This effort focuses on increasing the crew's comprehension of physical and virtual intelligent agent actions, intentions, goals, and general reasoning in order to increase the effectiveness of human-agent teaming. The effort will increase soldiers situational awareness and team resilience as well as inform effective use of intelligent assets. ***FY 2020 Plans:*** Will create first of its kind machine-learning based Learning - Warfighter Machine Interfaces (L-WMI) technology to enhance crew?s ability to plan missions. Apply theoretical approaches to increase a crew's comprehension of unmanned vehicle actions, intentions, goals, and general reasoning to operationally relevant, multi-tasking, team crew software-in-the-loop environments; integrate with L-WMI technology to improve planning based on crew?s improved comprehension of crew interactions with unmanned vehicles. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.	-	-	8.108
Title: Agents Understanding Crew	-	-	6.185

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF6 / *Crew Augmentation and Optimization Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: This effort focuses on increasing intelligent agent ability to understand crew actions, intentions, goals, and general reasoning in order to increase the effectiveness of human-intelligent agent teaming. The effort will enable effective adaptation by intelligent agents, increase appropriateness of intelligent agent actions, increase manned/unmanned team resilience, and is critical for intelligent approaches to dynamic team tasking. ***FY 2020 Plans:*** Will generate and enhance real-time algorithms to enhance ability of intelligent agents to understand vehicle crew behaviors, states, and intentions; integrate with L-WMI technology to improve planning based on crew?s ability to predict crew dynamics and capability changes over mission. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.			
Title: Joint Human-Agent Teamwork ***Description:*** This effort focuses on providing human intelligent agent teams that have the capability to perform as well as soldier teams, but with additional capabilities including: greater team resilience with robust and adaptive performance, faster dynamic human-agent team reconfiguration to match capabilities to mission requirements, faster and more informed team decision making, and reduced numbers of soldiers as well as risks to them. ***FY 2020 Plans:*** Will create novel technologies to identify gaps in common situational awareness between and among vehicle crew and intelligent agents. Perform soldier-based assessment of simulated technology concepts and soldier-focused experimentation. Assessment and experimentation will be performed in an operationally relevant, crew teaming environment. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.	-	-	4.616
Accomplishments/Planned Programs Subtotals	-	-	23.027

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF6 / *Crew Augmentation and Optimization Tech*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BF8 / *Artificial Intelligence & Machine Learning Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF8: *Artificial Intelligence & Machine Learning Tech*	-	0.000	0.000	18.651	-	18.651	18.938	19.246	31.852	58.094	0.000	146.781

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602705 Electronics and Electronic Devices
* Project EM8 High Power And Energy Component Technology
PE 0602120A Sensors and Electronic Survivability
* Project TS2 Robotics Technology
PE 0602783A Computer and Software Technology
* Project Y10 Computer/Info Sci Tech

A. Mission Description and Budget Item Justification

This Project develops and characterizes artificial intelligence and machine learning software and algorithms to team with soldiers in support of fully autonomous maneuver of the Next Generation Combat Vehicle (NGCV)and other autonomous systems, both physical and non-embodied. Efforts develop capabilities for NGCV and other autonomous agents that increase autonomy, unburdening the soldier operator, with a high degree of survivability and lethality in a highly contested environment. This work also investigates power distribution and conversion technologies to provide compact, efficient, and high power capabilities for electrical and electro-mechanical loads supporting both mobile and stationary unmanned platforms. Research enables combat vehicles to rapidly learn, adapt, and reason faster than the adversary; accomplish missions in contested, austere and congested environments, characterized by lack of structure, adversarial actions, and minimal a priori knowledge; and provide force reduction through self-learning vehicles that can operate in complex militarily relevant environments.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

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

Work in this Project is performed by the United States Army Futures Command.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Advanced Distributed Power for Autonomous Platforms	-	-	1.536
Description: The effort investigates power distribution and conversion technologies to provide compact, efficient, and high power capabilities for electrical and electro-mechanical loads supporting both mobile and stationary platforms. High voltage			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF8 / *Artificial Intelligence & Machine Learning Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
and intelligent control methods will be coupled with the ongoing research in autonomy technologies to provide advanced performance enhancements in mobility and capabilities for these platforms. Research on innovative electric machines covering both electrical generation and motor technologies will focus on providing efficient, power dense, fault tolerant generation and mobility capabilities. Research addresses current and future Army-unique power delivery challenges in compact autonomous air and ground platforms and provides increased mission effectiveness with reduced cognitive burden. ***FY 2020 Plans:*** Will investigate optimization methods and analytical techniques to provide mission effective energy management at the tactical unit level; will investigate control methods and circuitry that enable intelligent power control at the module and component levels within the power distribution system; will develop power-dense direct current (DC)-DC distribution hardware and software that autonomously manages power conversion and distribution. Methods to be considered include embedded sensors, machine learning, and energy flow analysis. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.			
Title: Scalable, Adaptive, and Resilient Autonomous Systems	-	-	7.336
Description: This effort develops and matures emerging research in Artificial Intelligence/Machine Learning (AI/ML) , human agent teaming, scalable and collaborative behaviors, embodied and embedded intelligence, and autonomous operations for next generation Army platforms in dynamic Army relevant environments, architectures, and missions. Specific focus will be on application of AI/ML to autonomous systems and human-intelligent agent teaming; scalable and collaborative behaviors in support of heterogeneous air and ground manned-unmanned teaming (MUM-T) operations; methods for embodied and embedded intelligence for increased understanding, manipulation, and reflexive maneuver through and interaction with dynamic environments; techniques for improved perception, decision making, and adaptive behaviors in contested environments for MUM-T; and new methods for testing and evaluating emerging technologies for intelligent and autonomous systems under Army relevant constraints and environments and in Army relevant architectures. ***FY 2020 Plans:*** Will develop architectures, algorithms, data sharing approaches, and control methodologies to enable scalable numbers of heterogeneous, air and ground intelligent systems to collaboratively perform (autonomous and semi-autonomous) maneuver			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
foroperations. Will investigate methods, metrics, and tools to facilitate, simulate, and enable testing and evaluation of emerging approaches for individual and collaborative intelligent systems in Army relevant constraints and environments. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.			
Title: Context-Based Information Dynamics ***Description:*** This effort investigates techniques that integrate on-board and external information sources, and it applies ML analytic approaches to support automated intelligence analysis and decision making. The goal is to enable tactical agents to cooperatively share relevant and timely tactical information within a distributed environment. ***FY 2020 Plans:*** Will investigate intelligent approaches that are resilient to adversarial threats and to continuous learning threats and maximize soldier and agent situational awareness; investigate methods and models for complex or social event processing, with compact representations, efficient pattern evaluation, and mission-centric focus to accelerate reasoning and decision making; study self-aware characteristics of intelligent or non-stationary agents. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.	-	-	2.389
Title: Heterogeneous Computing and Computational Sciences ***Description:*** This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing and processing capabilities to the soldier on the battlefield. ***FY 2020 Plans:*** Will develop resource constraints-aware heterogeneous adaptive computing abstractions, optimizations, and algorithms. Will develop AI/ML algorithms and models to build local decision making framework to enable intelligent computational off-loading and distributed computing under resource constrained and contested environments. Preliminary design and construction of	-	-	1.761

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
an adaptive heterogeneous computing testbed that combines processors with varying capabilities and size, weight and power footprints to allow for exploration and optimization of Army tactical application processing. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.			
Title: Machine Learning with Constrained Resources ***Description:*** This effort will research new ML and reinforcement learning methods to address issues of statistically mismatched and incomplete information which must be annotated, collected, classified and used for rapid decisions by joint intelligent agent-Human teams. In addition, multi-modal human interaction approaches will be investigated to ensure effective soldier interactions and understanding of intent. The goal of this research is enable joint human-intelligent agent decision making, optimizing the strengths of each in the decision process and creating an adaptive, agile team. This work applies research conducted in PE 611102/AA6 (Robotics and Mobile Energy) and Project AA9 (Information and Networking). ***FY 2020 Plans:*** Will investigate novel on-line ML approaches that enable high-speed (similar to human speed) mobility of autonomous ground vehicles in complex environments on which the vehicle has not been previously trained and by teaming with the soldier to accelerate algorithm training and provide dynamically changing goals for the autonomous ground vehicle. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.	-	-	4.134
Title: Ground Robotic Vehicle Mobility & Propulsion Technology ***Description:*** Applied research in ground robotic vehicle mobility and propulsion technologies to enhance intelligent vehicle performance (speed, acceleration, mobility, maneuverability, adaptability, etc.) and enable Army robotic platform maneuverability in complex terrain and environments. ***FY 2020 Plans:*** Will establish a novel AI/ML algorithm framework to improve vehicle maneuver performance in complex terrains, environments, and damage conditions. ***FY 2019 to FY 2020 Increase/Decrease Statement:***	-	-	1.495

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	18.651

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BF9 / *Sensors for Autonomous Operations and Surv Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	0.000	0.000	15.283	-	15.283	16.554	19.440	13.250	13.398	0.000	77.925

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602709A Night Vision Technology
* Project H95 Night Vision and Electro Optic Technology

A. Mission Description and Budget Item Justification

This Project designs, and develops modular and adaptive sensor components, algorithms and machine learning/artificial intelligence tools which provide improved manned and unmanned ground vehicle situational understanding and enable automatic target recognition and autonomous navigation in all environments. The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Next Generation Combat Vehicle, Soldier Lethality, and Future Vertical Lift Modernization Priorities.

Work in this Project is performed by the United States Army Futures Command.

This effort is coordinated with PE 0603462 (Next Generation Combat Vehicle Advanced Technology), 0603118 (Soldier Lethality Advanced Technology), and 0602143 (Soldier Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Sensors for Autonomous Operations and Survivability	-	-	15.283
Description: This effort will deliver component technologies which greatly improve current and future thermal sensor performance through novel materials, new pixel designs and enhanced image processing, compression, and analysis capabilities. Research into novel multi-function digital read-out integrated circuits and other sensor components will provide embedded on-chip, non-uniformity correction, dynamic motion compensation, on-chip stabilization of infrared imagery and data compression with a significant reduction in data transmission requirements, greatly increased sensitivity of low size, weight, power and cost thermal sensors, and imaging capabilities through natural and manmade obscurants. These components will enable sensor systems to provide vehicle borne and dismounted soldier situational understanding in all environments.			
FY 2020 Plans: Will develop on-chip non-uniformity correction to enable on-chip calibration pre-processing. Will mature digital read out integrated circuits with on-chip compression, enabling high resolution imaging within bandwidth constricted environments. Will design			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF9 / *Sensors for Autonomous Operations and Surv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
and develop dynamic on-chip compression of thermal imagery to allow for 10x reduction in data rate. Will investigate novel pixel designs using advanced Micro Electro-Mechanical Systems with low thermal mass and high thermal isolation to increase sensitivity. Will mature fabrication techniques and pixel design to reduce thermal mass to enable the read-out integrated circuit to read entire focal plane array (FPA) at once (snapshot) and enable increased frame rate. Will validate novel high sensitivity uncooled longwave infrared FPAs for low size, weight, power and cost applications and to address 360-degree situational awareness requirements. Will design and develop compact high resolution thermal imaging sensors with three-dimensional imaging algorithms to enable compact navigation and threat detection capabilities. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602709A (Night Vision Technology) / Project H95 (Night Vision and Electro Optic Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	15.283

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*				Project (Number/Name) BG2 / *Modeling and Simulation for MUMT Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
BG2: *Modeling and Simulation for MUMT Technology*	-	0.000	0.000	3.966	-	3.966	4.060	7.525	7.767	7.853	0.000	31.171

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project Project T40 Mob/Wpns Eff Tech

A. Mission Description and Budget Item Justification

This Project develops Modeling and Simulation (M&S) tools and technologies to assess and improve freedom of movement for ground forces and supports vehicle developers by addressing challenges for robotic and ground vehicles. Through experimental investigation and design, this project develops obstacle detection and classification algorithms for dynamic mobility hazards in urban and complex environments. This project provides developers with tools to evaluate system performance reducing the need for physical testing including: real-time mobility decision support tools, vehicle-terrain interactive models for autonomous convoy operations, simulation tools for vehicle mobility in highly altered terrain, and M&S tools for predicting the performance of autonomous vehicles in a wide variety of weather and terrain conditions. These M&S technologies can be integrated across Army vehicle platforms as required.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

This effort is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Mobility in Complex Environments	-	-	3.966
Description: This effort develops real-time mobility warning technology for manned and unmanned ground vehicles to include a real-time hardware-in-the-loop simulation environment to investigate autonomous vehicle maneuver, matures mobility obstacle detection algorithms, and refines near real-time mobility prediction software in the urban environment.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG2 / *Modeling and Simulation for MUMT Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Will develop and improve a simulation environment to investigate autonomous vehicle maneuver; will develop software to automatically detect mobility obstacles in near real-time and mature sensor fusion methods; and will refine mobility algorithms for near real-time predictions. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure>.			
Accomplishments/Planned Programs Subtotals	-	-	3.966

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*				Project (Number/Name) BG6 / *Advanced Concepts for Active Defense Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
BG6: *Advanced Concepts for Active Defense Technology*	-	0.000	0.000	53.469	-	53.469	55.437	51.645	56.306	56.586	0.000	273.443

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project C05 Armor Applied Research
PE 0602618A Ballistics Technology
* Project H80 Survivability and Lethality Technology

A. Mission Description and Budget Item Justification

This Project researches advanced materials and mechanisms to defeat the most common and most dangerous threats that are expected to be encountered by our ground forces in near, mid and far term. Work conducted in this Project will result in concepts for Adaptive and Cooperative Protection of ground combat vehicles. Modern protective technology implements complex kinematic mechanisms in order to bend, break and disperse threat projectiles before they can injure crew or disable vehicles. These "mechanisms" of the future will have unprecedented access to information through advanced sensors (electro-optic, infrared, radio frequency, magnetic, acoustic), data, communications, high speed digital signal processing, and fusion of information to initiate high-speed controls and actuation to adjust and adapt protective measures and materials. The research strategy will develop experimental and computational tools and techniques (high resolution instrumentation to observe impact events, theories and algorithms to explain these phenomena and numerical implementation of these algorithms) for the development of mass-efficient armor mechanisms. Complimentary armor mechanisms will be co-developed to create multi-threat armor technologies that meet specific military requirements and these will form the building blocks for Adaptive and Cooperative Protection Technologies. Additionally research will focus on subcomponent/component models to predict performance of early concepts and the means to evaluate effectiveness on ground platforms. The Project will balance developments of active threat defeat measures with the necessary advanced passive and reactive components that will ultimately provide for full system solutions which meet the requirements of current and next generation ground tactical and combat vehicles. The Emerging Overmatch Technologies effort will maximize the synergy between protection technologies that are complimentary to the lethality mission to re-establish overmatch of Army technologies.

This Project is coordinated with and transition to Projects in PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and builds upon weapon target interaction research in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

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

Work in this Project is performed by the United States Army Futures Command.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG6 / *Advanced Concepts for Active Defense Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Computational and Experimental Capability ***Description:*** This effort will develop computational design tools and computational and experimental capabilities that support development of advanced protection systems. Such systems include passive, active and hybrid solutions for defeating (multiple) anti-armor threats and exploit solid-dynamic, explosive-driven and magneto-hydrodynamic target interactions. This work allows for predicting armor performance and understanding mechanisms, regardless of vehicle platform, with improved and quantified confidence. This effort leverages the Department of Defense and Department of Energy (DOE) Technical Coordination Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics. ***FY 2020 Plans:*** Will perform limited verification and validation assessments of computational capability; will transition impact mechanics computational models to DOE to further enhance armor design and experimental computational capability; continued improvement and transition of computational modeling and simulation capabilities to improve associated design tools; determine physical mechanisms that contribute to multi-material armor design by increasing imaging and velocity measuring diagnostic capability as well as design of novel experiments. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.	-	-	4.868
Title: Multi-Threat Armor Technologies ***Description:*** This effort develops multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats including kinetic and chemical energy as well as blast threats. Most effective designs will be transitioned to PE 0603462A (Next Generation Combat Vehicle Advanced Technology) for further design and maturation. ***FY 2020 Plans:*** Will computationally and experimentally explore novel passive, reactive, and active armor protection concepts in support of next generation combat vehicle protection; continue to improve understanding of hybrid armor multi-hit capabilities; continue to evaluate promising multi-threat armor designs utilizing hybrid electromagnetic armor/energetic technologies; explore top attack protection designs and potential mechanisms; develop active lightweight kinetic energy penetrator defeat mechanisms. Validate performance to TRL 4 for most promising designs for transition to PE 0603462A (NGCV Advanced Technology). ***FY 2019 to FY 2020 Increase/Decrease Statement:***	-	-	9.413

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG6 / *Advanced Concepts for Active Defense Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.			
Title: Advanced Armor and Protection Technologies ***Description:*** This effort enables development of next generation of lightweight protective concepts and technologies for defeat of current and future threats by utilizing real-time information, combined with threat knowledge, to provide ever-increasing protection. This effort funds research into the fundamental physics of new terminal effects concepts and provides a mechanistic understanding of threat platform interaction. The effort investigates the ability to analytically simulate complex threat interactions. Experiments will be conducted to validate the efficacy of the designs. ***FY 2020 Plans:*** Will develop lightweight armor for protection against Kinetic Energy (KE) and Chemical Energy (CE) threats. Will utilize advanced multi-physics computational tools developed under the computational experimental capability effort to conduct parametric analysis of threat-target interactions. The results of this analysis will aid the design of advanced armor concepts that will undergo physical experimentation (ballistic testing) to validate performance. The most promising concepts will be further developed and transitioned to PE 0603462A (NGCV Advanced Technology) for component development and maturation. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.	-	-	5.986
Title: Adaptive and Cooperative Protection ***Description:*** This effort pursues a holistic approach toward achieving significant weight reduction and protection from future threats by utilizing real-time information, combined with threat knowledge, to provide ever-increasing protection. This approach includes integrating individual vehicle capabilities of armor, underbody blast protection, active protection systems, and advanced soft kill methods into one layered solution to maximize survivability and minimize weight for combat and tactical vehicles. ***FY 2020 Plans:*** Will continue to mature selected adaptive armor mechanisms and conduct additional experiments against challenging threats; will continue to explore soft-kill countermeasures in conjunction with novel threat independent protection mechanisms coupled with an integrated threat warning sensor capability. ***FY 2019 to FY 2020 Increase/Decrease Statement:***	-	-	9.965

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG6 / *Advanced Concepts for Active Defense Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.			
Title: Emerging Overmatch Technologies ***Description:*** This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination against current and future threats. This research will heavily leverage other efforts within PE 0602145A (NGCV Technology) and PE 0603462A (NGCV Advanced Technology). ***FY 2020 Plans:*** Will evaluate coupled lethality and protection concepts; will continue to explore advanced protection and lethal mechanisms to enhance the next generation combat vehicle and small autonomous systems. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.	-	-	2.055
Title: Survivability/Lethality/Vulnerability Analysis Tools and Methodology ***Description:*** This effort devises state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats against future weapon systems. ***FY 2020 Plans:*** Will develop indirect and precision fire vulnerability and lethality models by investigating methodologies to provide sensitivity analyses on burst height, angle of fall, azimuth and elevation including lethal mechanisms and collateral hazards. Will examine physics-based finite element vulnerability and lethality models by exploring enhanced methods and tools for analysis of underbody threats, blast effects, fire, and combined effects. Will develop personnel vulnerability modeling by investigating models of variability in human morphology and anatomy, including the standard 95th percentile male and female warfighter. Will refine advanced visualization and interactive modeling techniques by developing scene-based models (including terrain) of multiple, complex engagements. ***FY 2019 to FY 2020 Increase/Decrease Statement:***	-	-	5.071

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.			
Title: Warrior Injury Assessment Manikin (WIAMAN) ***Description:*** This Project develops an improved demonstrator blast test manikin, data acquisition system, and injury prediction methods and tools that incorporate new medical research and which provides an improved capability to measure and predict skeletal injuries for vehicle occupants during under-body blast events. ***FY 2020 Plans:*** Will perform experimental testing and validation of WIAMAN performance. Additional match pair testing will be conducted to confirm Advanced Technology Demonstration (ATD) performance to cadaveric specimens. Subcomponent and component certification testing will be completed to confirm data reliability. ATD performance experiments will be conducted to validate performance to requirements. The development of Finite Element Model tools will be completed and validated to allow for accurate pre-shot predictions. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.	-	-	1.439
Title: Ground Systems Active Defense Technology Research ***Description:*** This effort contributes to the Army's ground vehicle survivability by developing technologies which electronically or physically defeat an incoming threat before it contacts the vehicle. These technologies involve sensors and effectors interacting with an incoming threat to disrupt or destroy in while it is in flight or before it is even fired at a vehicle. This effort designs and develops modern armors that directly complement active defense technologies in order to implement sophisticated mass efficient mechanisms and leverage investments in materials to act as a system for the defeat of advanced threats. This effort designs and develops active blast mitigation technologies to counter the effects of underbody attacks to ground vehicles. This effort will also design and develop the required advanced structures required to accommodate active blast mitigation technologies into vehicles. The design of the structure and active defense technology is critical to an effective blast survivability solution. ***FY 2020 Plans:*** Will perform requirements definition and lab scale performance validation of a small flyout countermeasure. Will begin conducting research into component packaging and integration methods and concepts, including complementary base vehicle armor components to capture residual fragments from countermeasure engagements. Packaging and integration subcomponent tests	-	-	14.672

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
will be conducted to feed design trade studies. Initial component designs for countermeasure and base vehicle armor will be developed and analyzed. Will design and develop an advanced soft-kill countermeasure technology. Will conduct testing to capture performance characteristics of the soft-kill countermeasure technology to validate the feasibility and effectiveness against advanced and emerging threats. Will build upon FY19 requirements definition and lab scale performance validation of advanced Improvised Explosive Device concepts and advanced active blast mitigation systems. Initial component designs will be developed and analyzed. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	53.469

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BG8 / *Obscuration Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BG8: *Obscuration Technology*	-	0.000	0.000	4.070	-	4.070	2.622	2.677	2.731	2.761	0.000	14.861

Note

In Fiscal Year (FY) 2020 this Project was realigned from:\
Program Element (PE) 0602622A Chemical, Smoke and Equipment Defeating Technology\
* Project 552 Smoke/Novel Effect Mun

A. Mission Description and Budget Item Justification

This Project investigates and evaluates obscurant technologies that degrade threat force surveillance sensors and defeat the enemy's target acquisition devices, missile guidance, and directed energy weapons. This Project focuses on advanced infra-red and multi-spectral obscurant materials that provide effective, affordable, and efficient screening of deployed forces, while being safe and environmentally acceptable.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is related to and fully coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Obscuration Technologies for Active Protection Systems	-	-	1.500
Description: This effort investigates dissemination technologies for various obscurants. ***FY 2020 Plans:*** Will conduct modeling and analysis of new vehicle protection concepts to determine effectiveness of obscurant dissemination. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602622A (Chemical, Smoke and Equipment Defeating Technology) / Project A552 (Smoke/Novel Effect Mun) in FY20 as part of the financial restructure.			
Title: Obscuration Enabling Technologies	-	-	2.570

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG8 / *Obscuration Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment across the electromagnetic spectrum. ***FY 2020 Plans:*** Will continue to mature and characterize advanced bi-spectral, advanced microwave, and spectrally selective obscurants. Will continue to investigate effects against various threat technologies (e.g., sensors, missile seekers) for various obscurants. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602622A (Chemical, Smoke and Equipment Defeating Technology) / Project A552 (Smoke/Novel Effect Mun) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	4.070

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BH2 / *C4ISR Modular Autonomy Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH2: *C4ISR Modular Autonomy Technology*	-	0.000	0.000	4.874	-	4.874	5.153	2.701	2.755	2.786	0.000	18.269

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602709A (Night Vision Technology
* Project H95 Night Vision and Electro Optic Technology

A. Mission Description and Budget Item Justification

This Project researches and develops multifunction mission command, sensing, and communications technologies and approaches to enable the required Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities for autonomous and semi-autonomous platforms. Efforts support Manned/Unmanned Teaming and combined arms maneuver in complex environments.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

Work in this Project is performed by the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: C4ISR Modular Autonomy Technology	-	-	4.874
Description: Investigates and matures embedded processing algorithms utilized in soldier systems and platforms to improve the warfighter?s decision efficiency and ability to perform Intelligence, Surveillance, and Reconnaissance (ISR), Target identification and discrimination			
FY 2020 Plans: Will develop foundational signal and image processing algorithms; will build algorithm framework to support cognitive autonomous processing; will identify functions to assist human operators.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH2 / *C4ISR Modular Autonomy Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602709A (Night Vision Technology) / Project H95 (Night Vision and Electro Optic Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	4.874

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BH5 / *Platform Electrification and Mobility Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH5: *Platform Electrification and Mobility Tech*	-	0.000	0.000	10.024	-	10.024	12.810	12.897	7.012	4.080	0.000	46.823

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project H91 Ground Vehicle Technology
* Project H77 National Automotive Center

A. Mission Description and Budget Item Justification

This Project researches and develops advanced power and energy technologies for combat ground vehicles that are necessary for parallel hybrid, series hybrid and all-electric vehicle systems.

This Project also continues the Advanced Vehicle Power Technology Alliance (AVPTA) between the Department of Energy and the Department of the Army with a focus on energy storage for electrification, providing an emphasis on developing advanced technologies that enable military ground vehicles to become significantly more energy efficient. The Alliance is chartered to accelerate the conceptualization and transition into deployment of inventive and creative energy-saving concepts that the Nation needs to achieve energy security. This Project researches energy storage technologies in support of lighter military vehicles which are more fuel-efficient and expeditionary with superior mobility and protection of both vehicles and occupants.

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

Work is performed by the United States Army Futures Command.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: AVPTA - Energy Storage	-	-	0.914
Description: This effort develops and matures advanced energy storage technologies to improve power and energy performance and safety for vehicles. Higher energy stored with less space and weight increases vehicle efficiency and range. Ensures			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH5 / *Platform Electrification and Mobility Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
electrified ground vehicles have enough power for mobility, silent watch, and enables energy based capabilities including electromagnetic armor and directed energy weapons. ***FY 2020 Plans:*** Research energy storage, battery chemistry and packaging technologies to determine approach that can be developed to meet the needs of hybrid and all-electric drive combat and tactical platforms. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Title: Novel Propulsion Research ***Description:*** This effort performs research to assess and evaluate the optimal electrified propulsion system configuration for future military tactical and combat ground vehicle applications. This effort will investigate and model parallel hybrid-electric, series hybrid-electric, fuel cell and all-electric propulsion systems for the future military vehicle applications. Research is required to understand how electrified propulsion may impact future fleet mobility requirements, soldier operational scenarios, operational energy reduction, enablement of future lethality and defensive systems, sensors, and ancillary electrical loads. Novel propulsion systems such as fuel cells, high speed diesel engines, mega-watt generators, quad sprocket tracked and multi-drive wheeled mobility, as well as the logistic support and infrastructure requirements will be investigated. ***FY 2020 Plans:*** Will perform comprehensive research of novel propulsion system configurations for future military tactical and combat ground vehicle applications. Will explore current and future military requirements, potential novel propulsion system technology, component maturation, performance modeling, simulated soldier operational scenarios, Joint Operational Energy Initiative assessments, and logistical support. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.	-	-	1.628
Title: Platform Electrification and Mobility Research ***Description:*** This effort develops technologies required to electrify both manned and unmanned Next Generation Combat Vehicle platforms. The effort develops a modular and scalable electrification architecture. The effort develops technologies to increase electric power such as a high voltage/temperature generator, high power/ temperature power electronics, electric drive motors,	-	-	7.482

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH5 / *Platform Electrification and Mobility Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
and energy storage. Electrification of these platforms will enable advanced lethality and protection systems, reduced battlefield fuel consumption, and provide new capabilities such as burst acceleration, extended silent mobility and silent watch. ***FY 2020 Plans:*** Will develop and model an electrification architecture that supports hybrid, fuel cell and all-electric powertrains and that is scalable for both manned and unmanned tactical and combat vehicles. Will develops high voltage/high temperature generator, power electronics, electric motor drives, and energy storage system. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	10.024

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BH7 / *Enhanced VETRONICS Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH7: *Enhanced VETRONICS Technology*	-	0.000	0.000	3.603	-	3.603	3.675	3.751	6.155	6.223	0.000	23.407

Note

In Fiscal Year (FY) this Project was realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices:
* Project EM8 High Power and Energy Component Technology
PE 0602601A Combat Vehicle and Automotive Technology:
* Project H91 Ground Vehicle Technology

A. Mission Description and Budget Item Justification

This Project addresses the development of materials and device designs for compact, high-efficiency, high-temperature, and high-power Army ground tactical and combat vehicles including hybrid-electric propulsion, electric power generation and conversion, and smart micro-grid power distribution. This Project investigates aluminum gallium nitride materials for high power applications.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

Work in this PE is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Electronic Components and Materials Research	-	-	3.603
Description: This effort investigates material, device and module technologies to reduce weight, volume and energy losses for ground tactical and combat vehicles electrification while providing enhanced mission effectiveness through smart operation. Technologies provide devices and modules for high power hybrid-electric propulsion, electric power generation and conversion, and smart power distribution. Research addresses current and future Army-unique performance and operational requirements for ground vehicle mobility.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH7 / *Enhanced VETRONICS Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Will investigate and characterize high-power devices that enable high-power density and efficient electrical propulsion, and electrification of ground vehicle sub-systems; will explore integration of metallic phase change thermal management techniques to manage electrical power module and component temperatures; will develop multi-discipline parametric optimization tool for power packaging; and will study advanced materials and device structures to determine the potential of utilizing AlGaN materials for high-power application to NGCV priorities. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from of PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) and PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.603

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BH9 / *Protection for Autonomous Systems Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH9: *Protection for Autonomous Systems Tech*	-	0.000	0.000	2.548	-	2.548	2.000	3.500	3.570	3.609	0.000	15.227

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project C05 Armor Applied Research

A. Mission Description and Budget Item Justification

This Project analyzes the emerging requirements for the protection and survivability of future autonomous combat platforms. Studies will be conducted at both the platform and force level to identify unique survivability needs of these platforms. It will also mature component technologies to address identified capability gaps.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is conducted by United States Army Futures Command.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Protection for Autonomous Systems	-	-	2.548
Description: This effort contributes to the Army's ground platform risk reduction efforts which seek to address technical challenges in the areas of survivability and protection for autonomous systems. Specifically, this effort focuses on developing novel ballistic protection and sensor protection concepts to ensure autonomous ground vehicles can continue their mission in contested environments.			
FY 2020 Plans: Will determine the potential vulnerabilities to an autonomous ground combat vehicle through modeling and simulation using physics-based tools. Will develop the capability to validate those vulnerabilities in a laboratory environment.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH9 / *Protection for Autonomous Systems Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) in FY20 as part of the the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	2.548

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BI2 / *Sensor Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BI2: *Sensor Protection Technology*	-	0.000	0.000	10.584	-	10.584	11.499	11.786	12.033	12.178	0.000	58.080

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) PE 0602120A Sensors and Electronic Survivability
* Project H16 S3I Technology
PE 0602705A Electronics and Electronic Devices
* Project H94 Elect and Electronic Dev
PE 0602712A Countermine Systems
* Project H35 Camouflage & Counter-Recon Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops techniques for masking friendly force capabilities and intentions. The Project pursues technologies to reduce the susceptibility of sensor systems to detection and targeting by threat forces, as well as to inform the development of next generation signature reduction schemas. This Project also designs, investigates, fabricates, evaluates and characterizes advanced sensor protection technologies, components, and concepts that will enable the future soldier to see and operate through a laser directed energy weapon attack. Both active and passive protection technologies will be investigated to protect Army sensors that operate in the visible, short-wave infrared, mid-wave infrared, and long-wave infrared spectra from battlefield laser threats. Areas of research include passive optical limiters such as nonlinear organic dyes, semiconductors, and meta-materials, as well as fast active switches and tunable filters. Technologies investigated include novel optics designs combined with signal processing, spectral filtering, and threat sensing algorithms.

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

Work in this Project supports the Army Science and Technology Next Generation Combat Vehicle, Soldier Lethality, and Future Vertical Lift modernization priorities.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Sensor Protection Technology	-	-	6.688
Description: This effort will design and develop component technology to improve protection of sensors and sensor electronics from threats via techniques to harden optics, reduce sensor optical cross sections, novel coating approaches, filter improvements,			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BI2 / *Sensor Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
and emerging signature reduction schemas. This effort is coordinated with PE 0603462A (NGCV Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), 0603465A (Future Vertical Lift Advanced Technology), and 0602143A (Soldier Lethality Technology). ***FY 2020 Plans:*** Will mature emerging optical window technologies to reduce the amount of laser energy arriving on a thermal sensor before it has a chance to reflect off of the focal plane array. Will investigate novel threat reduction technologies to protect emerging high sensitivity uncooled longwave infrared sensors. Will determine mobile camouflage system susceptibility to electro-optic/infrared cameras. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology), PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elec and Electronic Dev), and PE 0602712A (Countermine Systems) / Project H35 (Camouflage & Counter-Recon Tech), in FY20 as part of the financial restructure.			
Title: Laser Protection Technologies ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive optical limiting materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active man-made material-based solutions will be investigated for uncooled sensors in the long-wave infrared. Vulnerability of sensors and optical sensor systems will be studied against high-power and ultra-short pulsed laser threats to determine protection requirements. ***FY 2020 Plans:*** Will investigate tunable mid-wave infrared filter designs and improve tunable long-wave infrared filters based on previous experiments; will improve multi-chromophore solid-state optical limiter to increase operational bandwidth; will investigate pulsed wave laser limiter concepts in the mid-wave infrared; and will improve high-power continuous wave laser protection concepts. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** PE 0602145A (NGCV Technology) / Project BI2 (Sensor Protection Technology) was previously PE 0602712A (Countermine Systems) / Project H35 (Camouflage & Counter-Recon Technology), a portion of PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices), and a portion of PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) in FY19. Funding has been realigned in FY20 to reflect the financial restructure.	-	-	3.896
Accomplishments/Planned Programs Subtotals	-	-	10.584

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BI2 / *Sensor Protection Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BI4 / *Materials Application and Integration Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BI4: *Materials Application and Integration Tech*	-	0.000	0.000	8.313	-	8.313	9.561	9.730	9.921	10.023	0.000	47.548

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology, Project:
* H84 Materials
PE 0602601A Combat Vehicle and Automotive Technology, Project:
* H77 National Automotive Center

A. Mission Description and Budget Item Justification

This Project designs, develops, fabricates and evaluates a variety of materials (e.g. metals, ceramics, polymers and composites) to enable more survivable, lighter weight vehicle armor, chemical and biological protection, armaments and electronics for the next generation combat vehicle. Research focuses on unique and /or novel materials properties, developing physics-based models, materials characterization techniques, non-destructive testing methods and advanced fabrication/processing methodologies to transition candidate solutions for maturity, scale-up, and integration into systems.

This Project also continues the Advanced Vehicle Power Technology Alliance between the Department of Energy and the Department of the Army with a focus on materials, providing an emphasis on developing advanced technologies that enable military ground vehicles to become significantly more energy efficient. The Alliance is chartered to accelerate the conceptualization and transition into deployment of inventive and creative energy-saving concepts that the Nation needs to achieve energy security. This Project matures and integrates lightweight materials and joining technologies in support of lighter military vehicles which are more fuel-efficient and expeditionary with superior mobility and protection of both vehicles and occupants.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is conducted by United States Army Futures Command.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics) and 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology). This work is also coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BI4 / *Materials Application and Integration Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Lightweight Armor Materials and Processes for Vehicle Protection ***Description:*** This effort conducts applied research to design, develop and evaluate lightweight armor materials and structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. This effort also explores ground vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (i.e., shock, vibration, harshness, and damping). ***FY 2020 Plans:*** Will investigate new metal alloys, including corrosion resistant magnesium alloys and lighter weight high hardness steels; will assess the causes of delayed cracking in high hardness steel armor by performing stress corrosion cracking characterization on a statistically significant number of armor plates; will develop novel composite design capabilities to enable improved, lightweight ballistic resistance using first principles methods and techniques. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.	-	-	3.907
Title: Novel Armor Materials and Processes for Vehicle Protection ***Description:*** Develop novel metal alloys and associated processes through the scale-up and exploitation of revolutionary new metal alloys, which have demonstrated capabilities to overcome traditional engineering trade-offs (e.g., strength and ductility) with exceptional high temperature stability. ***FY 2020 Plans:*** Will develop scalable processing methods for strengthened nanocrystalline iron materials and generate initial ballistic data; will investigate the processing of aluminum alloys with novel chemistries for the generation of hydrogen. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.	-	-	2.513
Title: Advanced Vehicle Power Technology Alliance Materials ***Description:*** This effort develops and matures lightweight materials and joining technologies in support of lighter military vehicles which are more fuel-efficient and expeditionary with superior mobility and protection of both vehicles and occupants. Lighter materials/constructions and advances in joining technologies such as multi-material and dissimilar material joining will lead to lightweight military vehicle structures.	-	-	1.893

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BI4 / *Materials Application and Integration Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
FY 2020 Plans: Will continue to develop lightweight materials such as iron, manganese, aluminum (FeMnAl) alloy; magnesium and high strength aluminum alloys; will validate material and component performance through experiments on manufacturability, blast/ballistic performance, machinability, weldability, corrosion and stiffness; will investigate and develop solid state joining methods such as friction stir dovetailing and scribing for joining dissimilar materials; will develop, characterize and validate innovative weld wire materials for joining high strength aluminum alloys and advanced high strength steels; will Investigate emerging breakthrough techniques in dissimilar material joining. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	8.313

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BI9 / *Vehicle System Security Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BI9: *Vehicle System Security Technology*	-	0.000	0.000	2.951	-	2.951	2.530	2.426	2.285	2.127	0.000	12.319

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601 Combat Vehicle and Automotive Technology:
* Project H77 National Automotive Center

A. Mission Description and Budget Item Justification

This Project develops ground vehicle cyber protection and resilience technologies to increase the cybersecurity of ground vehicles and ensure their continued operation in near-peer cyber contested environments. This Project will develop cybersecurity technologies at the vehicle platform level to defeat cybersecurity threats and maintain assured vehicle functionality and freedom of maneuver in the cyber warfighting domain. This effort is critical to address the continuous expanding vulnerability of military platforms to cyber threats due to their increasing reliance on computers, networks, data, digitization, and communications technology.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Funding has been realigned in FY20 to reflect the new financial restructure.

Work in this Project will be conducted by the U.S. Army Futures Command.

Additionally, work in this project will be coordinated with and transitioned to projects identified by the U.S. Army Futures Command Cyber Community of Practice.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Vehicle System Security Technology	-	-	2.951
Description: This effort develops cybersecurity technologies to defeat cybersecurity threats and maintain assured vehicle functionality and freedom of maneuver in the cyber warfighting domain. This effort develops technologies required to maintain operating tempo and overmatch capability during offensive digital attacks to ground vehicle systems. Additionally, the technologies developed will maintain critical vehicle functionality in peer and near-peer cyber-contested environments through			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BI9 / *Vehicle System Security Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
robust cyber-defensive protections. The effort will also develop cyber-defensive technologies to mitigate risk of future and emerging enemy cyberattack vectors by designing highly assured systems with cybersecurity designed from the beginning. ***FY 2020 Plans:*** Will develop quantifiable security and resiliency metrics to inform digital protection requirements for future ground vehicle capabilities; will develop an advanced data bus technology with embedded cyber-resilient defensive agents to protect against offensive and malicious attacks and ensure continued freedom of maneuver in the cyber warfighting domain; will develop resilient technologies for real-time threat detection and operation in near-peer cyber-contested environments. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** PE 0602145A (NGCV Technology) / Project BI9 (Vehicle System Security Technology) was previously PE 0602601 (Combat Vehicle and Automotive Technology) / Project H77 (National Automotive Center) in FY19. Funding has been realigned in FY20 to reflect the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	2.951

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BJ2 / *Tactical and Navigation Lasers Sensors Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	0.000	0.000	4.990	-	4.990	5.458	5.567	5.678	5.742	0.000	27.435

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602709A Night Vision Technology:
* Project H95 Night Vision and Electro Optic Technology

A. Mission Description and Budget Item Justification

This Project designs and develops novel laser sensor technologies which provide improved maneuver, lethality, and survivability capabilities via manned and autonomous navigation, adversary sensor threat detection, and target detection and designation in all environments. It will deliver novel laser technologies which will provide low Size, Weight, and Power laser sources for optical augmentation detection systems; and compact Laser Detection And Ranging sources for situational awareness and air and ground vehicle operations and navigation in all environments. This Project is a critical enabler for autonomous operations in environments where other imaging technologies are not sufficient.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle, Soldier Lethality, and Future Vertical Lift.

Work in this Project is performed by the United States Army Futures Command.

This effort is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), 0603465A (Future Vertical Lift Advanced Technology), and 0602143A (Soldier Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Tactical and Navigation Lasers Sensors Technology	-	-	4.990
Description: This effort designs and develops novel low Size, Weight, and Power, compact, high peak power pulsed laser sources for optical augmentation detection systems; and compact Laser Detection And Ranging sources for situational awareness and manned and unmanned air and ground vehicle operations and navigation in all environments. This effort is coordinated with PE 0603462A (NGCV Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), 0603465A (Future Vertical Lift Advanced Technology), and 0602143A (Soldier Lethality Technology).			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ2 / *Tactical and Navigation Lasers Sensors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Will develop mid-wave infrared component technology and conduct field trial to evaluate range performance and optical detection capabilities. Will investigate laser detection and ranging applications to support autonomous vehicle operations. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602709A (Night Vision Technology)/ Project H95 (Night Vision and Electro Optic Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	4.990

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BJ3 / *Hydrogen Based Combat System Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BJ3: *Hydrogen Based Combat System Technology*	-	0.000	0.000	7.127	-	7.127	6.180	4.599	3.655	2.899	0.000	24.460

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology:
* Project H77 National Automotive Center.

A. Mission Description and Budget Item Justification

This Project focuses on developing the controls required to integrate multiple fuel cell stacks in order to generate sufficient electrical power for combat systems both for mobility and to enable future lethality, protection, communications and sensor capabilities. This Project also identifies and develops the solutions for generating and moving hydrogen in a battlefield environment, enabling vehicles to take advantage of the efficiencies of fuel cell vehicles.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

This effort is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Hydrogen Based Combat System Technology	-	-	7.127
Description: This effort develops the required fuel cell controls and hydrogen generation technologies required to leverage commercial development in hydrogen based fuel cells to create energy efficient combat and tactical systems.			
FY 2020 Plans: Will develop the controls strategy for combining multiple commercial fuel cell stacks into one combat vehicle power module; will develop an aluminum based hydrogen generation system that can provide hydrogen to vehicles effectively and efficiently.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ3 / *Hydrogen Based Combat System Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from 0602601A (Combat Vehicle and Automotive Technology) / Project H77 (National Automotive Center) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	7.127

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BJ7 / *Detection of Explosive Hazards Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BJ7: *Detection of Explosive Hazards Technology*	-	0.000	0.000	11.882	-	11.882	12.115	12.326	10.717	10.837	0.000	57.877

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602712A Countermine Systems:
* Project H24 Countermine Tech

A. Mission Description and Budget Item Justification

This Project designs and develops adaptive, modular sensing technologies for manned and unmanned vehicles with highly specialized emerging artificial intelligence/ machine learning tools for the autonomous detection of mines, minefields and improvised explosive devices (IEDs) in high clutter environments as well as technology to defeat near peer mines, minefields and IEDs in all environments. This effort is a critical enabler of future complex breach operations.

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

Work in this Project supports Army Modernization Priority Next Generation Combat Vehicle, and Soldier Lethality.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is coordinated with PEs 0633462A (Next Generation Combat Vehicle Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), and 0602143A (Soldier Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Detection of Explosive Hazards Technology	-	-	11.882
Description: This effort focuses on designing and developing novel component technology for detection and defeat of mines, minefields, IEDs and other explosive hazard threats for manned and unmanned vehicles. Artificial Intelligence and machine learning tools will be exploited to provide autonomous capabilities and enable increased survivability through greatly increased mine detection standoff ranges. This effort is coordinated with PEs 0633462A (NGCV Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), and 0602143A (Soldier Lethality Technology). ***FY 2020 Plans:*** Will design modular, adaptive, reduced size, weight and power explosive hazard (EH) detection payloads for incorporation on small unmanned aerial and ground vehicles; will determine sensor component performance against expected threats through			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ7 / *Detection of Explosive Hazards Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
collection and analysis of data from different standoff sensor combinations to include close-in sensors; will validate different sensor modalities to determine ideal component mix for EH detection in urban and arctic environments; will mature EH detection algorithms through their application against novel threat data sets; will validate sensor fusion using results of data collections will investigate techniques to exploit vulnerabilities of near peer EH threats. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602712A (Countermine Systems) / Project H24 (Countermine Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	11.882

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BJ9 / *Autonomous Mobility Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BJ9: *Autonomous Mobility Tech*	-	0.000	0.000	3.060	-	3.060	2.500	4.000	0.000	0.000	0.000	9.560

Note

Project BJ9 Autonomous Mobility Tech is a new start in Fiscal Year (FY) 2020.

A. Mission Description and Budget Item Justification

This Project designs and develops Artificial Intelligence and Machine Learning (AI/ML) technologies to increase autonomy and mobility to perform teamed operations with manned and unmanned air and ground vehicles in a military relevant environment through data collection on relevant platforms. Data collection investigates the usage of both simulation and live data. Simulation will provide a baseline to collect, clean, and analyze data that meets the need for developing algorithms to enable both intelligent formation control and Unmanned Aerial Vehicle (UAV) map input for Unmanned Ground Vehicle Mobility. This Project will allow proper collection techniques, tools, and data to maximize embedded autonomy using ML and other AI methods before utilizing live data collection. The Project will use AI/ML techniques to develop intelligent formation control to be used on maintained roads and in complex terrain without the need for Global Positioning System. Data will be collected from mounted platforms utilizing special internal and external sensors to develop algorithms for exact positioning, undistributed formation control, and increased speeds of unmanned platforms. Also, the Project will use AI/ML techniques to develop intelligent autonomous ground platform planning through the use of UAV mapped areas. Data collected from the UAV will be converted to maneuverable information for manned ground platform with the identification of enemy positions, go/no-go areas, terrain classification, and optimal suggested paths.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

This work is conducted by the United States Army Futures Command.

This work is coordinated with PE 0603462A (Next Generation Combat Vehicles Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Big Data Storage Techniques	-	-	2.960
Description: This effort develops techniques and technologies for storage of machine learning data sets to be used collaboratively for Army research.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ9 / *Autonomous Mobility Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Will develop automated data labeling/cleaning techniques across large amounts of data. Will examine and integrate storage requirements of different types of datasets into a unified system. Will integrate hardware and software components for the storage sub-system. Will integrate each step in storage process into a single pipeline for ease of access and use. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort is a new start in FY20.			
Title: Unmanned Aerial Vehicle Mapping ***Description:*** Develop a collaboration of UAV map input for ground vehicle mobility via artificial intelligence and machine learning. ***FY 2020 Plans:*** Will develop UAV and ground vehicle architectures for integration of artificial intelligence. Will integrate existing UAV and ground vehicle architectures into single architecture for collaboration and data passing. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort is a new start in FY20.	-	-	0.100
Accomplishments/Planned Programs Subtotals	-	-	3.060

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BK2 / *Virtual Prototyping Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK2: *Virtual Prototyping Technology*	-	0.000	0.000	5.426	-	5.426	5.426	5.300	5.426	5.155	0.000	26.733

Note

Project BK2 Virtual Prototyping Technology is a new start in Fiscal Year (FY) 2020.

A. Mission Description and Budget Item Justification

This Project matures an integrated Virtual Prototyping capability that investigates Next Generation Combat Vehicle (NGCV) technology integration into a range of novel ground vehicle design concepts that will be analyzed and evaluated through virtual experimentation to provide engineering data and operational feedback to inform NGCV analysis and requirements. Designs and analyzes novel NGCV system level ground vehicle concepts by integrating advanced mobility, survivability, lethality, sensing and electrical/electronic technologies to address emerging and future advanced threats. This Project provides system level ground vehicle design concepts and performance analysis, assesses cost and performance trades, and provides real-time soldier feedback on technology performance for the Army's NGCVs. Technologies to be evaluated include high efficiency advanced powertrains, power generation, active protection systems, active blast, advanced lethality and robotic control and autonomy technologies. The NGCV virtual experiments provide an efficient means to give warfighters an up-front, virtual hands-on operational evaluation of next generation ground vehicle concepts and emerging technologies. The Virtual Prototyping results provide critical inputs to the Army's NGCV program by providing independent technical and operational performance results, as well as assessing trades for the Army's next generation of ground combat vehicles.

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

Work in this Project supports the Army Modernization Priority NGCV.

This work is conducted by United States Army Futures Command.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Virtual Prototyping	-	-	5.426
Description: This effort addresses technical and integration challenges in the areas of mobility, survivability, lethality, vehicle architecture, and systems integration for the Army?s next generation of ground combat vehicles. Specifically, this effort focuses on developing integrated design concepts, performance analysis, identifying and assessing trade space, and conducting virtual operational experiments for the NGCV. The combination of technical performance and operational feedback provides insights			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BK2 / *Virtual Prototyping Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
into warfighter behaviors and tactics, and informs requirements for the Army?s next generation of ground combat vehicles and technologies. ***FY 2020 Plans:*** WIII generate multiple novel NGCV manned and unmanned system level ground vehicle concepts, assess performance, and conduct soldier involved virtual experiments to provide operational feedback from warfighters on NGCV system designs and technology performance. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort is a new start in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	5.426

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BK3 / *Next Gen Intelligent Fire Control (NG-IFC) Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	0.000	0.000	1.050	-	1.050	3.450	2.850	1.770	0.892	0.000	10.012

Note

Project BK3 Next Gen Intelligent Fire Control (NG-IFC) Tech is a new start in Fiscal Year (FY) 2020.

A. Mission Description and Budget Item Justification

This Project will develop armament specific hardware, algorithms and architectures to support Next Generation Combat Vehicle with the necessary fire control on future manned and unmanned platforms.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is related to and fully integrated with the efforts funded in PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Next Generation Intelligent Fire Control Technology	-	-	1.050
Description: This effort investigates image sets for computer vision algorithms, target acquisition validation schemes and experimentation of large caliber armament systems. ***FY 2020 Plans:*** Will conduct experiments with pre-shot hardware for future integration into unmanned ground vehicle system and develop common fire controller components. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort is a new start in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	1.050

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BK3 / *Next Gen Intelligent Fire Control (NG-IFC) Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) BK5 / *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	0.000	0.000	1.190	-	1.190	0.913	0.939	0.580	0.378	0.000	4.000

Note

Project BK5 Adv Direct In-Direct Armament Sys (ADIDAS) Tech is a new start in Fiscal Year (FY) 2020.

A. Mission Description and Budget Item Justification

This Project matures and conducts experiments on component technologies for large caliber direct fire light-weight armament systems that will exceed the current capability of 120mm direct fire and be optimized for future operational environment with cross-domain engagement capability.

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

Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is related to and fully integrated with the efforts funded in PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Advanced Direct In-Direct Armament System Technology	-	-	1.190
Description: This effort designs and develops technologies for large caliber direct fire light-weight armament systems that will exceed the current capability of 120mm direct fire cannons and be optimized for future operational environment, including dense urban, with cross-domain engagement capability. Specifically, this effort matures technologies for rapid fire on-the-move at all elevations (direct & indirect), compact ammunition design with advanced ignition, advanced recoil mitigation to reduce impulse and automated ammunition handling and reloading.			
FY 2020 Plans: Will investigate armament system configurations for high elevations and advanced recoil mitigation to reduce impulse. Will develop component technologies for ammunition handling and the primary weapon that support the configurations needed for high elevation and reduced impulse.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BK5 / *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
This research effort is a new start in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	1.190

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A