Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army											Date: May 2021	
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*							
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	255.041	258.351	172.166	-	172.166	-	-	-	-	-	-
BF1: *Autonomous Ground Resupply Tech*	-	10.836	10.615	-	-	-	-	-	-	-	-	-
BF3: *Combat Vehicle Robotics Tech*	-	11.178	9.163	16.810	-	16.810	-	-	-	-	-	-
BF6: *Crew Augmentation and Optimization Tech*	-	22.079	19.022	8.906	-	8.906	-	-	-	-	-	-
BF8: *Artificial Intelligence & Machine Learning Tech*	-	21.134	21.425	13.912	-	13.912	-	-	-	-	-	-
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	17.072	36.836	35.489	-	35.489	-	-	-	-	-	-
BG2: *Modeling and Simulation for MUMT Technology*	-	3.953	3.273	6.718	-	6.718	-	-	-	-	-	-
BG6: *Advanced Concepts for Active Defense Technology*	-	51.275	45.754	30.541	-	30.541	-	-	-	-	-	-
BG8: *Obscuration Technology*	-	3.903	2.620	2.576	-	2.576	-	-	-	-	-	-
BH2: *C4ISR Modular Autonomy Technology*	-	4.674	-	-	-	-	-	-	-	-	-	-
BH5: *Platform Electrification and Mobility Tech*	-	9.612	20.563	13.781	-	13.781	-	-	-	-	-	-
BH7: *Enhanced VETRONICS Technology*	-	3.455	-	-	-	-	-	-	-	-	-	-
BH9: *Protection for Autonomous Systems Tech*	-	2.443	1.444	-	-	-	-	-	-	-	-	-
BI2: *Sensor Protection Technology*	-	10.149	10.340	5.878	-	5.878	-	-	-	-	-	-
BI4: *Materials Application and Integration Tech*	-	7.971	7.689	7.648	-	7.648	-	-	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army												Date: May 2021
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*							
BI9: *Vehicle System Security Technology*	-	2.829	2.676	2.359	-	2.359	-	-	-	-	-	-
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	4.785	5.372	5.364	-	5.364	-	-	-	-	-	-
BJ3: *Hydrogen Based Combat System Technology*	-	1.515	-	-	-	-	-	-	-	-	-	-
BJ7: *Detection of Explosive Hazards Technology*	-	11.393	-	-	-	-	-	-	-	-	-	-
BJ9: *Autonomous Mobility Tech*	-	2.934	2.407	3.848	-	3.848	-	-	-	-	-	-
BK2: *Virtual Prototyping Technology*	-	5.203	8.295	8.169	-	8.169	-	-	-	-	-	-
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	1.007	4.043	0.987	-	0.987	-	-	-	-	-	-
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	1.141	3.814	9.180	-	9.180	-	-	-	-	-	-
BP5: *Ground Vehicle Technology (CA)*	-	44.500	43.000	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The Fiscal Year (FY) 2022 Direct War/Enduring Operations dollars in the amount of $0.987 million in Project BF8 Artificial Intelligence & Machine Learning Tech will continue to support the 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.

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

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).

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
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*

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.

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	263.547	219.565	237.850	-	237.850
Current President's Budget	255.041	258.351	172.166	-	172.166
Total Adjustments	-8.506	38.786	-65.684	-	-65.684
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-1.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	43.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.350	-			
• SBIR/STTR Transfer	-8.856	-3.214			
• Adjustments to Budget Years	-	-	-65.684	-	-65.684

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: BP5: *Ground Vehicle Technology (CA)*		
Congressional Add: *Prototyping Energy Smart Autonomous Ground Systems*	10.000	-
Congressional Add: *Highly Electrified Vehicles*	5.000	-
Congressional Add: *Additive Metals Manufacturing*	3.000	-
Congressional Add: *RPG and IED Protection*	3.000	-
Congressional Add: *Modeling and Simulation*	3.000	-
Congressional Add: *Structural Thermoplastics*	3.000	-
Congressional Add: *Advanced Materials Development for Survivability*	10.000	-
Congressional Add: *Autonomous Vehicle Mobility*	7.500	-
Congressional Add: *Program increase - modeling and simulation*	-	10.000
Congressional Add: *Program increase - silicon carbide electronics*	-	6.000
Congressional Add: *Program increase - highly electrified vehicles*	-	5.000
Congressional Add: *Program increase - additive metals manufacturing*	-	10.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
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*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Program increase - prototyping energy smart autonomous ground systems*	-	12.000
Congressional Add Subtotals for Project: BP5	44.500	43.000
Congressional Add Totals for all Projects	44.500	43.000

Change Summary Explanation

FY2022 funding change due to partial administrative realignments of research in 4 Projects BI2, BH5, BG6 and BF6 to PE 0602144A Ground Technology for better alignment to the mid- to far term priorities of the Ground portfolio; administrative realignment from Project BF8 to university-based research projects in the Ground, Air, Network, Soldier and Lethality BA2 portfolios; realignment from Project BG6 to PE 0603041A All Domain Convergence Advanced Technology for Collaborative convergence advanced technology development.

BF3 - Funding in this effort was increased to emphasis the development of the Human Robotic Interactions, with a major Engineering
Evaluation Test (EET) being conducted to technically understand the maturation level of each technology and how an operator will interact with the robotic asset.
BF6 - Funding change reflects planned lifecycle of this effort. Funding in this effort was increased to emphasis the development of the Human Robotic Interactions, with a major Engineering
Evaluation Test (EET) being conducted to technically understand the maturation level of each technology and how an operator will interact with the robotic asset.
BF8 - Funding increase reflects planned lifecycle of this effort to focus on architectures and models for tactical teaming. / Funding is realigned in FY 2022 to PE 0602180A (Artificial Intelligence Technologies) / CN7 Predictive Maintenance Applied / In FY2022, funding from this effort was administratively realigned to university-based research projects in the Ground, Air,
Network, Soldier and Lethality BA2 portfolios
BF9 - Immaterial Change
BG2 - Funding increase in FY22 will expand analytical tool development to include varied meteorological conditions and terrain types and will support development of obstacle detection algorithms.
Research Project in to support the application of AI/ML technology for predictive maintenance.
BG6 - In FY 2022, this effort has been realigned to PE 0602144A Project CG7 Ground Protection Concepts and Technologies. / In FY2022, funding is realigned from PE 602145A Project BG6 to Advancing Concepts and Technology Forecasting
(611102CH9); Collaborative Convergence Adv Tech (633041CM2) ; Ground Protection Concepts and Technologies
(622144CG7).
BI2 - In FY 2022, this effort has been administratively realigned to PE 0602144A Project CG5 Ground Vehicle Sensor Concepts and Technologies.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BF1: *Autonomous Ground Resupply Tech*	-	10.836	10.615	-	-	-	-	-	-	-	-	-

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. Increased capabilities will transition to PE 0603462 (Next Generation Combat Vehicle Advanced Technology) to be integrated into a Soldier evaluation to obtain user feedback and inform and 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 NGCV.

Work in this Project is conducted by the United States (US) Army Engineer Research and Development Center and coordinated with US Army Futures Command.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and the Leader/Follower Program of Record.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Software for Autonomous Systems	9.593	9.700	-
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.			
FY 2021 Plans: Continue to develop advanced software behaviors and algorithms for integration into the fail-safe autonomous ground vehicle architecture and conduct field testing to validate increased robotic capabilities, which include: the integration of trailers (forward and reverse), convoy reverse capabilities, convoy formations, dynamic route planning and world terrain modeling to minimize the cognitive load placed on Soldiers managing groups of unmanned systems.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
This project ends in FY 21.			
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.	1.243	-	-
Title: Simulation Tools for AGR ***Description:*** This effort designs and develops real-time and high-fidelity, hardware and software-in-the-loop simulators capable of rapid design and assessment of ground vehicle autonomous behaviors through integration with autonomy solutions. ***FY 2021 Plans:*** Investigate simulation design, development, and performance as well as develop tools to explore autonomous system performance; develop simulation-enabled analysis methods for Autonomous Ground Resupply capstone events; and investigate integration of additional sensors and algorithms into simulation tools. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This project ends in FY 21.	-	0.915	-
Accomplishments/Planned Programs Subtotals	10.836	10.615	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BF3: *Combat Vehicle Robotics Tech*	-	11.178	9.163	16.810	-	16.810	-	-	-	-	-	-

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 (NGCV).

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Autonomous Behaviors and Perception	5.104	3.555	9.413
Description: This effort contributes to the 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 2021 Plans: Develop the dynamic obstacle detection and avoidance capability and integrate with advanced off-road autonomous navigation and conduct experiments for defined missions with tactical formations at operationally relevant speeds.			
FY 2022 Plans: Will develop and validate object recognition and environment understanding for autonomous vehicles. Develop and validate a basic framework for applying this knowledge to operationally relevant missions (per U.S military doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF)), enabling customized behaviors to specific combat missions, and prioritization of autonomous mobility tasks and maneuvers when multiple tasks are assigned to a vehicle or team of vehicles. Will develop models to integrate Army operational architectures and military autonomous behavior architectures in Autonomous Ground Vehicle Reference Architecture (AGVRA). Develop robotic-specific cyber architectural views across the autonomous architecture focused on getting autonomous systems certified under the Department of Defense Risk Management			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Framework. Develop system behavior and structure in assurance testing via model-based systems engineering and formal methods to be containerized and integrated with DoD cloud services. Develop security enhancements in autonomous system component registries to improve Robot Operating System-Military (ROS-M). ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding realigned from the Autonomous Architecture effort in this Project is to focus on the development of the autonomous technologies, integration of Army operational and autonomous behavior architectures in AGVRA at the Engineering Evaluation Test (EET) in FY22.			
Title: Autonomous Architecture ***Description:*** This effort contributes to the 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 as well as the Robotic Operating Systems ? Military (ROS-M) framework. ***FY 2021 Plans:*** Continue to develop and establish ROS-M framework of reusable and adaptable software developed in collaboration with other Government Agencies and industry to align the robotics community to a common architecture. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects realignment of funding for this effort to the Autonomous Behaviors and Perception effort in this Project.	1.973	1.661	-
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 2021 Plans:*** Mature the operator-directed voice recognition for command and control of the robotic ground system maneuver. Assess the performance of how naturally the robotic system interacts with human operators through experiments or experimentation to improve manned-unmanned system teaming. ***FY 2022 Plans:*** Will design and develop the enhanced robotic warfighter-machine?s interface technologies for a combat scenario to demonstrate the ability to operate the robotic vehicle with decreased time to complete a task, thereby enabling the Warfighter to focus on	4.101	3.947	7.397

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
the overall mission. Will investigate the enhanced robotic warfighter-machine?s interface technologies to enhance the robotic operator?s control of mobility, their reaction time of alerts and their overall success of the mission. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding is increased for planned progression of this effort to research being performed and evaluated at the EET in FY22. The research focus is on development of the Human Robotic Interactions and how an operator will interact with the robotic asset.			
Accomplishments/Planned Programs Subtotals	11.178	9.163	16.810

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BF6: *Crew Augmentation and Optimization Tech*	-	22.079	19.022	8.906	-	8.906	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project administratively to Program Element (PE) 0602144A Ground Technology / Project CG8 Human Autonomy Teaming.

A. Mission Description and Budget Item Justification

This Project designs 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 through 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 (NGCV).

Work in this effort is performed by the United States (US) Army Futures Command.

This work is done in coordination with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and PE 0602143 (Soldier Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Crew Station / Closed Hatch Operations ***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.	3.856	-	-
Title: Crew Understanding Agents	7.945	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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.			
Title: Agents Understanding Crew ***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.	5.924	-	-
Title: Joint Human-Agent Teamwork ***Description:*** Will design and develop Commander?s interface to enable dynamic task reassignment across crew members and unmanned platforms to provide capability of crew members to manually share critical tasks as capabilities and mission needs change; Will investigate novel algorithms and communication protocols for developing, maintaining and sharing situational awareness across a distributed heterogeneous team to enable improved decision making and rapid team reconfiguration; Will develop novel machine learning approaches to enable Soldiers to rapidly train artificial intelligence systems on simulated and physical platforms	4.354	-	-
Title: Crew & Robotic Mission with Agent Technology ***Description:*** This effort focuses on the design, development and validation of hardware and software for establishing crew to robotic mission operator interactions to address full vehicle performance. Included are simulation tools and hardware for Soldier-in-the-loop testing including the Learning Warfighter Machine Interface (L-WMI), a seven-Soldier vehicle crew configuration command vehicle simulator; personalization of crew and robotic operator configurations to permit reconfiguration for role, mission requirements and Soldier monitoring; optimization of vehicle crew interactions to permit sharing, reallocation and management of tasks, as well as situational awareness and data management. ***FY 2021 Plans:*** Validate enhancements to the crew?s ability to plan missions and optimization of crew?s comprehension of crew interactions with unmanned systems by integrating the L-WMI onto a motion-based simulation platform. Validate behavioral and communications-based Soldier state assessment approaches in an operationally-relevant, motion-based simulation environment. ***FY 2022 Plans:***	-	1.498	0.487

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Will validate optimized sensing approaches to process, share and improve situational awareness (SA) across the crew and improve decision making and mission success within a NGCV formation. Will validate personalization of Warfighter Machine Interface (WMI) configuration to permit role/mission requirement reconfiguration and Soldier monitoring. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort to focus on SA/decision making across the crew for mission success, and personalization of WMI configuration .			
Title: Crew Capability Enhancement ***Description:*** This effort focuses on the dynamic interaction of Soldiers, responsible for both manned and unmanned ground vehicles, working together within a platoon formation. Research focuses on the simultaneous use of multiple technologies by Soldiers including transparent multi-modal user interfaces, commander?s tools for maintaining and enhancing situation awareness, decision aids for enabling dynamic resource allocation and orchestration, and tools to interact with and adapt vehicle based autonomy. Products will include artificial intelligence algorithms, information display technologies, and team-centric design principles. ***FY 2021 Plans:*** Develop a concept for a Commander?s interface to demonstrate dynamic task reassignment across crew to enable crewmembers to manually share critical tasks as capabilities and mission needs change; investigate novel algorithms and communication protocols for developing, maintaining, and sharing situational awareness across a distributed Soldier-Artificial Intelligence team to enable improved decision making and rapid team reconfiguration. ***FY 2022 Plans:*** Will design and develop algorithms that provide an enhanced understanding of crew status, actions, intentions, and goals during simulated mission execution; design and develop initial data-driven approaches to cue Vehicle Commander of possible task sharing opportunities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.877	3.233
Title: Characterize Soldier-Adaptive AI Interactions ***Description:*** This effort develops approaches for characterizing Soldier interactions and overall human-system performance of mixed Soldier and intelligent-agent teams to enable robust human system performance for manned and unmanned teams. This effort will focus on flexible, tailorable methodologies for laboratory-grade, high-resolution characterization of joint Soldier and Artificial Intelligence (AI) enabled intelligent-agent adaption in complex environments.	-	2.443	1.133

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Create algorithms for characterizing crew behavior and adaptations; create algorithms for characterizing AI behavior and adaptations; develop initial advanced techniques for integrating subject matter expertise with machine learning approaches for characterizing intelligent-agent behaviors and adaptations. ***FY 2022 Plans:*** Will design and develop initial capability to characterize the interactions between the Soldier and AI-enabled system behaviors, and the ability to adapt to each other during unscripted simulated mission exercises. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding realigned to support higher priority artificial intelligence effort.			
Title: Human Augmentation for Collective Training ***Description:*** This effort investigates assessment techniques of crew performance to inform the development of individual and collective training for military vehicles. Assessment techniques will be applicable across a wide-variety of vehicle platforms, training tasks and vehicle crew roles. This effort will support training and increased force readiness of vehicle crews in complex environments by developing accurate and efficient performance assessment techniques evaluated in complex Operational Environments (OE) enabled by the latest advances in simulation and training technology. ***FY 2021 Plans:*** Design and conduct laboratory experiments to investigate training and visual display concepts that improve coordination and communication in manned-unmanned teaming operations in experimental crew station environments. Investigate and validate training methods using reconfigurable unmanned system command vehicle representative training system testbeds to support improved individual and crew adaptation to dynamic task-changing events and inform training system design for embedded and non-embedded training capabilities. ***FY 2022 Plans:*** Will investigate embedding of synthetic training environments in ground vehicle embedded computing devices to assess crew performance. Will investigate and design simulation capability for researching embedded training concepts using game engine based simulators. Will conduct experiments to determine data outputs required for live training and develop protocols to deliver data to the processing system for engagement modeling, real-time casualty assessment, and precision targeting. Will research mechanisms for high speed filtering and attribution of terrain features for ground platform training or operational use. Will design and conduct laboratory experiments pertaining to training Soldiers to accommodate task reassignments in order to improve	-	2.254	1.883

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
coordinated platoon-level maneuver in manned-unmanned team operations, utilizing experimental crew stations. Will conduct experiments to investigate and validate intelligent data routing techniques for improved live-synthetic training data transmission. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort for reduced experimentation.			
Title: Platoon Teaming Capability ***Description:*** This effort focuses on the design, development and validation of intelligent, real-time, within-vehicle task management; data-driven allocation of situational awareness (SA) across platforms within the platoon; coordinated platoon-level manned-unmanned teaming (MUM-T) semi-autonomous maneuver with complex formations; and on-the-fly, platoon-level task optimization. This effort includes WMI modification to evaluate these capabilities in application of intelligent task management and data-driven prediction of crew to support changing mission goals. ***FY 2021 Plans:*** Validate interface for manual, pre-planned, cross-vehicle task reassignments by the team leader in order to enhance team performance based on crew status and mission objectives. Conduct experiment utilizing limited semi-autonomous maneuver for unstructured off-road operations in a motion-based simulation environment. ***FY 2022 Plans:*** Will validate approaches for sharing of critical tasks between crewmembers and intelligent technologies based on crewmember workload in order to enhance team performance. Will conduct experiment utilizing limited semi-autonomous maneuver for unstructured off-road operations in a live field exercise. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort for increased focus on experimentation in live field exercises.	-	1.339	2.170
Title: Soldier?AI Team Mission Planning for Dynamic Complex Environments ***Description:*** Planning in multi-domain operations environments is complex and has increased temporal and spatial sensitivities for Soldiers to integrate with AI systems to plan missions. This effort provides the fundamental concepts and technologies to enable Soldiers and AI systems to team together to plan for multi-domain operations from a ground vehicle perspective. This effort focuses on planning enablers to maximize manned-unmanned team performance across squads and platoons and includes crew station-based emerging technologies in the areas of human- interaction with AI technologies and human-guided machine intelligence. Approaches focus on modeling both Soldier and AI capabilities and their limitations as a function of the mission environment and mission requirements, and applying those models to forming mission plans. ***FY 2021 Plans:***	-	1.251	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Conduct experiments to augment Learning Warfighter-Machine Interface capabilities to include enhanced mission planning capabilities that account for the relationship between terrain and environmental features as well as crew performance across multiple manned and unmanned ground vehicles. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to a new Project titled Human Autonomy Teaming in PE 0602144A_CG8.			
Title: Dynamic Soldier-AI Team Resource Allocation ***Description:*** This effort focuses on creating the concepts and technologies necessary to dynamically allocate Soldiers and unmanned systems during missions in to adapt mission plans to adversarial actions and other events at a squad and platoon level, including responding to degradation or loss of team capabilities, changes in mission goals or priorities, and responding to adversarial actions. The effort includes the allocation of Soldiers, platforms, and platform sub-system capabilities with the focus to ensure that future AI and automation capabilities are focused on the circumstances and conditions where they are most likely to be successful, and to ensure that the resources of the Soldier-AI team are focused appropriately to ensure mission success. ***FY 2021 Plans:*** Design and develop Commander?s interface to enable dynamic task reassignment across crew to provide capability of crew members to manually share critical tasks as team capabilities and mission needs change; investigate novel algorithms and communication protocols for developing, maintaining, and sharing situational awareness across a distributed heterogeneous team to enable improved decision making and rapid team reconfiguration. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to a new Project titled Human Autonomy Teaming in PE 0602144A_CG8.	-	2.434	-
Title: Soldier Cognition-Centric Interface Technologies ***Description:*** This effort creates cognitive-centric displays that ensure Soldiers are focused on aspects of situational awareness, mobility, target engagements, and communications that are critical to mission performance as future crew stations and displays provide vast amounts of multi-domain information that has the potential to distract, overwhelm, and mislead Soldiers. This effort ensures that our systems do not capture and misdirect Soldier attention and/or cognition, maximizing the utility of AI systems to the Soldier. This effort enables Soldiers to better understand the actions, goals, intents, and general reasoning of the AI systems to ensure they are effectively used, but not inappropriately relied upon. ***FY 2021 Plans:***	-	1.598	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Investigate novel approaches to characterize overall team cohesion in a distributed Soldier-AI team; and conduct experiments to examine approaches for quantifying a crew?s trust in AI-enabled autonomous systems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to a new Project titled Human Autonomy Teaming in PE 0602144A_CG8			
Title: Enabling Soldier-AI Technology Adaptation ***Description:*** This effort develops technologies to rapidly adapt and upgrade AI-enabled system capabilities in response to advancements in AI in the commercial and adversary environments. Two focus areas include enabling technology adaption during Soldier experimentation and enabling data to be collected during these events for rapid development of technology updates and modifications. This effort has four goals: 1) increasing the ability of Soldier-AI teams to rapidly adapt to adversarial actions, new technologies, environmental changes, and mission requirements; 2) decreasing the data requirements to train and adapt AI-enabled systems; 3) increasing Soldier trust and use of technology; and 4) ensuring ethical decisions by using Soldiers to guide the actions and in-field adaptations of Soldier-AI team behaviors. ***FY 2021 Plans:*** Leverage data from multiple sensor systems and sensing approaches to improve robustness of real-time algorithms for understanding crew status, actions, intentions, and goals; investigate the ability for using information regarding crew behavior, physiology and interaction with intelligent agents to inform the development of novel approaches for assessing effectiveness of Soldier-AI teams; develop novel machine learning approaches to enable Soldiers to rapidly train AI systems on simulated and physical platforms. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to a new Project titled Human Autonomy Teaming in PE 0602144A_CG8.	-	3.328	-
Accomplishments/Planned Programs Subtotals	22.079	19.022	8.906

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BF8: *Artificial Intelligence & Machine Learning Tech*	-	21.134	21.425	13.912	-	13.912	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding from this Project was realigned to:
Program Element (PE) 0602144A (Ground Technology) / CI2 Ground Enabling University Applied Research
PE 0603119A (Ground Advanced Technology) / CJ9 Ground Enabling University Advanced Development
PE 0602141A (Lethality Technology) / CJ1 Lethality Enabling University Applied Research
PE 0602182A (C3I Applied Research) / CN4 Network Enabling University Applied Research
PE 0602183A (Air Platform Applied Research) / CL5 Air Platform Enabling University Applied Research
PE 0602184A (Soldier Applied Research) / CN9 Soldier Enabling University Applied Research
PE 0602180A (Artificial Intelligence Technologies) / CL7 ATR using Multiple Cooperative Sensors Tech
PE 0602180A (Artificial Intelligence Technologies) / CN7 Predictive Maintenance Applied Research

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. This Project also matures emerging research leading to potential technology development in areas of strategic importance to the Army by bringing competitively selected Universities with research teams into Technical Alliances.

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 (US) Army Futures Command.

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

JUON CC-0558 $0.991M.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Title: Advanced Distributed Power for Autonomous Platforms ***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 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.	1.395	-	-
Title: Scalable, Adaptive, and Resilient Autonomous Systems ***Description:*** This effort develops and matures emerging research in Autonomous Vehicle intelligence and decision making, 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 the application of Artificial Intelligence/Machine Learning (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 2021 Plans:*** Investigate and develop methods for metric- and semantic-based world models as well as small unmanned aerial system and unmanned ground system coordinated maneuver; validate AI/ML methods to enable tactically-informed behaviors and maneuver of autonomous systems under Army-relevant constraints and environments. ***FY 2022 Plans:*** Will investigate methods and conduct experiments to increase operational speed and environmental complexity for air and ground based autonomous vehicle perception, learning, reasoning, navigation, and physical capabilities to augment and increase the freedom of maneuver in complex and contested environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:***	7.194	4.062	2.903

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
In FY 2022, funding was partially realigned to PE 0602180A (Artificial Intelligence Technologies) Project CL7 (ATR using Multiple Cooperative Sensors Tech) to support artificial intelligence advancements.			
Title: Context-Based Information Dynamics ***Description:*** This effort investigates techniques that integrate on-board and external information sources, and it applies Machine Learning (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 2021 Plans:*** Investigate methods for using machine learning approaches to provide information mediation and transformation to identify approaches that address tactical dynamics and challenges of distributed intelligent command and control system interoperation. ***FY 2022 Plans:*** Will accelerate the intelligence and design phases of decision making by investigating methods and software that are semantically-aware and can identify, characterize, and exploit data from sensors and other information assets; design and develop capabilities that build on theories and fundamental models for accelerating the intelligence and design phases of machine and human decision making, through the use of aforementioned models. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort to develop software for the intelligence and design phases of decision making	2.248	2.235	2.459
Title: Heterogeneous Computing and Computational Sciences ***Description:*** This effort researches and develops algorithms and architectures to allow adaptable, energy efficient 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 2021 Plans:*** Continue to develop adaptive computation algorithms for AI/ML processing at resource-constrained tactical edge for NGCV platforms, and to build local decision making framework to enable intelligent computational off-loading and distributed computing under resource constrained and contested environments. ***FY 2022 Plans:***	1.620	1.794	1.810

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Will design dynamic, scalable architectures to enable energy efficient computation on the tactical edge battlefield; develop algorithms and protocols for resilient teaming and coordination of decentralized and distributed computing device; explore intelligent algorithms for adaptive computing and information processing scheduling and distribution under mission constraints. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort to develop algorithms and protocols for resilient teaming.			
Title: Machine Learning with Constrained Resources ***Description:*** This effort will research new Machine Learning (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 to 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 0611102A (Defense Research Sciences) / AA6 (Robotics and Mobile Energy) and AA9 (Information and Networking). ***FY 2021 Plans:*** Investigate novel machine learning approaches that allow trained models to be transferred between autonomous ground vehicles operating in similar domains; investigate algorithms that allow learned models to be developed from synthetic or offline training data; develop algorithms that allow autonomous ground vehicles to use semantic representations of the environment to navigate in complex environments; extend surrogate models for use of physical self-awareness for autonomous flight of unmanned aerial systems (UASs) to incorporate differing, static weather conditions, including pressure, wind-speed, and direction incorporating uncertainty in weather conditions; investigate the use of cyber agility and deception algorithms and methodologies as well as additional evasion defensive algorithms against Adversarial Machine Learning (AML) techniques in order to make tactical and enterprise systems resistant to attacks on their cyber defenses that rely on ML. ***FY 2022 Plans:*** Will explore cost-effective secure communication and data processing protocols that can be implemented in a resource-constrained tactical network; develop spatial-temporal graphs, graph neural networks, and deep learning algorithms to assist inferring temporal causality relationships of communication and services among assets; research noisy or corrupted military radar intelligence to develop unsupervised machine ML algorithms to generate multiple synthetic reconstructions from a heavily down-sampled image; research signal modulation schemes for low-signature communications and develop unsupervised ML algorithms to encode and decode text messages; develop algorithms for prototype platforms that allow trained models to be transferred between autonomous ground vehicles operating in similar domains; investigate machine learning approaches that allow relevant portions of trained models to be transferred across environments; conduct scientific experimentation to measure	3.993	4.010	4.200

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
the ability of autonomous ground vehicles to navigate complex environments using semantic representations of the environment and reason over semantic observations in the environment; develop, explore, and define assessment metrics and machine learning approaches for training, augmenting, and assessing interaction between and across multi-agent systems and between soldiers and intelligent agents during joint collaborative tasks; design and conduct empirical analysis of modeling and simulation environments augmented with context-aware intelligent agents to enhance mission rehearsal, planning, and decision-making in the command and control operations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
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.	1.354	-	-
Title: Intelligence for High Operational Tempo Maneuver ***Description:*** Applied research on intelligence for cognitive learning and control architectures to enable efficient and full use of embodied physical capabilities and create the machine intelligence required of autonomous systems to understand physical limitations. Investigates the means through which robotic physical performance attributes (e.g. speed, agility) will be coupled with artificial intelligence to enable resilient maneuver in high operational tempo missions in complex environments. ***FY 2021 Plans:*** Investigate efficient algorithms that respond quicker to increase maneuver speed, agility, and adaptability of autonomous systems over complex terrain. Establish cognitive and control architectures that enable closed-loop self-aware and resilient tactical teaming behaviors at high operational tempos. ***FY 2022 Plans:*** Will conduct fundamental research, drawing on existing state-of-the-art work and biological inspiration, on novel models and algorithms that are capable of maneuver over or through complex terrain at high operational tempos, with efficiency in terms of physical movement (i.e. energy) and computation; conduct research on architectures and models that provide predictable performance appropriate for tactical teaming. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort to focus on architectures and models for tactical teaming.	-	1.324	1.540
Title: Autonomous Mobility NGCV Challenge	-	3.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: Develop novel behaviors and algorithms for autonomous off-road mobility in tactical environments to meet capability needs of the Next Generation Combat Vehicle (NGCV). ***FY 2021 Plans:*** Investigate novel algorithms for autonomous off-road navigation behaviors in complex environments at more operationally relevant speeds. Approaches will include learning from Soldier experimentation events to enable more tactically relevant behaviors with improved resiliency over current approaches. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, funding was realigned to PE 0602180A (Artificial Intelligence Technologies) Project CL7 (ATR using Multiple Cooperative Sensors Tech) to support artificial intelligence advancements.			
Title: Operational Assessment of Artificial Intelligence Developmental Systems ***Description:*** This effort supports the Combatant Commander's needs by performing operational assessments of AI-intense developmental weapon systems. ***FY 2021 Plans:*** Continues to work on an operational assessment of Artificial Intelligence developmental systems in support of the Combatant Commander identified need in FY20. ***FY 2022 Plans:*** Will continue to work on an operational assessment of Artificial Intelligence developmental systems in support of the Combatant Commander identified need in FY21. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is realigned from support to the Combatant Commanders.	-	2.000	1.000
Title: Army Universities and Technical Alliances Collaboration ***Description:*** This effort conducts research leading to potential emerging technology development in areas of strategic importance to the Army in AI/ML and Robotics by bringing competitively selected Universities with research teams into Technical Alliances. The Technical Alliance collaborations consist of large collaborative hubs focused on developing and transitioning research in Army critical areas. Technical Alliances will be used to exploit opportunities to advance new capabilities through a sustained long- term multidisciplinary research effort. The primary focus of the Technical Alliances is expanding the frontiers of knowledge in research areas where the Army has enduring needs, and integrates state-of-the-art research programs at academic institutions to increase the supply of scientists and engineers to advance and optimize research within Army laboratories.	-	3.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Investigate and research technologies for ground vehicles focusing on autonomy, AI/ML and robotics. Will research geospatially-enabled, autonomy-related machine learning technologies, advanced teaming, and navigation/routing necessary for the Ground Portfolio, NGCV and the Army Modernization Priorities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY2022, funding from this effort was administratively realigned to university-based research projects in the Ground (PE 0602144A), Air (PE 0602183A), Network (PE 0602182A), Soldier (PE 0602184A) and Lethality (PE 0602141A) Enabling Projects.			
Title: Small Sample Learning ***Description:*** This effort develops and explores novel algorithms that seek to reduce the time, manpower, and funding necessary to train artificial intelligence/machine learning (AI/ML) systems in image detection.	0.350	-	-
Title: Automated Target Recognition Applied Research ***Description:*** This effort investigates and develops intelligent algorithms to rapidly detect, identify, and cue kinetic options for identified adversary targets.	2.980	-	-
Accomplishments/Planned Programs Subtotals	21.134	21.425	13.912

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	17.072	36.836	35.489	-	35.489	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project designs and develops modular and adaptive sensor components, novel embedded processing approaches, innovative threat cueing solutions and novel multi-function sensor payloads integrated with algorithms and machine learning/artificial intelligence tools to provide improved manned and unmanned ground vehicle situational understanding that enables aided target recognition (AiTR) 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 (NGCV), Soldier Lethality (SL), and Future Vertical Lift (FVL) Modernization priorities.

Work in this effort is performed by the United States (US) Army Futures Command.

This effort is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), 0602143A (Soldier Lethality Technology), 0602148A (Future Vertical Lift Technology) and 0603465A (Future Vertical Lift Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Sensors for Autonomous Operations and Survivability	14.589	-	-
Description: This effort will deliver sensor component technologies which greatly improve current and future uncooled 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. This effort will research and develop threat cueing algorithms for unmanned aerial sensor borne electro-optic/infrared and ground penetrating radar sensors, and for ground vehicle based 360 degree sensors. This effort will investigate, develop and validate target detection and recognition algorithms with low false alarms rates and high probability of detection while on-the-move. These components will enable sensor systems to provide vehicle borne and dismounted soldier situational understanding in all environments and improve lethality by reducing decision making timelines.			
Title: Advanced Sensors with Embedded Processing	-	25.177	26.309

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: Designs and develops advanced, automated multi-spectral and multi-function sensor components, and image processing techniques with improved performance in all environments and against all threats to include low-contrast targets in camouflage or in degraded conditions to enable combined arms maneuvers in complex environments for NGCV via manned, optionally manned, and robotic platform applications. ***FY 2021 Plans:*** Validate Digital Readout Integrated Circuit (DROICs) with high dynamic range and on-chip compression to enable high resolution imaging within bandwidth constricted environments. Mature on-chip non-uniformity correction for electro-optical / infrared (EO/IR) sensor components. Mature and demonstrate dynamic on-chip compression of thermal imagery to allow for up to 10x reduction in data rate. Begin development of pixel designs using advanced Micro-Electro Mechanical System (MEMS) to increase sensitivity. Mature compact high resolution uncooled thermal imaging sensors with integrated three-dimensional imaging algorithms to enable compact navigation and threat detection capabilities. Investigate exploitable scene features and target signatures throughout visible to long wave infrared portions of the spectrum to aid in robust threat detection through experiments during various times-of-day/night, sky irradiance, targets and backgrounds. Investigate the environmental parameters and target properties governing target detectability by EO/IR sensors operating at differing wavelengths to identify optimal sensor configurations. ***FY 2022 Plans:*** Will optimize on-chip non-uniformity correction for electro-optical / infrared (EO/IR) sensor components. Will complete development of pixel designs using advanced MEMSs to increase sensitivity. Will optimize new electronics readout circuitry for high sensitivity uncooled sensors and conduct experiments to ascertain the limits of sensitivity possible with the new readouts. Will investigate components necessary to enable uncooled longwave infrared (LWIR) sensors using smaller pixel pitch and larger pixel count. Will determine the performance of improved uncooled LWIR sensor components for threat warning. Will validate cooled digital ROICs to ensure they provide maximum attainable bit depth and information content available for high dynamic range imaging in order to see all threats no matter the level of clutter or degraded imaging environment. Will integrate low power processing threat warning approaches into the digital ROICs. Will determine new exploitable scene features and target signatures in the polarized visible through LWIR portions of the spectrum. Will determine optimal sensor configurations governing correlation between environmental parameters, target properties, low to moderately cluttered background suppression, and target detectability with polarized EO/IR sensors operating at differing wavelengths. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Multi-Mission Payload	-	5.988	3.289

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: Investigates, designs and develops sensor payloads for ground vehicle based unmanned aerial system to detect line of sight, and beyond line of sight threats and complex obstacles such as personnel and vehicles in all environments. ***FY 2021 Plans:*** Investigate and design unmanned aerial system (UAS) mountable polarized EO/IR sensors. Conduct experiments co-registering EO/IR, and other modalities to determine design impact to detection performance. Investigate various polarized sensor designs for vehicular, dismounted Soldier, and UAS mountable configurations enabling wider field of regard terrain coverage. ***FY 2022 Plans:*** Will mature higher resolution polarized optical sensor components for vehicular, dismounted Soldier, and UAS mountable configurations enabling wider field of view terrain coverage, smaller threat object detectability, and extended range leading to more advantageous UAS flight paths. Will determine new exploitable scene features and target signatures with concealment penetrating radar portions of the spectrum. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle glide path of this effort.			
Title: Automated Threat Cueing ***Description:*** Investigates, matures and validates novel image processing and threat recognition and detection methods to enable automated search and detection of open and concealed threats for cueing and target hand-off to maintain overmatch via speed in cluttered environments. ***FY 2021 Plans:*** Develop threat cueing algorithms utilizing EO/IR, novel compact ground penetrating radar, and position sensors for on-the-move target detection and tracking. Research novel two-dimensional and three-dimensional based algorithms utilizing exploitable features and signatures of threats in close combat open terrain scenarios. ***FY 2022 Plans:*** Will conduct experiments to validate processing approaches utilizing EO/IR and position sensors for on-the-move target detection and tracking. Will investigate novel imaging techniques utilizing exploitable optical polarization-based features and signatures of threats in close combat open terrain scenarios to validate threat cueing and recognition. Will conduct experiments with compact ground and concealment penetrating radar antenna designs to determine optimal small UAS and ground vehicle mountable configurations and assess detection capability in low clutter. Will investigate stacking registered radar and EO/IR imagery to	-	5.671	5.891

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
improve clutter suppression. Will develop thermal spectral imaging techniques for dimensionality reduction for significantly improved target detection. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Sensors for Automated Target Recognition Applied Research ***Description:*** This effort researches and investigates the pairing of ground borne, airborne, and soldier worn sensors with artificial agents to rapidly detect and identify adversary targets.	2.483	-	-
Accomplishments/Planned Programs Subtotals	17.072	36.836	35.489

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BG2: *Modeling and Simulation for MUMT Technology*	-	3.953	3.273	6.718	-	6.718	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project to Program Element (PE) 0603462A NGCV Advanced Technology / Project BG3 Modeling and Simulation for MUMT Advanced 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 investigation and design, this project develops obstacle detection and classification algorithms for dynamic mobility hazards in urban and complex environments. This project develops 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 (NGCV).

Work in this Project is conducted by the United States (U.S.) Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

This effort is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / Project BG3 (Modeling and Simulation for MUMT Advanced Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Mobility in Complex Urban Environments	3.953	-	-
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.			
Title: Simulation Tools for CoVeR	-	3.273	6.718

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: This effort develops M&S capabilities to evaluate hardware and software technologies enabling battlefield autonomy in complex environments and adaptive learning algorithms for predicting mobility performance in challenging environments. ***FY 2021 Plans:*** Develop M&S tools for autonomous vehicle design at the component level for successful maneuver in unstructured environments; develop analytical tools for predicting autonomous maneuver performance in unstructured environments. ***FY 2022 Plans:*** Will develop M&S enabled analytical tools and adaptive learning models for predicting autonomous vehicle performance across varying meteorological conditions and terrain; and will develop advanced algorithms to detect obstacles that affect maneuver corridors in unstructured environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase in FY22 will expand analytical tool development to include varied meteorological conditions/terrain types and will support development of obstacle detection algorithms.			
Accomplishments/Planned Programs Subtotals	3.953	3.273	6.718

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BG6: *Advanced Concepts for Active Defense Technology*	-	51.275	45.754	30.541	-	30.541	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project administratively to Program Element (PE) 0602144A Ground Technology / Project CG7 Ground Protection Concepts and Technologies.

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 the near, mid and far term. Work conducted in this Project will result in concepts for Adaptive and Cooperative Protection of ground combat vehicles. 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 active components to provide solutions which will help meet the requirements of current and next generation ground tactical and combat vehicles.

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 0602144A (Ground Technology) and 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 supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Computational and Experimental Capability	4.565	6.532	-
Description: This effort will develop computational design tools as well as 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 exploiting 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			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics. ***FY 2021 Plans:*** Increase computational modeling capability to predict performance of hybrid armor protection mechanisms during threat impact; develop machine learning methods for terminal effects interaction with protection mechanisms; develop diagnostic capability to capture three-dimensional x-ray imagery of experimental threat impacts. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort has been realigned to PE 0602144A Project CG7 Ground Protection Concepts and Technologies.			
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. ***FY 2021 Plans:*** Design armor mechanisms and technologies to defeat a wide range of threats to include medium and large caliber projectiles, anti-tank guided missiles, and rocket propelled grenades through the use of high performance computing, analytic modeling, and laboratory experiments; design an optimized vehicle hull concept that includes adaptive and active protection concepts for a combined threat suite through computational and experimental methods. ***FY 2022 Plans:*** Will validate and mature passive and reactive armor mechanisms and concepts to defeat kinetic and chemical energy threats in support of next generation combat vehicles; validate and mature active lightweight kinetic energy penetrator defeat mechanism; explore lightweight materials for defeat of medium caliber projectile threats. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort for increased focus on kinetic and chemical energy threats.	9.110	7.213	8.060
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.	5.683	7.216	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Design and develop armor technologies to defeat top-attack munitions using modeling, simulation, and experimental techniques; conduct experiments to explore electro-magnetic protection mechanisms and associated physics for armor technologies and use modeling and simulation in conjunction with the experimental results to evaluate the integration of multiple technologies to provide electro-magnetic protection mechanisms. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort has been realigned to PE 0602144A Project CG7 Ground Protection Concepts and Technologies.			
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. This effort will investigate modern protective technologies that implement complex kinematic mechanisms in order to bend, break and disperse threat projectiles before they can injure crew or disable vehicles. ***FY 2021 Plans:*** Design a countermeasure and launch mechanism to defeat anti-armor threat weapons implemented in a novel manner to increase protection coverage. Utilize modeling, simulation, and experimental capabilities to develop adaptive armor protection mechanisms to defeat current and emerging threats. ***FY 2022 Plans:*** Will validate adaptive protection threat interception concept experimentally with integrated sensors and control mechanisms; mature the adaptive armor mechanisms utilizing modeling, simulation, and experimental capabilities to ensure defeat of current and emerging threats; explore novel countermeasures to defeat threat Anti-Tank Guided Munitions (ATGMs) and top attack munitions; mature top attack protection mechanism to defeat emerging threats. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	9.663	11.628	6.059
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	1.752	2.220	2.267

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
heavily leverage other efforts within PE 0602145A (Next Generation Combat Vehicle Advanced Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology). ***FY 2021 Plans:*** Conduct validation experiments to determine the effects of coupling of autonomy protection and lethality concepts. Partner with The Research and Analysis Center (TRAC) to conduct Advanced Warfighting Simulation scenario iterations and evaluate combat effectiveness of these concepts. ***FY 2022 Plans:*** Will develop autonomous behaviors specific to perimeter defense and pursuit-evasion to adversarial threats, accounting for team maneuver relative to agents and anticipated attrition; develop autonomous tactical behaviors using simulation with cooperative teaming of up to seven friendly agents engaging a similarly sized adversarial team; validate autonomous behaviors in physical experiments with a minimum of three robotic vehicles. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Survivability/Lethality/Vulnerability Analysis Tools and Methodology	4.768	5.224	5.167
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 2021 Plans:*** Complete development and validation of lethality and vulnerability analysis methods that account for multi-hit effects; models will be tailored to assess NGCV weapon systems and effects of direct fire ammunition on NGCV protection technologies; refine and demonstrate effectiveness of smart NGCV munitions in contested and degraded environments of multi-domain operations; investigate vulnerabilities of Artificial Intelligence associated with cognition capabilities provided by sensors which can be degraded when operating in contested environments and explore implications of these vulnerabilities on machine learning performance; investigate the implications of vulnerabilities to robotic combat vehicles on manned-unmanned teaming performance; validate models for active protection systems and extend them to investigate adaptive protection systems. ***FY 2022 Plans:*** Will complete development of methodologies for a ballistic lethality analysis capability for NGCV Smart Munitions in Electronic Warfare (EW) congested environments, an Active Protection System soft kill analysis capability for Vehicle Protection Systems, and probabilistic analysis capabilities for teamed autonomous Unmanned Ground Vehicle systems in support of Robotic Combat			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Vehicle effectiveness performance trades. Will continue developing, refining and validation of multi-discipline analysis capabilities for Active Protection Systems in EW contested environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
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.	1.136	-	-
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 and are optimized to work with 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 and active protection system residuals. 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 2021 Plans:*** Conduct experiments to baseline current platform survivability solutions to determine effects of residual debris from an Active Protection System (APS) engagement on protection levels for ground platforms. Investigate if residual debris impacts to explosive reactive armor introduces a vulnerability to ground vehicles. Design armor solutions that balance requirements for protection from threat projectiles and APS residual projectiles and validate the concept to use armor and occupant protection technologies for vehicle survivability and soldier protection. Develop test methods for evaluating occupant protection technologies to mitigate injuries resulting from APS engagement residual effects. Leverage modeling and simulation to predict and potentially enhance performance of protection systems. ***FY 2022 Plans:*** Will investigate the integration of several novel survivability and protection technologies for emerging threats with complex defeat mechanisms. These technology concepts will be evaluated in advanced modeling and simulation (M&S) to create high fidelity integrated component concepts. The best performing concepts will be fabricated for physical testing to validate technology	14.598	5.721	5.783

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
performance. Will leverage internal modelling and simulation capability to determine path forward for protection system and enhancements. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Advanced Threat APS Radar Technology ***Description:*** This effort develops ground combat vehicle survivability technologies including radar techniques to support hard-kill countermeasures as a part of an integrated survivability suite for ground combat platforms in all-weather, day or night conditions with 360 degree situational awareness and Kinetic Energy threat defeat. ***FY 2022 Plans:*** Develop tools to support characterization of techniques. Perform study to identify and harness open RF and radar specific interfaces applicable to the APS mission. Perform study on timeline to counter stressing threats (KE rods) in support of developing radar resource management techniques to enable KE defeat and additional missions without increasing vehicle signature or adversely impacting the engagement timeline. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change for this new effort in FY22 was realigned from PE 0602150 Project AE4 Collaborative ISR Sensors Technology.	-	-	3.205
Accomplishments/Planned Programs Subtotals	51.275	45.754	30.541

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BG8: *Obscuration Technology*	-	3.903	2.620	2.576	-	2.576	-	-	-	-	-	-

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 (NGCV).

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Obscuration Technologies for Active Protection Systems ***Description:*** This effort investigates dissemination technologies for various obscurants.	1.407	-	-
Title: Obscuration Enabling Technologies ***Description:*** This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment across the electromagnetic spectrum. This effort also provides vulnerability assessments against enemy threat systems. ***FY 2021 Plans:*** Validate packing and dissemination techniques for advanced obscuration materials including bi-spectral, advanced microwave, and spectrally selective obscurants. Mature advanced bi-spectral materials for screening obscuration module. Perform threat modelling for unmanned ground and aerial systems sensor systems. Evaluate obscuration technologies against threat systems to determine probability-of-hit for vehicle platforms. ***FY 2022 Plans:***	2.496	2.620	2.576

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Will investigate multi-spectral materials for obscuration use to defeat ground and aerial threats. Will develop and evaluate obscuration technologies for integration into the Air Domain (e.g., use obscuration to mask offensive aerial attacks, use obscuration to defend incoming aerial threats by masking/confusing guidance systems). ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	3.903	2.620	2.576

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BH2: *C4ISR Modular Autonomy Technology*	-	4.674	-	-	-	-	-	-	-	-	-	-

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 effort is performed by the United States (US) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: C4ISR Modular Autonomy Technology ***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	4.674	-	-
Accomplishments/Planned Programs Subtotals	4.674	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BH5: *Platform Electrification and Mobility Tech*	-	9.612	20.563	13.781	-	13.781	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project administratively to Program Element (PE) 0602144A Ground Technology / Project CG6 Ground Vehicle Power and Energy Concepts and Tech

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 in this effort is performed by the United States (US) Army Futures Command.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: AVPTA - Energy Storage	0.762	-	-
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 electrified ground vehicles have enough power for mobility, silent watch, and enables energy based capabilities including electromagnetic armor and directed energy weapons.			
Title: Novel Propulsion Research	1.476	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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.			
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, 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.	7.374	-	-
Title: Scalable Electrification & Control Architecture ***Description:*** This effort develops the power distribution and control components to implement a common, scalable, electrified vehicle power architecture to enable advanced lethality and protection capabilities, fast vehicle charging from the grid, and silent mobility on combat platforms across light to heavy weight classes. This power architecture enables the hybrid electric, fuel cell electric, and all-electric powertrains. ***FY 2021 Plans:*** Develop high voltage power distribution components that enable electrified powertrains. Develop the high voltage power converter to enable advanced lethality/protection capabilities and high voltage battery storage. Develop import/export power converter to enable fast vehicle charging from local power sources. ***FY 2022 Plans:*** Will mature high voltage power distribution component that enables electrified powertrains. Will validate the import/export power converter enabling fast vehicle charging from the grid. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding reflects reduced effort required to mature and evaluate components developed in FY21.	-	1.996	1.430
Title: Platform Electrification Research	-	11.251	8.253

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: This effort designs and develops the electric power generation, energy storage and electrified components and sub-systems required to electrify combat vehicles across light to heavy weight classes. ***FY 2021 Plans:*** Design internal components for a high voltage power system electric generator and high power inverter. Design electric drive motors. Design thermal management system for a modular electrification architecture. Design electric turret drive. Investigate novel battery chemistries that could provide up to four times more energy storage density than current batteries. Design and develop modules for a modular high voltage energy storage system. Design mobility/silent watch range extender. ***FY 2022 Plans:*** Will mature designs for internal components for electric generator. Will mature designs for electric drive motors. Will mature designs for final drive component of a modular electrification architecture. Will develop cells for increased energy storage systems. Will characterize module performance for modular high voltage energy storage system. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned reduction of investment in electric turret drive.			
Title: Advanced Mobility Research ***Description:*** This effort develops a lightweight composite running gear system for medium combat vehicle applications which offers significantly reduced system weight, maintenance, noise and vibration over conventional running gear systems. Advanced composite tracks coupled with low cost, low complexity suspension systems improve operational capability via increased mobility. ***FY 2021 Plans:*** Research novel running gear systems using composite materials to reduce weight. Investigate new joining methods for rubber band track connections. ***FY 2022 Plans:*** Will design and conduct experiments on critical track components, materials and joints to validate performance. Will also design and conduct experiments on critical suspension components to validate performance. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects reduced amount of effort required for experimentation compared to the development activities in FY21.	-	3.322	2.054
Title: Advanced Distributed Power for Autonomous Systems ***Description:*** This effort develops technologies for electrification of both manned and unmanned Next Generation Combat Vehicle platforms. Electrification of these platforms enables advanced lethality and protection systems, reduced battlefield	-	1.563	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
fuel consumption, and provides new capabilities such as burst acceleration, extended silent mobility, and silent watch. This effort investigates and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on high power/ temperature power electronics, magnetic gears, electric drive motors, and advanced artificial intelligence/machine learning (AI/ML) enabled autonomous control components and power management. Investigation of advanced control methods at the module and conversion component levels provides an understanding of the impact AI/ML and energy usage tracking can have on power optimization and mission effectiveness. The research enables the integration of components? status and behavior into system level management algorithms that support manned and autonomous operations while providing modular and scalable electrification architectures. This effort also investigates magnetic gear technologies that do not have physical connections connected to electrical motors and generators to reduce size and weight with increased reliability and performance providing increased torque, speed and range. Results of the research informs the Novel Propulsion Research effort in this Project. ***FY 2021 Plans:*** Perform experiments on electrical conversion design concepts from PE 0602145A (Next Generation Combat Vehicle Technology), Project BH7 (Enhanced VETRONICS Technology) to understand performance and operational parameters of the components; investigate techniques to improve power conversion component performance through advanced control techniques and methodologies; investigate methods to monitor energy use and losses in real time; analyze performance of power modules utilizing AI/ML control methods to experimentally determine performance improvement enabled by use of reinforcement machine learning algorithms; analyze performance of the 200:1 gear ratio magnetic gear; and initiate improvement for reduced weight design to determine performance envelope. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to Project CG6 Ground Vehicle Power and Energy Concepts and Technologies under PE 0602144A.			
Title: Power Electronic Components and Materials ***Description:*** This effort investigates and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on semiconductor power switches, power switch modules and packaging, and power switch module thermal management. Investigation high voltage/high frequency power semiconductor materials and devices concentrates on efficient power switching under militarily relevant temperature ranges. Development of multi-disciplinary parametric design optimization software tools and multi-functional package structures provides advances in device packaging technology to fully realize device performance improvements. Results of the research will inform the Novel Propulsion Research effort in PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Technology).	-	2.431	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Determine performance of Gallium Nitride based power device process enhancements through modeling and device performance analysis; develop fabrication processes to enable wide?band-gap and ultra-wide-band-gap semiconductor device technologies; incorporate magnetic material analysis algorithms to expand the design envelope for the parametric optimization simulation tool used in this effort; analyze and investigate the performance of metallic phase change thermal management techniques; determine performance of power module designs for 20 kiloWatts per Liter (kW/L) and 25 kiloWatts per kilogram (kW/kg) power ratings as well as examine concepts, designs, and processes to achieve objective goal of 40kW/L and 50 kW/kg power ratings. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort is administratively realigned to Project CG6 Ground Vehicle Power and Energy Concepts and Technologies under PE 0602144A.			
Title: Robotic Combat Vehicle Silent Watch and Mobility Range Extension ***Description:*** This effort designs and develops the Jet Propellant 8 (JP8) reformer based silent watch and mobility extension subsystem required to electrify robotic combat vehicles. The Army's robotic combat vehicles are expected to have increased silent watch and silent mobility requirements that are not met by current technologies. ***FY 2022 Plans:*** Will mature metal supported solid oxide fuel cell technology and investigate approaches for increased density and faster start times on an integrated JP8 reformer and fuel cell technology. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This is a planned new effort in FY22 and the funding reflects the research required on JP8 reformer and fuel cell technology.	-	-	2.044
Accomplishments/Planned Programs Subtotals	9.612	20.563	13.781

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army										Date: May 2021		
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BH7: *Enhanced VETRONICS Technology*	-	3.455	-	-	-	-	-	-	-	-	-	-

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 (NGCV).

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Electronic Components and Materials Research	3.455	-	-
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.			
Accomplishments/Planned Programs Subtotals	3.455	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BH9: *Protection for Autonomous Systems Tech*	-	2.443	1.444	-	-	-	-	-	-	-	-	-

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 (NGCV).

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Protection for Autonomous Systems	2.443	1.444	-
Description: This effort contributes to the Army's ground platform risk reduction efforts which that seek to address technical challenges of survivability and protection for autonomous systems. Specifically, this effort focuses on developing protection concepts for unique unmanned systems to ensure autonomous ground vehicles can continue their mission in contested environments. ***FY 2021 Plans:*** Evaluate the vulnerability of autonomous ground system components such as sensors, enabling autonomous maneuver against threats to include electromagnetic effects. Evaluation will be conducted in order to understand potential threat-based mission impacts and degraded operation of unmanned system components to inform future hardening activities for military applications. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding was realigned to PE 633041 All Domain Convergence Advanced Technology / Project CM8 Convergence Battlefield Integration .			
Accomplishments/Planned Programs Subtotals	2.443	1.444	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BI2: *Sensor Protection Technology*	-	10.149	10.340	5.878	-	5.878	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funding was partially realigned from this Project administratively to Program Element (PE) 0602144A Ground Technology / Project CG5 Ground Vehicle Sensor Concepts and Technologies

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 effort is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603118A (Soldier Lethality Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), and PE 0602143A (Soldier Lethality Technology)

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Sensor Protection Technology	6.494	6.189	5.878
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, and emerging signature reduction schemas.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Investigate new protective sensor coatings that maximize transmission for sensor frequency bands while minimizing energy transmission of other frequencies including lasers to protect sensor components while still meeting environmental performance and durability requirements. Develop and evaluate new designs to reduce optical cross section (OCS) and resist sensor damage for emerging large format electro-optical/infrared focal plane arrays. Evaluate concealment performance of camouflage technologies in all environments against reflective, emissive, and radar threat sensors. ***FY 2022 Plans:*** Will conduct experiments with high transmission optical coatings on operationally equivalent sensor components to validate performance against metrics. Will mature out-of-band protective window coatings and validate performance against a selection of emerging threats. Will develop protection approaches for uncooled sensors. Will investigate agile visible filter materials to determine protection thresholds. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle for this effort.			
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 2021 Plans:*** Analyze results of study previously conducted on threats to sensor systems and develop optical system protection concepts to mitigate the impact of the study findings; validate ultrashort laser sensor focal plane array damage protection materials; conduct high-power laser experiments to test protection concepts; investigate the capabilities of tunable infrared filters coupled with shape memory alloy shutters for protection of uncooled infrared sensors. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY 2022, this effort has been administratively realigned to PE 0602144A Project CG5 Ground Vehicle Sensor Concepts and Technologies.	3.655	4.151	-
Accomplishments/Planned Programs Subtotals	10.149	10.340	5.878

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BI4: *Materials Application and Integration Tech*	-	7.971	7.689	7.648	-	7.648	-	-	-	-	-	-

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 effort is performed by the United States (US) Army Futures Command.

Work in this Project leverages research from 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).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Lightweight Armor Materials and Processes for Vehicle Protection	3.817	-	-
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).			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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 2021 Plans:*** Investigate performance of nanocrystalline and novel high-hardness metal alloys, validating their use for ballistic protection applications; investigate corrosion-resistant magnesium alloys and validate for ballistic protection and structural applications. ***FY 2022 Plans:*** Will conduct microstructural assessments with load-state testing to characterize Aluminum-Magnesium alloy to correlate microstructural changes to meso- and macro-scale mechanical behavior for ballistic protection; examine potential for adhesively bonded multilayer composite structures to deflect incoming threats; develop a high toughness, low cost high hard steel alloy for weldable, bendable structural applications using in-house casting/processing capabilities and prior characterization and assessment of commercial alloys to; and optimize the engineering and manufacturing principles of high energy ball milling to effectively generate sufficient quantities of powders to fabricate oxide dispersion strengthened alloy plates for ground combat vehicle ballistic applications. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	2.387	7.689	7.648
Title: Advanced Vehicle Power Technology Alliance Materials ***Description:*** This effort develops and matures lightweight materials and joining technologies to enable lighter, more fuel-efficient tactical and combat vehicles with superior mobility and protection of both vehicles and occupants. Lighter materials and advances in joining technologies such as multi-material and dissimilar material joining will lead to lightweight military vehicle structures.	1.767	-	-
Accomplishments/Planned Programs Subtotals	7.971	7.689	7.648

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BI9: *Vehicle System Security Technology*	-	2.829	2.676	2.359	-	2.359	-	-	-	-	-	-

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.

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

Work in this effort is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and 0602213A (C3I Applied Cyber).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Vehicle System Security Technology	2.829	2.676	2.359
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 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 2021 Plans: Develop resilient runtime functionality in vehicle electronic components in a security centered databus and Vehicle Integration of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)/Electronic Warfare Interoperability (VICTORY) architecture-compliant security protocols.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Investigate and develop military vehicle resilient runtime hypervisor technology approaches to provide cyber-resiliency to military ground vehicles through the use of virtualized components to spin-up near instant replacements for compromised electronic control unit components. The hypervisor will provide full segmentation between operational and safety-critical vehicle databus messages. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort with the reduction in vehicle integration research.			
Accomplishments/Planned Programs Subtotals	2.829	2.676	2.359

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	4.785	5.372	5.364	-	5.364	-	-	-	-	-	-

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 (SWaP) laser sources for optical augmentation detection systems; and compact Laser Detection And Ranging (LADAR) 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 (NGCV), Soldier Lethality, and Future Vertical Lift (FVL).

Work in this effort is performed by the United States (US) 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 2020**	**FY 2021**	**FY 2022**
Title: Tactical and Navigation Lasers Sensors Technology	4.785	5.372	5.364
Description: This effort designs and develops novel low SWaP, compact, high peak power pulsed laser sources for optical augmentation detection systems; and compact LADAR sources for situational awareness and manned and unmanned air and ground vehicle operations and navigation in all environments. Effort delivers component technologies needed to support future Army autonomous, covert targeting approaches.			
FY 2021 Plans: Investigate emerging longwave infrared (LWIR) laser sources and integrate with a novel solid state laser in order to achieve a LWIR solution with sufficient power to meet battlefield needs. Design and build brassboard demonstrator for evaluation in a laboratory environment.			
FY 2022 Plans: Will continue development of a brass-board, solid-state longwave infrared (LWIR) laser; mature the components to allow testing in field-relevant environment. Will conduct experiments to evaluate LWIR laser performance, when combined with pulse-detecting			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
LWIR detector arrays, to determine effectiveness of detection of relevant threats, 3-dimensional imaging and targeting. Will demonstrate midwave infrared and LWIR pulse detection camera in laboratory environment. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	4.785	5.372	5.364

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BJ3: *Hydrogen Based Combat System Technology*	-	1.515	-	-	-	-	-	-	-	-	-	-

Note

In Fiscal Year (FY21) this Project is realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology:
* Project BH5 Platform Electrification and Mobility Tech

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.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Hydrogen Based Combat System Technology	1.515	-	-
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.			
Accomplishments/Planned Programs Subtotals	1.515	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BJ7: *Detection of Explosive Hazards Technology*	-	11.393	-	-	-	-	-	-	-	-	-	-

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 effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Detection of Explosive Hazards Technology	11.393	-	-
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.			
Accomplishments/Planned Programs Subtotals	11.393	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BJ9: *Autonomous Mobility Tech*	-	2.934	2.407	3.848	-	3.848	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project designs and developsArtificial 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 Systems (UAS) 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 UAS mapped areas. Data collected from the UAS 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 (NGCV).

Work in this effort is performed by the United States (US) Army Futures Command.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Big Data Storage Techniques ***Description:*** This effort develops techniques and technologies for storage of machine learning data sets to be used collaboratively for Army research.	2.891	-	-
Title: Unmanned Aerial Vehicle (UAV) Mapping ***Description:*** Develop a collaboration of UAV map input for ground vehicle mobility via artificial intelligence and machine learning.	0.043	-	-
Title: Formation Control ? Novel Technique Investigation	-	2.407	3.848

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Description: This effort focuses on performing the applied research needed to investigate cutting edge ML techniques to be used for advanced collaborative movement. Areas of investigation here look to advance the utility of ML mobility beyond the current, widely utilized algorithms to allow for more natural coordination of autonomous vehicles and Soldiers. ***FY 2021 Plans:*** Perform thorough survey of cutting edge ML techniques, investigate the algorithms that apply to formation control, and conduct experiments to determine applicability to NGCV. ***FY 2022 Plans:*** Will improve and mature algorithms developed in FY21 that apply to formation control for autonomous maneuver in operationally relevant environments. Will conduct experiments to determine how well the ML data infrastructure and data sets support the autonomous system development and determine the applicability to NGCV. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort with increased experimentation on the data infrastructure support for autonomous systems.			
Accomplishments/Planned Programs Subtotals	2.934	2.407	3.848

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BK2: *Virtual Prototyping Technology*	-	5.203	8.295	8.169	-	8.169	-	-	-	-	-	-

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.

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Virtual Prototyping	5.203	8.295	8.169
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			
FY 2021 Plans: Design and develop new NGCV manned and unmanned ground vehicle concepts. Integrate new advanced technology components such as lethality and protection systems in a virtual environment. Conduct analyses, trade studies, and Soldier-in-the-loop virtual experiments to provide Warfighter feedback on design concepts and inform NGCV performance and suggest			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
design paths to improve performance. Partner with industry to generate additional NGCV ground vehicle design concepts to expand the investigation of enabling technologies and performance for NGCV. ***FY 2022 Plans:*** Will use modeling and simulation to virtually design, develop, and assess new Next Generation Combat Vehicle (NGCV) manned and unmanned systems that include projected far term lethality, mobility, sensing, and protection technologies. Will integrate these technologies into multiple optionally manned tank (OMT) and heavy robotic combat vehicle (RCV-H) trade analyses and NGCV requirements. Will use knowledge and analyses for investments and inform NGCV acquisition planning. Will implement a public private partnership with industry to generate additional OMT vehicle design concepts to expand the knowledge of enabling technologies, obtain innovative design approaches, and provide additional data analyses for multiple NGCV efforts. Will conduct Soldier-in-the-loop feedback to assess the government and industry OMT concepts for mission performance, Soldier OMT Tactics, Techniques, and Procedures (TTPs) for the new technologies and capabilities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	5.203	8.295	8.169

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	1.007	4.043	0.987	-	0.987	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project will develop armament specific hardware, algorithms and architectures to support Next Generation Combat Vehicle (NGCV) 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 NGCV.

Work in this effort is performed by the United States (US) 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 2020	FY 2021	FY 2022
Title: Next Generation Intelligent Fire Control Technology	1.007	4.043	0.987
Description: This effort investigates image sets for computer vision algorithms, target acquisition validation schemes and experimentation of large caliber armament systems. ***FY 2021 Plans:*** Validate fire control system components and algorithms for implementing machine learning training; develop new algorithms and models to generate and validate prioritized target lists using documented battlefield metrics; and conduct experiments to collect fire control scenario data to support algorithm/model training and development. ***FY 2022 Plans:*** Will investigate various machine learning methods to process and prioritize target sets in a dynamic battlefield based on evolving mission objectives. Will conduct experiments to inform future fire control development, validation schemes, and evaluate platform components. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Reduction in funding reflects planned reduction of validation and experimentation efforts.			
Accomplishments/Planned Programs Subtotals	1.007	4.043	0.987

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	1.141	3.814	9.180	-	9.180	-	-	-	-	-	-

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. This Project also researches large caliber direct fire munitions to project overwhelming lethality while ensuring maneuver forces remains mobile and sustainable during close-combat engagements at extended ranges.

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 effort is performed by the United States (US) 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) and PE 0602141A (Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Direct In-Direct Armament System Technology ***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.	1.141	-	-
Title: Advanced Lethality ? Kinetic Energy (AL-KE) ***Description:*** This effort designs and develops component technologies for large caliber direct fire light-weight armament systems that will exceed the current 120mm direct fire cannon performance for future operational environments, including dense urban, with multi -domain engagement capability. The component technologies that support rapid fire on-the-move (direct & indirect) engagements include: compact ammunition design with advanced ignition, reduced gun impulse on platform through advanced recoil mitigation techniques, fire control and automated ammunition handling and reloading.	-	1.432	1.443

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Investigate range-extending technologies for direct fire kinetic energy ammunition with increased propulsion efficiency; Design and develop direct fire kinetic energy cartridge technologies to defeat future threats to ground vehicle systems. ***FY 2022 Plans:*** Will investigate technologies to improve kinetic energy delivery at extended ranges to increase engagement distance and decrease engagement time, including work to investigate sensor fusion, real time processing and penetrator diversion techniques. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort			
Title: NGCV Penetrator Technology for Decisive Lethality ***Description:*** This effort develops energy-efficient lethal mechanism technologies for next-generation warheads and projectiles for large-caliber ammunition launched from direct fire weapon systems that maximize the lethality against an array of targets and provide tactical advantage at extended ranges for next generation threats. The results of this research will provide the basis for the lethality required for the next generation of combat vehicles and enable the development of the next generation of ammunition to ensure lethal overmatch throughout the operational environment. ***FY 2021 Plans:*** Develop kinetic energy penetrator concepts for next generation armament systems to enable decisive lethality capabilities for the next generation of combat vehicles including tanks and unmanned platforms. ***FY 2022 Plans:*** Will explore suitability of higher energy launchers for next generation armament systems; continue to identify and develop promising kinetic energy penetrator concepts to enable decisive lethality capabilities for the next generation of combat vehicles. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase to support additional research in kinetic energy penetrator concepts in order to support Next Generation Combat Vehicle modernization priority goals.	-	2.382	3.086
Title: Advanced Lethality Armament System? Large Caliber (ALAS-LC) ***Description:*** Investigate increased lethality solutions for next generation large caliber direct fire armament systems that will ensure battlefield dominance of US ground forces. Design reduced recoil armament systems capable of increased rate of fire enabled by a compact autoloader with performance that exceeds current state of the art 120mm direct fire cannons for current and future Army platforms.	-	-	4.651

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2022 Plans: Will investigate technologies for large caliber direct fire light-weight armament systems that exceed the performance of 120mm direct fire cannons. Will investigate technologies for rapid fire, on-the-move, compact ammunition design, accuracy and advanced recoil mitigation supporting future Army platforms. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY22, this is a planned new effort under the Project for development of next generation large caliber armament systems technologies in order to support Next Generation Combat Vehicle modernization priority goals.			
Accomplishments/Planned Programs Subtotals	1.141	3.814	9.180

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*				Project (Number/Name) BP5 / *Ground Vehicle Technology (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BP5: *Ground Vehicle Technology (CA)*	-	44.500	43.000	-	-	-	-	-	-	-	-	-

Note

Congressional Interest Item funding provided for Ground Vehicle Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Ground Vehicle Technology.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Congressional Add: Prototyping Energy Smart Autonomous Ground Systems ***FY 2020 Accomplishments:*** Program Increase supported applied research on Prototyping Energy Smart Autonomous Ground Systems. Work executed by Army Futures Command.	10.000	-
Congressional Add: Highly Electrified Vehicles ***FY 2020 Accomplishments:*** Program Increase supported applied research on Highly Electrified Vehicles. Work executed by Army Futures Command.	5.000	-
Congressional Add: Additive Metals Manufacturing ***FY 2020 Accomplishments:*** Program Increase supported applied research on Additive Metals Manufacturing. Work executed by Army Futures Command.	3.000	-
Congressional Add: RPG and IED Protection ***FY 2020 Accomplishments:*** Program Increase supported applied research on RPG and IED Protection. Work executed by Army Futures Command.	3.000	-
Congressional Add: Modeling and Simulation	3.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BP5 / *Ground Vehicle Technology (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: Program Increase supported applied research on Modeling and Simulation. Work executed by Army Futures Command.		
Congressional Add: Structural Thermoplastics ***FY 2020 Accomplishments:*** Program Increase supported applied research on Structural Thermoplastics. Work executed by Army Futures Command.	3.000	-
Congressional Add: Advanced Materials Development for Survivability ***FY 2020 Accomplishments:*** Program Increase supported applied research on Advanced Materials Development for Survivability. Work executed by Army Futures Command.	10.000	-
Congressional Add: Autonomous Vehicle Mobility ***FY 2020 Accomplishments:*** Program Increase supported applied research on Autonomous Vehicle Mobility. Work executed by Army Futures Command.	7.500	-
Congressional Add: Program increase - modeling and simulation ***FY 2021 Plans:*** Conduct applied research in Modeling and Simulation. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - silicon carbide electronics ***FY 2021 Plans:*** Conduct applied research in Silicon Carbide Electronics. Work executed by Army Futures Command.	-	6.000
Congressional Add: Program increase - highly electrified vehicles ***FY 2021 Plans:*** Conduct applied research in Highly Electrified Vehicles. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - additive metals manufacturing	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BP5 / *Ground Vehicle Technology (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Conduct applied research in Additive Metals Manufacturing. Work executed by Army Futures Command.		
Congressional Add: Program increase - prototyping energy smart autonomous ground systems ***FY 2021 Plans:*** Conduct applied research in Prototyping Energy Smart Autonomous Ground Systems. Work executed by Army Futures Command.	-	12.000
Congressional Adds Subtotals	44.500	43.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A