Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army											Date: April 2022	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
Total Program Element	-	258.341	245.525	174.090	-	174.090	174.430	167.609	165.991	159.516	0.000	1,345.502
BF1: *Autonomous Ground Resupply Tech*	-	10.615	-	-	-	-	-	-	-	-	0.000	10.615
BF3: *Combat Vehicle Robotics Tech*	-	9.163	16.719	20.742	-	20.742	17.366	16.738	15.907	15.591	0.000	112.226
BF6: *Crew Augmentation and Optimization Tech*	-	19.022	8.883	10.761	-	10.761	11.613	11.603	10.036	10.033	0.000	81.951
BF8: *Artificial Intelligence & Machine Learning Tech*	-	21.425	13.732	19.906	-	19.906	20.439	17.379	17.385	17.381	0.000	127.647
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	36.836	35.470	22.683	-	22.683	25.216	24.584	24.729	25.450	0.000	194.968
BG2: *Modeling and Simulation for MUMT Technology*	-	3.273	6.718	5.591	-	5.591	5.502	4.565	4.239	4.386	0.000	34.274
BG6: *Advanced Concepts for Active Defense Technology*	-	44.894	30.524	33.656	-	33.656	33.021	32.815	37.553	33.777	0.000	246.240
BG8: *Obscuration Technology*	-	1.500	2.576	2.722	-	2.722	2.762	2.786	2.787	2.787	0.000	17.920
BH5: *Platform Electrification and Mobility Tech*	-	20.563	13.781	14.226	-	14.226	13.702	17.136	17.276	14.769	0.000	111.453
BH9: *Protection for Autonomous Systems Tech*	-	0.146	-	-	-	-	-	-	-	-	0.000	0.146
BI2: *Sensor Protection Technology*	-	7.390	5.829	6.229	-	6.229	5.508	5.922	8.407	7.677	0.000	46.962
BI4: *Materials Application and Integration Tech*	-	4.378	7.648	7.722	-	7.722	7.941	7.466	7.001	6.999	0.000	49.155
BI9: *Vehicle System Security Technology*	-	2.676	2.359	-	-	-	-	-	-	-	0.000	5.035
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	5.372	5.364	5.673	-	5.673	5.765	5.818	5.816	5.814	0.000	39.622

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army											Date: April 2022	
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*							
BJ9: *Autonomous Mobility Tech*	-	2.407	3.811	-	-	-	-	-	-	-	0.000	6.218
BK2: *Virtual Prototyping Technology*	-	5.191	8.169	9.622	-	9.622	9.866	9.878	10.579	10.577	0.000	63.882
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	16.676	0.962	-	-	-	-	-	-	-	0.000	17.638
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	3.814	9.180	13.526	-	13.526	12.299	8.841	4.276	4.275	0.000	56.211
BP5: *Ground Vehicle Technology (CA)*	-	43.000	73.800	-	-	-	-	-	-	-	0.000	116.800
CU5: *Platform Agnostic Armaments Applied Technology*	-	-	-	1.031	-	1.031	3.430	2.078	-	-	0.000	6.539

Note

Project CU5 (Platform Agnostic Armaments Applied Technology) is a new start project for Fiscal Year 2023 (FY23).

A. Mission Description and Budget Item Justification

This Program element (PE) line is directly aligned to the Next Generation Combat Vehicle (NGCV) Army Modernization Priority. This PE researches, designs, and evaluates combat vehicle technologies that enable the Army to have a smarter, faster, more lethal, more precise, more protected, and more adaptable force. The focus is on building upon the foundational vehicle architectures to support the Next Generation of Combat Vehicles, to include autonomy architecture, power architecture, vehicle electronic architecture, physical architecture, lethality architecture and vehicle protection architecture. The research conducted will provide technologies to enable leap ahead capabilities for manned, optionally manned and unmanned vehicles that deliver decisive lethality.

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

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

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army	Date: April 2022
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*

B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	258.351	172.166	0.000	-	0.000
Current President's Budget	258.341	245.525	174.090	-	174.090
Total Adjustments	-0.010	73.359	174.090	-	174.090
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	73.800			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.010	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	174.090	-	174.090
• FFRDC Transfer	-	-0.441	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: BP5: *Ground Vehicle Technology (CA)*		
Congressional Add: *Program Increase - Modeling and Simulation*	10.000	-
Congressional Add: *Program Increase - Silicon Carbide Electronics*	6.000	5.500
Congressional Add: *Program Increase - Highly Electrified Vehicles*	5.000	5.000
Congressional Add: *Program Increase - Additive Metals Manufacturing*	10.000	-
Congressional Add: *Program Increase - Prototyping Energy Smart Autonomous Ground Systems*	12.000	10.000
Congressional Add: *Advanced Materials Development for Survivability*	-	5.000
Congressional Add: *Advanced Optics Program*	-	4.300
Congressional Add: *Digital Design and Simulated Testing*	-	4.000
Congressional Add: *Fast-Refueling Fuel Cell Engines*	-	7.000
Congressional Add: *Hydrogen Technologies*	-	10.000
Congressional Add: *Machine Learning Optimized Power Electronics*	-	3.000
Congressional Add: *Systems Engineering for Autonomous Ground Vehicles*	-	9.000
Congressional Add: *Vehicle Equivalency Framework Utilizing Multiple Additive Manufacturing Platforms*	-	5.000
Congressional Add: *Virtual Experimentation of Autonomous and Non-Autonomous Combat Vehicles*	-	3.000
Congressional Add: *Zero Emission Combat Vehicles*	-	3.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army	Date: April 2022
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 2021	FY 2022
Congressional Add Subtotals for Project: BP5	43.000	73.800
Congressional Add Totals for all Projects	43.000	73.800

Change Summary Explanation

Fiscal Year 2023 (FY23) funding increase reflects the fact that the FY22 President's Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army											Date: April 2022	
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 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
BF1: *Autonomous Ground Resupply Tech*	-	10.615	-	-	-	-	-	-	-	-	0.000	10.615

A. Mission Description and Budget Item Justification

This Project 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 Autonomous Ground Resupply (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 0603462A (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 NGCV Army Modernization Priority.

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 2021**	**FY 2022**	**FY 2023**
Title: Software for Autonomous Systems ***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.	9.700	-	-
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.	0.915	-	-
Accomplishments/Planned Programs Subtotals	10.615	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BF3: *Combat Vehicle Robotics Tech*	-	9.163	16.719	20.742	-	20.742	17.366	16.738	15.907	15.591	0.000	112.226

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 Next Generation Combat Vehicle (NGCV) Army Modernization Priority .

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) and transitions to PE 0604017A (Robotics Development).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Autonomous Behaviors and Perception	3.555	9.018	13.258
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 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 Framework. Develop system behavior and structure in assurance testing via model-based systems engineering and formal			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
methods to be containerized and integrated with Department of Defense (DoD) cloud services. Develop security enhancements in autonomous system component registries to improve Robot Operating System-Military (ROS-M). ***FY 2023 Plans:*** Will develop and validate object classification and scene understanding for autonomous vehicles, enabling them to identify objects in the environment and their significance in the overall scenario within government autonomy software, Robotic Technology Kernel (RTK). Will mature the basic scene understanding framework created in Fiscal Year 2022 (FY22), resulting in an improved framework enabling customized reactions to specific situations and arbitrating between existing tasks. Will research a comprehensive cyber-hardened software suite to make RAS resilient to existing and emerging cyber threats. Will research the use of enhanced a-priori data for advanced navigation and reconnaissance maneuvers for implementation in RTK. Will investigate space, weight, and power (SWAP) reduction for RTK autonomy kit hardware on small unmanned ground vehicles (UGVs). Will develop and mature additional mission subsets and task decompositions within the operational reference models for the AGVRA. Will develop an experimental unified architecture and associated model profile, library and views realizing current technologies within a model-based systems engineering (MBSE) environment. Will develop and mature the ROS-M to support the registration and distribution of developed autonomous software solutions and supporting tools. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding is increased in FY2023 for the addition of advanced capabilities in the areas of autonomous forward surveillance and small UGVs as deployable sensors. This includes research on use of enhanced a-priori data, and reduction of SWAP for small UGVs.			
Title: Autonomous Architecture ***Description:*** This effort contributes to the NGCV RAS to design and develop 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 matures 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 ROS-M framework.	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 2022 Plans:***	3.947	7.087	5.412

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 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 2023 Plans:*** Will design and develop robotic soldier machine interface technologies to become more efficient and effective for a robotic operator to complete missions in a simulated combat scenario built on government owned Warfighter Machine Interface (WMI) software. Will investigate improved language control with tactical commands for a robotic operations to bring a more natural implementation of teaming within a command and control scenario to improve mission timelines and overall mission success. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding is decreased in FY23 to support increased emphasis on additional capabilities in the Autonomous Behaviors and Perception task within the Project			
Title: M&S for Autonomy Enabled Ground Systems ***Description:*** This effort contributes to the NGCV RAS program by designing and developing modeling and simulation (M&S) tools for the development and evaluation of autonomy technologies. The effort designs and develops tools necessary to virtually evaluate autonomy algorithms developed under the Combat Vehicle Robotics (CoVeR) program. The capabilities and contents of the M&S tools will emulate the CoVeR Engineering Evaluation Test (EET) events conducted in PE 0603462A (Next Generation Ground Vehicle Advanced Technology) / Project BF4 (Combat Vehicle Robotics Adv Tech) and allowing these tools to be run at scale on other Army and Department of Defense compute platforms. ***FY 2023 Plans:*** Will mature M&S capability to support CoVeR evaluations with the first Virtual EET planned for the Fall of 2024. Will mature the architecture to integrate and interoperate with key CoVeR technologies to include the RTK, Robotic Vehicle Integration and Safety (RVIS) and Warfighter Machine Interface (WMI). M&S capability will focus on real-time models of CoVeR platforms and sensors operating in terrains and scenarios focused on the 2024 EET event. Initial capability will focus on run-time configurability for experimental parameters and building the fundamental capabilities within the simulation to run at scale on externally provided cloud or High Performance Computing (HPC) resources. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding is increased in FY23 to develop and mature M&S tools necessary for the realization of virtual EET to support virtual evaluations prior to EET experiments.	-	-	2.072
Title: FY2022 SBIR/STTR Transfer	-	0.614	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	9.163	16.719	20.742

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BF6: *Crew Augmentation and Optimization Tech*	-	19.022	8.883	10.761	-	10.761	11.613	11.603	10.036	10.033	0.000	81.951

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-improved 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 Next Generation Combat Vehicle (NGCV)Army Modernization Priority .

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) and PE 0602143A (Soldier Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Crew & Robotic Mission with Agent Technology	1.498	0.468	-
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 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned conclusion of this task.			
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. The project funds research 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 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 2023 Plans:*** Will design and develop tools and technology aids within the Warfighter Machine Interface to ensure data sharing is customized to individual operators based on their roles in order to improve Soldier-autonomous system team function and cohesion. Will augment data-driven approaches to cue Vehicle Commander of potential task sharing opportunities through the addition of learning based methodologies. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	2.877	3.107	3.397
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. ***FY 2022 Plans:***	2.443	1.089	2.569

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will mature initial capability for characterizing Soldier-autonomous system teams by incorporating novel techniques that allow vehicle crews to increase the mission data viewed during after action reviews and compare to what was viewed while conducting the missions. Will determine initial visualizations of dynamic systems-based measures of crew-autonomous system effectiveness. Will investigate initial predictive models incorporating mission and human-in-the-loop data to predict team outcomes. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase supports the development of a predictive model of mission and human-in-the-loop data to predict team outcomes.			
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 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 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 2023 Plans:*** Will design and develop an embedded training architecture to be implemented within simulation environments and prototype ground vehicle platforms. Architecture development will support the conduct of experimentation into multi-modal embedded training approaches across a wide-variety of vehicle platforms and novel user interfaces. Will investigate instructional design based approaches and mature tools enabling immediate point of need training, classroom based training or after action reviews, and interactive episodic training across individual and crew configurations. Will investigate the underlying technical demands	2.254	1.809	1.890

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
required for embedded or peripheral training systems to support maneuverability and fires within the robotics and autonomous systems domain. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
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 conduct experiments with these capabilities in application of intelligent task management and data-driven prediction of crew to support changing mission goals. ***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 2023 Plans:*** Will validate approaches to efficiently process and share critical data for enhanced mutual crew-agent situational awareness across a mixed manned-unmanned platoon-level formation. Will validate algorithms to cue the vehicle commander of possible task sharing opportunities within a crew at the platoon level. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort to focus on enhanced crew-agent situational awareness and task sharing within a mixed manned-unmanned platoon-level formation.	1.339	2.085	2.905
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.	1.251	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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.	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.	1.598	-	-
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.	3.328	-	-
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:***	-	0.325	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	19.022	8.883	10.761

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BF8: *Artificial Intelligence & Machine Learning Tech*	-	21.425	13.732	19.906	-	19.906	20.439	17.379	17.385	17.381	0.000	127.647

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).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Scalable, Adaptive, and Resilient Autonomous Systems	4.062	2.757	8.226
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 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will design and develop methods to increase operational speed and distances in complex terrain. Will develop methods to integrate terrain awareness and platform capability into tactical decision-making process. Will design and develop methods to cooperate with multiple air and ground autonomous agents for improved maneuvers in complex terrain engaging vehicle perception, learning, reasoning, navigation and physical maneuver. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase is planned lifecycle of this effort and supports additional research into methods that coordinate multiple air and ground autonomous agents for improved maneuver.			
Title: Context-Based Information Dynamics ***Description:*** This effort investigates techniques that integrate on-board and external information sources, and it applies ML analytic approaches to support automated intelligence analysis and decision making. The goal is to enable tactical agents to cooperatively share relevant and timely tactical information within a distributed environment. ***FY 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 2023 Plans:*** Will experimentally validate intelligent system methods and interfaces that can identify, characterize, and exploit data from sensors and other information assets that are built on theories and fundamental models for human decision making. Will investigate novel and emerging visualization technologies and data driven decision tools that help develop situational awareness and understanding at varying echelons to more quickly and accurately assess and integrate information across domains in Multi Domain Operations (MDO) thereby enhancing mission effectiveness by improving decision cycles. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	2.235	2.335	2.600
Title: Heterogeneous Computing and Computational Sciences	1.794	1.719	1.916

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Description: This effort funds research to develop algorithms and architectures that 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 2022 Plans:*** 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 2023 Plans:*** Will apply advanced algorithms to Army-relevant tasks on low size, weight, and power (SWaP) computing devices. Will exercise the proposed algorithm/compute combinations on heterogeneous datasets to measure performance and efficiency. Will implement scalable task scheduling mechanisms that are robust to adversarial and organic failures and can be applied in centralized, distributed, and decentralized agent environments. Will develop scheduling routines to enable flexibility and efficiency under tactical environments and constraints. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Machine Learning with Constrained Resources ***Description:*** This effort will research new ML and reinforcement learning methods to address issues of statistically mismatched and incomplete information which must be annotated, collected, classified, and used for rapid decisions by joint intelligent agent-Human teams. In addition, multi-modal human interaction approaches will be investigated to ensure effective Soldier interactions and understanding of intent. The goal of this research is 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 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	4.010	3.988	4.501

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
allow relevant portions of trained models to be transferred across environments; conduct scientific experimentation to measure 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 2023 Plans:*** Will mature algorithms for prototype platforms that allow trained models to be transferred between autonomous ground vehicles operating in different environments. Will conduct experimentation to measure the ability of automated controller tuning techniques to improve autonomous navigation and coordination techniques to be executed across small teams of platforms. Will implement techniques for network load balancing, task sharing, and computational offloading in adversarial settings for resource constrained devices at the tactical edge. Will investigate artificial intelligence-based moving target defense security functionalities for software-defined networks (SDNs) and investigate the integration with signature detection systems. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
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 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 2023 Plans:***	1.324	1.462	1.627

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will design and develop novel models and algorithms that support biologically inspired robotics capable of efficient maneuver over or through complex terrain at high operational tempos; will continue research on architectures and models that provide predictable performance appropriate for tactical multi-agent teaming. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Autonomous Mobility NGCV Challenge ***Description:*** Develop novel behaviors and algorithms for autonomous off-road mobility in tactical environments to meet capability needs of the NGCV.	3.000	-	-
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 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 2023 Plans:*** Will continue to optimize results from ongoing studies to support Combatant Commander identified needs. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	2.000	1.000	1.036
Title: Army Universities and Technical Alliances Collaboration ***Description:*** This effort funds 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	-	-
Title: FY2022 SBIR/STTR Transfer	-	0.471	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	21.425	13.732	19.906

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	36.836	35.470	22.683	-	22.683	25.216	24.584	24.729	25.450	0.000	194.968

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 novel signal image processing techniques 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 Project is performed by the United States (US) Army Futures Command.

This research 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 2021	FY 2022	FY 2023
Title: Advanced Sensors with Embedded Processing	25.177	25.334	17.997
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 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 Micro-electromechanical systems (MEMS) 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 Regional Operations Intelligence Center (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			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will validate integration of on-chip non-uniformity correction for electro-optical / infrared (EO/IR) sensor components into the Digital Readout Integrated Circuit (DROIC). Will investigate on-chip signal processing to enable vast improvements in SWAP-C and System-On-Chip (SOC) capabilities. Will investigate cooled, long wavelength infrared (LWIR) asynchronous laser pulse detection DROICs for utilization with LWIR avalanche photodiode detectors to enable covert threat and target ranging. Will mature low-power processing threat warning component approaches and fuse contextual scene information to detect incoming threats. Will validate far target location techniques and investigate optimal sensor configurations for target detectability and background reduction of cluttered scenes. Will evaluate novel sensor modalities for multi-function imaging through battlefield obscurants. Will research adaptive sensor components which can autonomously adjust imaging from visible through LWIR wavebands based on real-time conditions. Will validate sensor performance and new exploitable target signatures to better detect targets in adverse conditions. Will conduct experiments with polarized EO/IR sensors in multiple locations to validate sensor performance across environments, times-of-day/night, weather conditions, and targets. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding is decreased in FY23 due to the completion of the high sensitivity, high speed uncooled infrared research in FY22.			
Title: Multi-Mission Payload ***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 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 2023 Plans:*** Will validate performance of high resolution polarized 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	5.988	3.167	2.407

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
more advantageous UAS flight paths. Will determine approaches for exploiting scene features and target signatures to enable detection of targets in varying environmental conditions using concealment penetrating radar. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Decrease represents completion of component design and maturation efforts and movement into less expensive component validation and integration efforts.			
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 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 unmanned aircraft system (UAS) and ground vehicle mountable configurations and assess detection capability in low clutter. Will investigate stacking registered radar and EO/IR imagery to improve clutter suppression. Will develop thermal spectral imaging techniques for dimensionality reduction for significantly improved target detection. ***FY 2023 Plans:*** Will mature processing approaches utilizing multi/hyperspectral and polarized EO/IR sensors as well as position sensors to improve on-the-move target detection and tracking. Will mature image formation and processing approaches for target detection in low clutter environments using small UAS mounted compact ground and concealment radar antennas. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Decrease represents completion of component design and maturation efforts and movement into less expensive processing techniques	5.671	5.673	2.279
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:***	-	1.296	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	36.836	35.470	22.683

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BG2: *Modeling and Simulation for MUMT Technology*	-	3.273	6.718	5.591	-	5.591	5.502	4.565	4.239	4.386	0.000	34.274

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 Next Generation Combat Vehicle (NGCV) Army Modernization Priority .

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 research 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 2021	FY 2022	FY 2023
Title: Simulation Tools for Combat Vehicle Robotics (CoVeR)	3.273	6.473	3.345
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 2022 Plans: Develop M&S enabled analytical tools and adaptive learning models for predicting autonomous vehicle performance across varying meteorological conditions and terrain; and develop advanced algorithms to detect obstacles that affect maneuver corridors in unstructured environments.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will validate high-fidelity M&S tools to support development of autonomous systems operating in mission-relevant environments; will mature tagged dataset of real and synthetic images for training autonomous algorithms through M&S. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort completing in Fiscal Year 2023 with transition of technologies for demonstration to Program Element (PE) 0603462A (Next Generation Combat Vehicle Advanced Technology) / Project BG3 (Modeling and Simulation for MUMT Advanced Tech).			
Title: Autonomous Vehicle/Terrain Interactions ***Description:*** This effort develops M&S capabilities to evaluate autonomous vehicle formation performance on mission-relevant terrain and climates (i.e. soft soil, gap crossing, obstacle override, cold regions, etc.). This effort develops algorithms for improved manned/unmanned and air/ground teaming for off-road tactical behaviors. ***FY 2023 Plans:*** Will develop complex obstacle detection and mobility predictions at tactically relevant speeds (high speed in complex terrain). Will develop M&S enabled analytical tools for operational effectiveness assessments. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The increase provides for increased modeling and simulation to evaluate autonomous vehicle formation performance.	-	-	2.246
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.245	-
Accomplishments/Planned Programs Subtotals	3.273	6.718	5.591

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BG6: *Advanced Concepts for Active Defense Technology*	-	44.894	30.524	33.656	-	33.656	33.021	32.815	37.553	33.777	0.000	246.240

A. Mission Description and Budget Item Justification

This Project funds research for 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 transitions 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 Next Generation Combat Vehicle (NGCV) Army Modernization Priority .

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Computational and Experimental Capability	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 Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics.			
Title: Multi-Threat Armor Technologies	7.213	7.763	8.477

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 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 2023 Plans:*** Will conduct experiments on a kinetic energy projectile defeat technology to counter multiple threats; will continue to mature a multi-hit projectile defeat mechanism; will conduct virtual experimentation studies to provide armor performance conceptualization, improvements, optimization, and mechanistic understanding to guide experimental programs. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.			
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.	7.216	-	-
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 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	10.768	5.836	6.570

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will assess a laser-based soft kill system; will transition an optical threat warner to PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / Project BG7 (Ground Systems Active Defense (GSAD) Advanced Tech) for maturation; will mature an adaptive reactive armor mechanism to defeat Anti-Tank Guided Munitions and Rocket-Propelled Grenades; will mature a collaborative multi-platform defense mechanism. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increased to support assessment of laser-based soft kill system.			
Title: Emerging Overmatch Technologies ***Description:*** This effort designs, develops, and conduct experiments to validate the lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination against current and future threats. This research will heavily leverage other efforts within PE 0602145A (Next Generation Combat Vehicle Advanced Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology). ***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 2023 Plans:*** Will design, develop, and conduct experiments to validate technologies, coupled with autonomous behaviors, that illustrate concepts for autonomous ground combat, focused on lethality and protection; will validate cooperative protection and intelligent lethal saturation in both simulation and physical experiments using a team of at least three drones and two unmanned ground vehicles; will generate and analyze effectiveness of concepts. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.	2.220	2.183	2.424
Title: Survivability/Lethality/Vulnerability Analysis Tools and Methodology	5.224	4.976	5.482

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 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 Vehicle effectiveness performance trades. Will continue developing, refining and validation of multi-discipline analysis capabilities for Active Protection Systems in EW contested environments. ***FY 2023 Plans:*** Will mature capabilities to analyze and model the vulnerabilities of autonomous unmanned ground vehicle systems and teaming with other manned and unmanned systems; will develop methodology for assessing capabilities of active and adaptive armor mechanisms and protection systems against combined threats; will continue to mature multi-hit modeling capability in support of next generation combat vehicle protection; will mature active protection system soft kill and hard kill analysis capability for vehicle protection systems; will continue t design, develop and validate multi-discipline analysis capability and transition methodologies to computational models; will perform limited validation assessment of computational capabilities for the next generation combat vehicle smart munitions in electronic warfare congested environments. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Ground Systems Active Defense Technology Research	5.721	5.570	6.682
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 2022 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 performance. Will leverage internal modelling and simulation capability to determine path forward for protection system and enhancements. ***FY 2023 Plans:*** Will build upon prior work to down-select the most promising technology concepts for defeat of emerging threats with complex defeat mechanisms, mature designs of selected technologies into components, and conduct component-level ballistic/blast experiments to validate threat defeat performance at bench-scale. Will leverage U.S. Army Combat Capabilities Development Command (DEVCOM) Ground Vehicle System Center (GVSC) modelling and simulation capability to identify system-level integration considerations in preparation for packaging and integration. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The funding increase is due to the need to validate the performance of the technology at the bench scale. The FY23 validation testing requires additional hardware and testing over what was done in FY22 in order to achieve statistical significance in the results in accordance with the project plan.			
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 2023 Plans:*** Will perform signature characterization of experimental prototype radar candidate technologies, investigate signature management techniques, and evaluate radiated sensor signatures during live fire tests against kinetic energy threats. Will provide hard-kill active protection system impact analysis for addressing additional future armor piercing threats. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	-	3.087	3.400

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Funding change reflects planned lifecycle of this effort.			
Title: Detection Avoidance Applique Technology Research ***FY 2023 Plans:*** Will investigate multiple passive signature management technologies and conduct experiments to characterize performance in spectrums of interest for new and existing ground combat vehicles. Will leverage modeling and simulation capabilities to define experimental plan. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The funding increase is due to the increase in effort for research of detection avoidance technology.	-	-	0.621
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	1.109	-
Accomplishments/Planned Programs Subtotals	44.894	30.524	33.656

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BG8: *Obscuration Technology*	-	1.500	2.576	2.722	-	2.722	2.762	2.786	2.787	2.787	0.000	17.920

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 Next Generation Combat Vehicle (NGCV) Army Modernization Priority.

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

Research 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 2021	FY 2022	FY 2023
Title: Obscuration Enabling Technologies	1.500	2.482	2.722
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 2022 Plans:*** 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 2023 Plans:*** Will mature risk factor mitigation technologies for bi-spectral materials that show promise to replace lower performing fielded bi-spectral obscurants. Will investigate improvements to advanced microwave obscuring materials. Will collaborate with subject matter experts from universities, private industry, other Military Services, and other government agencies to develop unique approaches to fabricate a spectrally selective obscurant for ground platform use. ***FY 2022 to FY 2023 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Funding change reflects planned lifecycle of this effort.			
Title: FY2022 SBIR/STTR Transfer	-	0.094	-
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	1.500	2.576	2.722

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BH5: *Platform Electrification and Mobility Tech*	-	20.563	13.781	14.226	-	14.226	13.702	17.136	17.276	14.769	0.000	111.453

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 funds research 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 2021	FY 2022	FY 2023
Title: Scalable Electrification & Control Architecture	1.996	1.378	1.977
Description: This effort designs and 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 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 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will conduct experiments to optimize the design of the high voltage power converter enabling directed energy weapons, high voltage batteries, and fuel cells. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Increase reflects planned lifecycle of this effort, moving from early development to assembly and experimentation.			
Title: Platform Electrification Research ***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 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 2023 Plans:*** Will validate the component level performance of the electric generator, electric drive motors, and final drive components of a modular electrification architecture. Will conduct experiments to quantify cell level performance of novel battery chemistry. Will design and develop a small integrated multi-cell module for high voltage storage system. Will develop concepts for plug-in hybrid combat vehicle technology focused on advanced batteries and compact electric sprocket drive systems. Will develop concepts for high speed battlefield charging capability for hybrid and battery electric vehicles to enable charging at a comparable rate to refueling. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** This project was increased in order to investigate high speed battlefield charging that will be required for the Army to field battery dominant electrified vehicles.	11.251	7.952	10.539
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 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 2022 to FY 2023 Increase/Decrease Statement:***	3.322	1.979	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Research completed in Fiscal Year 2022 (FY22).			
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 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.	1.563	-	-
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 this Project.	2.431	-	-
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:***	-	1.969	1.710

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will mature components for JP8 reformer with metal supported solid oxide fuel cell. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Decrease reflects planned lifecycle of this effort.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.503	-
Accomplishments/Planned Programs Subtotals	20.563	13.781	14.226

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BH9: *Protection for Autonomous Systems Tech*	-	0.146	-	-	-	-	-	-	-	-	0.000	0.146

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.

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

Research in this Project 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 2021	FY 2022	FY 2023
Title: Protection for Autonomous Systems ***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.	0.146	-	-
Accomplishments/Planned Programs Subtotals	0.146	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BI2: *Sensor Protection Technology*	-	7.390	5.829	6.229	-	6.229	5.508	5.922	8.407	7.677	0.000	46.962

A. Mission Description and Budget Item Justification

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

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

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

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

Work in this Project is coordinated with Program Element (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 2021	FY 2022	FY 2023
Title: Sensor Protection Technology	3.737	5.615	6.229
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 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			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
of emerging threats. Will develop protection approaches for uncooled sensors. Will investigate agile visible filter materials to determine protection thresholds. ***FY 2023 Plans:*** Will validate out-of-band longwave infrared (LWIR) window coatings against commercially available threats and begin to investigate coating performance against ultra-short pulsed lasers. Will conduct experiments validating the protection approaches of emerging high performance uncooled LWIR camera systems. Will determine capability gaps, and design and simulate mitigation techniques. Will validate effectiveness of visible filter materials against newly identified threats. ***FY 2022 to FY 2023 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 soldiers using day-view optical sights from a variety of laser threats. This research investigates 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 investigated against high-power and ultra-short pulsed laser threats to determine protection requirements.	3.653	-	-
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.214	-
Accomplishments/Planned Programs Subtotals	7.390	5.829	6.229

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BI4: *Materials Application and Integration Tech*	-	4.378	7.648	7.722	-	7.722	7.941	7.466	7.001	6.999	0.000	49.155

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 Next Generation Combat Vehicle Army Modernization Priority.

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

Work in this Project leverages research from Program Element (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 2021	FY 2022	FY 2023
Title: Novel Armor Materials and Processes for Vehicle Protection	4.378	7.369	7.722
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 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2023 Plans:*** Will design and develop novel aluminum-magnesium alloys based on microstructurally-informed models that meet Army objectives for ballistic performance without requiring additional processing. Will conduct experiments to expand the range of thickness for which high toughness, low cost, high hard steel armor alloy is weldable for structural applications, and transition the new material for evaluation in vehicle trials and assessments. If the welded steel meets performance requirements, will investigate performance of composition-optimized oxide dispersion strengthened plates manufactured using nanocrystalline powders and transition to full-scale ballistic assessments. if strengthened plates meet performance requirements, will systematically investigate integration of shape changing molecules and dynamic bonding molecules into adhesively bonded multilayer composite structures for reducing damage under high rate impact. Will design and develop scalable chemical agent resistant coatings (CARC) that provide enhanced camouflage reflectance and chemical agent resistivity. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding reduced due to decrease in microstructural assessments of Aluminum-Magnesium alloys as part of the planned lifecycle of the effort.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.279	-
Accomplishments/Planned Programs Subtotals	4.378	7.648	7.722

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BI9: *Vehicle System Security Technology*	-	2.676	2.359	-	-	-	-	-	-	-	0.000	5.035

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 Next Generation Combat Vehicle (NGCV) Army Modernization Priority.

Work in this Project 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 2021	FY 2022	FY 2023
Title: Vehicle System Security Technology	2.676	2.273	-
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 2022 Plans: 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 2022 to FY 2023 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
This project was ended to support higher Army priorities.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.086	-
Accomplishments/Planned Programs Subtotals	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 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	5.372	5.364	5.673	-	5.673	5.765	5.818	5.816	5.814	0.000	39.622

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 Next Generation Combat Vehicle (NGCV), Soldier Lethality, and Future Vertical Lift (FVL)Army Modernization Priorities.

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

This Project 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 2021	FY 2022	FY 2023
Title: Tactical and Navigation Lasers Sensors Technology	5.372	5.168	5.673
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 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 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 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will develop approaches to decrease the pulse duration of advanced longwave infrared (LWIR) lasers through maturation of the laser configuration and non-linear crystals for use in LWIR optical parametric oscillators. Will mature LWIR laser sources combined with pulse-detecting LWIR detector arrays such as avalanche photodiodes to increase detection range and improve range resolution. Will design LWIR based three-dimensional (3-D) ranging components. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.196	-
Accomplishments/Planned Programs Subtotals	5.372	5.364	5.673

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BJ9: *Autonomous Mobility Tech*	-	2.407	3.811	-	-	-	-	-	-	-	0.000	6.218

Note

In FY (Fiscal Year) 2023, funding in this project was realigned to: PE 0603462A (Next Generation Combat Vehicle Advanced Technology) Project BK1 (Autonomous Mobility Adv Tech)

A. Mission Description and Budget Item Justification

This Project designs and develops Artificial Intelligence and Machine Learning (AI/ML) technologies to increase autonomy and mobility to perform teamed operations with manned and unmanned air and ground vehicles in a military relevant environment through data collection on relevant platforms. Data collection investigates the usage of both live and simulation-based 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.

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

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

Research in this Project is coordinated with Program Element (PE) 0603462A (Next Generation Combat Vehicles Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Formation Control ? Novel Technique Investigation	2.407	3.671	-
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 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
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 2022 to FY 2023 Increase/Decrease Statement:*** This project completes in FY22 and transfers techniques to PE 0603462A / Next Generation Combat Vehicle Advanced Technology Project BK1: Autonomous Mobility Adv Tech to continue work in FY23			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.140	-
Accomplishments/Planned Programs Subtotals	2.407	3.811	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BK2: *Virtual Prototyping Technology*	-	5.191	8.169	9.622	-	9.622	9.866	9.878	10.579	10.577	0.000	63.882

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 modeling, simulation, and virtual experimentation to provide engineering data and operational feedback to inform NGCV analysis and requirements. This Project 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 (VEs) and System Integration Labs (SILs) provide an efficient means to give warfighters an up-front, virtual hands-on operational evaluation of next generation ground vehicle concepts, capabilities, 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.

Research in this Project supports the NGCV Army Modernization Priority.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Virtual Prototyping	5.191	7.871	9.622
Description: This effort utilizes virtual prototyping to address 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 that will inform designs and reduce development and testing time.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will use modeling and simulation to virtually design, develop, and assess new 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 2023 Plans:*** Will continue modeling and simulation to virtually design, develop, and assess new NGCV manned and unmanned systems that include projected lethality, mobility, sensing, and protection technologies. Will analyze these technologies integrated into multiple tank and Robotic Combat Vehicle (RCV) design approaches using multiple methods that include trade analysis tools that provide tradespace exploration, understanding, and traceability of NGCV requirements. Will continue to use knowledge and analyses to provide focus and targets for science and technology investments as well as inform NGCV acquisition planning and requirements development. Virtual Prototyping will also implement a public private partnership with industry to generate and advance tank 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 virtual experiments and develop System Integration Labs to assess the government and industry concepts for Military Utility, mission performance, Soldier preference, and explore Soldier derived tank TTPs for the new technologies and capabilities. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Increase in funding to investigate and develop experiments utilizing Soldier-in-the-loop and Hardware/Software-in-the-loop modeling and simulation technology. This effort will significantly reduce time/cost required by traditional physical demonstration programs and accelerating knowledge of emerging technologies.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.298	-
Accomplishments/Planned Programs Subtotals	5.191	8.169	9.622

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	16.676	0.962	-	-	-	-	-	-	-	0.000	17.638

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.

Research in this Project supports the NGCV Army Modernization Priority.

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

Research 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 2021	FY 2022	FY 2023
Title: Next Generation Intelligent Fire Control Technology ***Description:*** This effort investigates image sets for computer vision algorithms, target acquisition validation schemes and experimentation of large caliber armament systems. ***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 2022 to FY 2023 Increase/Decrease Statement:*** This effort completes in FY22 with transfer of technology to PE 0603462 Project BK4 Next Gen Intelligent Fire Control (NG- IFC) Adv Tech.	4.043	0.926	-
Title: FIRESTORM Applied Research ***Description:*** Designs networked lethality role-based architecture to support automated decision aids and target handoff capability for combined arms operations. Designs a hybrid distributed architecture that will ingest real-time, prioritized data for decision agents to support scalable operations with reduced processing time.	12.633	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: FY2022 SBIR/STTR Transfer	-	0.036	-
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	16.676	0.962	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army										Date: April 2022		
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 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	3.814	9.180	13.526	-	13.526	12.299	8.841	4.276	4.275	0.000	56.211

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.

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

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

Research 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 2021**	**FY 2022**	**FY 2023**
Title: Advanced Lethality ? Kinetic Energy (AL-KE)	1.432	1.390	1.671
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.			
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 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022	FY 2023
Will Investigate direct fire kinetic energy cartridge technologies and novel kinetic energy lethal mechanisms to defeat future threat(s). Will conduct experiments to improve accuracy and decrease engagement time at extended ranges; will mature sensor fusion, real time processing, and penetrator diversion techniques. ***FY 2022 to FY 2023 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 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 2023 Plans:*** Will investigate improvements in threat armor technology designed to protect against US systems. Will investigate attributes of promising penetrator concepts and identify suitable projectile technology to enable decisive lethality. Will refine attributes of high energy armaments and explore integration challenges. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding change reflects increase in research of projectile technologies.	2.382	2.974	3.461
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. ***FY 2022 Plans:***	-	4.481	8.394

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
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 2023 Plans:*** Will design and develop large caliber system and component technologies to increase direct fire lethal overmatch capabilities for current and future combat platforms. Will investigate system modeling and simulation techniques for assessing complex armament system component technologies including: fire control, weapon, and munition technologies. Will develop concepts to inform Army large caliber lethality. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The program funding increase is part of the projected lifecycle for this effort to inform large caliber options for a range of Army platforms.			
Title: FY2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.335	-
Accomplishments/Planned Programs Subtotals	3.814	9.180	13.526

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
BP5: *Ground Vehicle Technology (CA)*	-	43.000	73.800	-	-	-	-	-	-	-	0.000	116.800

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 2021	FY 2022
Congressional Add: Program Increase - Modeling and Simulation ***FY 2021 Accomplishments:*** Conducted applied research in Modeling and Simulation. Work executed by Army Futures Command.	10.000	-
Congressional Add: Program Increase - Silicon Carbide Electronics ***FY 2021 Accomplishments:*** Conducted applied research in Silicon Carbide Electronics. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Silicon Carbide Electronics	6.000	5.500
Congressional Add: Program Increase - Highly Electrified Vehicles ***FY 2021 Accomplishments:*** Conducted applied research in Highly Electrified Vehicles. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Highly Electrified Vehicles	5.000	5.000
Congressional Add: Program Increase - Additive Metals Manufacturing ***FY 2021 Accomplishments:*** Conducted applied research in Additive Metals Manufacturing. Work executed by Army Futures Command.	10.000	-
Congressional Add: Program Increase - Prototyping Energy Smart Autonomous Ground Systems	12.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
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 2021	FY 2022
FY 2021 Accomplishments: Conducted applied research in Prototyping Energy Smart Autonomous Ground Systems. Work executed by Army Futures Command. ***FY 2022 Plans:*** Congressional Interest Item funding provided for Prototyping Energy Smart Autonomous Ground Systems		
Congressional Add: Advanced Materials Development for Survivability ***FY 2022 Plans:*** Congressional Interest Item funding provided for Advanced Materials Development for Survivability	-	5.000
Congressional Add: Advanced Optics Program ***FY 2022 Plans:*** Congressional Interest Item funding provided for Advanced Optics Program	-	4.300
Congressional Add: Digital Design and Simulated Testing ***FY 2022 Plans:*** Congressional Interest Item funding provided for Digital Design and Simulated Testing	-	4.000
Congressional Add: Fast-Refueling Fuel Cell Engines ***FY 2022 Plans:*** Congressional Interest Item funding provided for Fast-Refueling Fuel Cell Engines	-	7.000
Congressional Add: Hydrogen Technologies ***FY 2022 Plans:*** Congressional Interest Item funding provided for Hydrogen Technologies	-	10.000
Congressional Add: Machine Learning Optimized Power Electronics ***FY 2022 Plans:*** Congressional Interest Item funding provided for Machine Learning Optimized Power Electronics	-	3.000
Congressional Add: Systems Engineering for Autonomous Ground Vehicles ***FY 2022 Plans:*** Congressional Interest Item funding provided for Systems Engineering for Autonomous Ground Vehicles	-	9.000
Congressional Add: Vehicle Equivalency Framework Utilizing Multiple Additive Manufacturing Platforms ***FY 2022 Plans:*** Congressional Interest Item funding provided for Vehicle Equivalency Framework Utilizing Multiple Additive Manufacturing Platforms	-	5.000
Congressional Add: Virtual Experimentation of Autonomous and Non-Autonomous Combat Vehicles	-	3.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
FY 2022 Plans: Congressional Interest Item funding provided for Virtual Experimentation of Autonomous and Non-Autonomous Combat Vehicles		
Congressional Add: Zero Emission Combat Vehicles	-	3.000
FY 2022 Plans: Congressional Interest Item funding provided for Zero Emission Combat Vehicles		
Congressional Adds Subtotals	43.000	73.800

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / *Next Generation Combat Vehicle Technology*	Project (Number/Name) CU5 / *Platform Agnostic Armaments Applied Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
CU5: *Platform Agnostic Armaments Applied Technology*	-	-	-	1.031	-	1.031	3.430	2.078	-	-	0.000	6.539

Note

This is a new start in FY 2023.

A. Mission Description and Budget Item Justification

This Project investigates technologies that holistically maximize armament performance, minimize target engagement timelines, reduce crew workloads, enhance responsiveness and enable collaborative lethal effectiveness on target across distributed platforms & missions. This project researches cross caliber weapon, munition & fire-control technologies to enhance Remote Weapon Systems (RWS) responsiveness and single or combined platform lethality in Multi-Domain Operations (MDO) environments.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Platform Agnostic Armaments Technology	-	-	1.031
Description: This effort designs and develops technologies that enables platform performance by increasing range without degrading accuracy, reducing size, weight, and power and impact to lighter platforms, enhancing weapon, munitions, fire control, & agnostic remote weapon automation tech to reduce the kill chain timeline. This effort enables Army Modernization and Multi-Domain Operations (MDOs) in support of the Army?s future and planned vehicles. ***FY 2023 Plans:*** Will investigate critical enabling technologies to increase range, accuracy, and lethal effectiveness for distributed remote armament systems; determine methods to reduce engagement time while decreasing size, weight, and power usage, as well as increasing performance and safety of remote weapon systems. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** In Fiscal Year (FY) 2023, this project is a new start.			
Accomplishments/Planned Programs Subtotals	-	-	1.031

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** CU5 / *Platform Agnostic Armaments Applied Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A